ISSN: 2320-5407 Int. J. Adv. Res. 13(02), 1203-1213

Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/20482
DOI URL: http://dx.doi.org/10.21474/IJAR01/20482

RESEARCH ARTICLE

BUTTERFLIES AND THEIR CONTRIBUTION IN AGRO-FORESTRY

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Manuscript Info

Manuscript History
Received: 23 December 2024
Final Accepted: 25 January 2025
Published: February 2025

Key words:-
Butterflies, Agro-Forestry, Ecological Indicators, Pollinators, Butterfly Garden, Conservation

Abstract

Butterflies are essential to the agro-forestry ecosystem, and their lives are intertwined with those of plants due to their co-evolution. Agroforestry contributes significantly to sustainable development, biodiversity maintenance, and food security. In fragmented agricultural landscapes, agroforestry activities may offer a habitat for forest butterflies and aid in their protection. Butterflies are the ecosystem's natural indicators as well as great pollinators. Some butterfly species travel great distances and transport pollen to plants located distantly from one another. Pollen migration causes genetic variation in plant species, improving their chances of surviving certain biotic and abiotic stresses. These insects also work as biological pest management tools and act as food for other creatures including birds, reptiles, and amphibians. However, because of the non-availability of suitable host plants, indiscriminate pesticide use, and a lack of knowledge about the value of these flying gems, the population of these insects is declining quickly. Agroforestry ecosystems provide suitable habitat for butterfly conservation; in turn, agroforestry cultivation can be greatly benefitted from beneficial insects such as butterflies in multifaceted ways, including pollination benefits, aesthetic value, and attraction spots as butterfly parks. Therefore, in this review we have attempted to discuss comprehensive role of butterflies in agroforestry system.

Introduction:-

Agroforestry is a land management practice that combines agriculture and forestry by integrating trees and shrubs into cropping and animal farming systems. It provides multitude of benefits such as increased economic gains, improved soil health, environmental benefits, recycling of the components and cutting down the production costs, etc. Agroforestry system can be benefitted from insect pollinators. In turn, agroforestry ecosystems are the most suitable systems for multiplication or butterfly conservation activities.

Butterfly belongs to one of the most specious insect groups that come in a variety of colours and sizes. There are 19,000 species of butterflies worldwide, which belong to the phylum arthropod (Ponder and Lunney, 1999). Majority of the species are found in tropical areas (approximately 80 percent of known species). Adult butterflies need liquid-based nourishment (Larson et al., 2001). Their ability to survive depends on the nectar that flowers generate as well as overripe fruits. The butterflies are the crucial component of ecosystems and provide numerous

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ecosystem services, where they serve as a pollinator, acts as a food source, and act as an indicators of the health of the ecosystem, play role in ecosystem restoration as well as offer some direct benefits to humans(Tiple et al., 2005).A significant part of pollination in the flowers that open throughout the day is done by butterflies. After bees and wasps, butterflies pollinate more than 20,000 types of both wild and cultivated plants(Corlett, 2004). Butterflies often prefer large, vibrant blooms with a platform for landing, and while they sip nectar from a flower, they collect pollen on their long, thin legs (Stökl et al., 2011). Numerous butterfly species can travel up to 3,000 miles at a time. Long-distance pollination is made possible by these journeys, which have also raised public interest in the species.

Butterflies are not only a beautiful addition to a flower garden, but they are also an important element of it because they are a good indicator of ecosystem health and provide practically all of the information about ecosystem balance. Aside from being a fascinating component of biodiversity, butterflies serve as indicators of environmental health and change (Fleishman and Murphy, 2009). Butterfly population increase often indicates a healthy ecosystem (Shi et al., 2009).It is well known that many plant and animal species co-occupy an ecological niche in any given ecosystem and prefersimilar combinations of terrain, soil, geography,and climate. This also holds true for butterflies, as some kinds of plants are necessary for the existence of butterfly species (Ghazanfar et al., 2016).Butterflies have specific habitat requirements. A fascinating aspect of studying localized butterflies is determining what microhabitats they require (Swengel, 2003). It in turn provides information on management of local habitat, flora and fauna. Moreover, these insects are excellent model organisms for biologicalandenvironmental research. For example, numerous biological phenomena, including mimicry, development, genetics, evolution, population dynamics, and conservation, are studied using butterflies (Wang et al.,2020).

Furthermore, butterflies are important ecological players in agricultural environments. In addition to pollination, they also contribute to important ecological processes including recycling nutrients (N, P, and K) that crops require and that were previously taken through plant absorption and uptake (Schmidt and Roland, 2006). Their larval stages release faeces, that are rather nutrient-rich, after feeding on the leaves of various wild plants that are present in agricultural fields and its surroundings (Marchiori and Romanowski, 2006). However, a thorough understanding of Lepidoptera foraging behaviour as well as their spatio-temporal distribution in agricultural environments is essential to the preservation, conservation, and use of this pollinator diversity. Agroforestry ecosystems can support the butterfly community's richness and functional diversity (Kuefler, 2008). Additionally, butterflies can bring direct economic benefits. Butterfly ecotourism draws a large number of tourists from across the globe every year, generating substantial income for local communities(Lemelin, 2019).

Thus, butterflies are vital to the productivity of natural and agricultural landscapes because as they provide a range of ecological benefits to native plant species and crops in diverse environments worldwide and bring economic and aesthetic benefits, which are explained in detail in the subsequent sections.

Ecosystem services of Butterflies

Butterflies as pollinating animals in the agroforestry ecosystem

Pollination is a vital part of plant reproduction that allows for the transfer of genetic material and the production of seeds. Pollen is a powdery substance produced by the anthers or the male parts inthe flower, and the female part in the flower is called the pistil, which consists of stigma, style, and ovary. The movement of pollen from the male portion to the female portionof a flower initiates conversion of female portion ovary into the fruit while the ovule turns into a seed. Pollen can be transferred by pollinating agents such as animals, water, wind, or even plants themselves. Pollinating animals, like bees, butterflies, and birds, carry pollen from plant to plant on their bodies. The various parts of flower for example petals and nectar produced by flowers attracts pollinating animals including butterflies. The flower petals are typically the most visible sections which draw in pollinating insects and act as landing pads. Nectar is a very nutritious liquid that includes lipids, carbohydrates, amino acids, vitamins, and other organic components and serves as essential food source for pollinators (Webb, 2008). Pollen from the flowers sticks to the small scales on the bodies of butterflies, who visit flowers to feed on nectar. Upon visiting another flower, the butterfly deposits pollen that adheres to its scales and brushes against the stigma of the flower. Pollen grain can be transferred by pollinators to far-distant areas (Pollinator.org).Further, the nectar feeding innovation plays a role in the reproductive and population biology of pollinating insects. Various aspects of the life history and reproductive biology of pollen-collecting butterflies are consistent with the hypothesis that the nutrients provided by pollens are of major importance to adult maintenance and reproductive activity (Gilbert, 1972).

Agroforestry system involves cultivating different crops and tress and many of them depends on cross pollination to produce economical yields. Butterflies and other invertebrates play a crucial role in the successful pollination of both wild and cultivated plants(Buchmann and Nabhan 1996). Butterflies from different families are found pollinating woody species such as *Ixora*, *Clerodendron* and *Bauhinia*(Momose,1998).The Nymphalidae butterfly family has been linked to the pollination of *Syzygium* species. In open areas, butterflies, including Hesperiidae, are prominent visitors to a variety of herbaceous plants (Corlett, 2004). The reproductive success of *Phlox pilosa*and*P. glaberrima* depends on multiple butterfly species, including *Colias*, *Pieris*, *Danaus*, and*Polites*(Reddi and Bai, 1984).*Anguria* is pollinated by the Heliconius butterfly. *Cadabafruiticosa* is pollinated by *Colotis eucharis*, *C. danae,*and*Anaphaeisaurota*(Reddi and Bai, 1984).Butterfly species, including other insect orders, are the majority pollinators of vegetable crops such as lettuce. So, insect pollinators are considered one of the cheapest and eco-friendliest approaches to maximizing the yield of cross-pollinated crops (Negi et al., 2020).List of pollinating butterfly species in different cropping elements of agroforestry system such as vegetables, trees, medicinal plants, flowers plants are provided in the table 1 and 2.

Table 1:- Vegetable/Fruit/medicinal plants dependent upon butterfly pollinators.

Sr. No.	Butterfly Species	Crop
1.	Multiple species	Lettuce (*Lactuca sativa*) (Negi et al., 2020)
2.	Helconius genus	Anguria (*Cucumis anguria*) (Reddi and Bai, 1984)
3.	Nymphalidae Species	*Syzygium*genus (Appanah, 1990)
4.	Plain Orange-tip (*Colotis eucharis*), crimson tip (*Colotisdanae*), Pioneer white (*Anaphaeisaurota*)	Indian Cadaba (*Cadaba fruiticosa*) (Reddi and Bai, 1984)
5.	Gray hairstreak (*Strymon melinus*) and the little yellow (*Euremalisa*)	Cotton (*Gossypium arboretum*) (Stokstad, 2021)
6.	Dingy skipper (*Erynnistages*), grizzled skipper (*Pyrgusmalvae*)	Salad burnet (*Sanguisorba minor*) (Askham and Hendry)

Table 2:- Flower crops dependent upon butterfly pollinators.

Sr. No.	Butterfly Species	Crop
1.	*Troidesbrookiana* (Papilionidae)	*Bauhinia* genus (Leguminosae) (Momose,1998).
2.	Multiple species	*Ixora* genus (Momose,1998).
3.	*Colias*,*Pieris*, *Danaus*	*Phlox* genus (Reddi and Bai, 1984)
4.	Common blue (*Polyommatus icarus*), Common emigrant (*Catopsilia Pomona*), Large Cabbage White (*Pieris brassicae*), Pea Blue (*Lampidesboeticus*), Plain tiger(*Danaus chrysippus*)	Coriander (*Coriandrum sativum*) (Shivashankara et al., 2016)
5.	Black swallowtail (*Papilio polyxenes*)	Dill (*Anethum graveolens*) (Eisenstein)
6.	Multiple Species	Carrot (*Daucus carota subsp. sativus*) (Cerruti et al.)

Role of butterflies in induction of genetic variation in plants and co-evolution of flowering plants and butterflies

Insects are the primary pollen carriers for many flowering plants, particularly in tropical and subtropical areas (Liu et al., 2015).Several reports have supported “pollinator-driven ecological speciation model”, where ecological shifts in pollination systems drive the evolution and species diversity of the plants. For example, as per studies of Valente et al. (2012) in the in southern African Gladiolus, recent pollinators like butterflies and moths, etc. are associated with increased diversification rates as compared to ancestral pollinators like increased tongue bees. Some butterfly species migrate over great distances, transferring pollen from one distant plant species to another. These mechanisms cause genetic variation in the plants as well as aids in the plant's ability to withstand disease and increases their chances of surviving (Kearney, 2015). The conservation of these rare endemics depends on the dynamics of community-level interactions, such as the mutualistic relationships between plants and pollinators(Jabis et al., 2011). Pollinators play a vital role in maintaining the long-term adaptive capacity of rare, endemic plant species as plants with an allogamous mating system and self-incompatibility rely on insects for both seed production and the preservation of genetic diversity(Kalpana et al., 2024). Butterflies from three families i.e. Hesperiidae (skippers), Papilionidae (swallowtails), Nymphalidae (brush-footed butterflies), were observed displaying potentially "effective" pollinator behaviorin *Abronia alpina*, a rare alpine endemic of the California Floristic Province. Thirteen species in the Nyctaginaceae have been documented to be sphingophilous, pollinated by hawk moths and nocturnal butterflies (Jabis et al., 2011). Butterflies and large moths are expected to travel between plants and between subpopulations more than other insect pollinators, affecting long-distance pollen dispersal (Jabis et al., 2011 and Skogen et al., 2019).

There are several reports from different parts of the world which have proved co-evolution of butterflies and plants. These findings can be extrapolated to agroforestry systems. For example, Asthon et al., (Asthon, 1988) studied the phenology of plant reproduction and evolution in mast-fruiting dipterocarps from West Malaysia and reported co-evolution between plants and pollinators. Ehrlich gave evidence that butterflies depend on nectar of flowers so they co-evolved corresponding to flowers of a plants (Ehrlich, 1984).The seminal work, by Ehrlich and Raven popularized coevolution, that combined chemical ecology, adaptive evolution, and macroevolutionary theories based on the intricate natural histories of flowering plants and butterflies popularized coevolution (Ehrlich and Raven, 1964). Feeny (1975) and Gilbert (1972) explained about biological process co-evolution that where two or more species affect each other's evolution through natural selection. The theory of plant-insect coevolution suggests that plants develop broad-spectrum chemical defenses, and some insects coevolve by detoxifying and using these compounds. Herbivores evolutionarily exhibit ability to escape host defences, after which plants that have developed relative chemical protection from herbivores undergo adaptive changes.Nahrstedt(1981)and Cavin (1988) demonstrated the coevolution of Passiflora plant against Heliconius butterfly species. Passiflora is specialised host plant for Heliconius larvae, and Passiflora has acquired strong chemical and morphological defences against Heliconius herbivory, including cyanogenic glycosides. Thus, several species of Heliconius developed the capacity to withstand or store elevated concentrations of these poisons. There is a remarkable closeness between the vegetation cover, composition, and butterfly's species (Keren et al., 2022). Fordyce (2010) experimentally proved that the host plant association plays profound role in the evolutionary history of butterflies. Comprehensive research on the evolution of pollinators and host components in agroforestry systems can be conducted to better understand host compatibility and incompatibility mechanisms with butterflies. This knowledge is useful for both butterfly conservation and crop protection.

Butterfly species composition and population level as ecological indicator of a healthier ecosystem

Currently, biodiversity assessment is a crucial instrument in determining how the environment and habitat are changing. The primary causes of changes in a habitat's biodiversity are human activity and environmental deterioration. As one of the planet's most diverse organisms, insects may be a key factor in determining the richness of the terrestrial ecosystem. According to research on biodiversity, butterflies are regarded as the "flagship of taxa" among insects. In 1988, Landres and in 1998, Simberlof proved that indicator species use variations in their own abundance to signal changes in the physical and chemical composition of the environment or the abundance of other species. These are referred to as ecological indicators, and their primary objective is to quantify the intricate system without overlooking other details.

Due to their fragility butterfly acts as indicators as they are quick to react to change so their struggle to survive is a serious warning about our environment. Habitats have been destroyed on a massive scale, and now patterns of climate and weather are shifting unpredictably in response to pollution of the atmosphere. However, the disappearance of these beautiful creatures is more serious than just a loss of colour in the countryside. As a significant herbivore in terrestrial ecosystems, butterflies rely on plants or other food sources during two life stages: as larvae, they chew on plants, and as adults, they eat on nectar. Butterfly diversity can be used as a proxy for the health of terrestrial ecosystems because of the close interaction between plants and insects in terms of functional diversity (Nelson, 2007). Furthermore, mature butterflies require a wide variety of additional materials for their survival and reproduction, such as water, pollen, mud, damp sand, carcasses, and animal excrement (Hardy et al., 2007). which are available in agricultural and agroforestry ecosystems. The butterfly diversity can act as indicator of condition of riparian habitat also, as the diversity of butterfly species in riparian zones is influenced by the connection between the area and a river. Since plants found in wetland environments play a crucial role as larval food sources and provide nectar for adult insects.

Several butterflies have specific host plants as larvae and are therefore vulnerable to any alterations that impact those plants (Ward, 2001). Butterfly communities are very responsive to alterations in the forest environment also, as they are highly affected by shifts in habitat disturbance or quality (Collinge, 2003). Additionally, butterflies are easily observed and their species are more well-known than many other insect groups, making them valuable subjects for studying ecological disturbance indicators. Their small size, small reproductive cycle, and positioning at lower levels in the food chain, enable them to adapt rapidly to environmental challenges. Therefore, in many regions of the world, Lepidoptera are widely accepted as ecological indicators of ecosystem health (Oostermeijer and Swaay, 1998) and meet a number of the criteria set forth by Hilty and Merenlender (2000). The taxonomy of butterflies is well understood, with a well-defined life history and biology. Several of their physical tolerances, like light, temperature, and the conditions in which they live, have been measured (Pollard et al., 1998). Demonstrations have been made regarding associations with changes in ecosystem conditions (Swengel, 1998). All these studies highlight the use of butterflies as indicators of ecosystem health and suggest that they can also be employed to monitor changes in agroforestry systems, reflecting biodiversity and other key ecosystem health parameters.

Butterfly as integral part of food chain: Providers and Predators

Butterflies play a significant role in the food chain. Different developmental stages of butterflies serve as food source for other organisms. Birds and other predators feed on butterflies and also, they serve as hosts to numerous parasitoids that help control crop pests. Numerous birds will consume monarch butterflies if they are readily accessible (Petersen, 1964). Monarchs grouped in large numbers can provide ample food and are easy targets for predators (Journeynorth.org). They provide food for mice, lizards, spiders, and other creatures (Goodliving.org, Halaliet al., 2019). A decline in butterfly populations could affect the entire ecosystem. According to studies of Stephen Dickie, birds organize their entire breeding season around the time when caterpillars will be most plentiful. Particularly in agricultural and agroforestry systems, when combined with poultry, butterflies and their caterpillars can serve as food for growing chicks. Additionally, caterpillars act as preferred hosts for egg-laying and reproduction of certain parasitic flies and wasps (carbon-based-ghg.blogspot.com).

Majority of the caterpillars are plant eaters, but a few are carnivorous.The carnivorouscaterpillars of the Harvester butterfly (*Fenisecatarquinius*) feed on woolly aphids. The female butterfly lays her eggs in the centre of aphid colonies, making the caterpillars useful for biological pest control(Opler and Krizek, 1984). Some butterfly larvae feed on harmful insects, and a few even prey on ants. Certain carnivorous butterflies consume other insects, such as mites, during their larval stage. It is estimated that less than 1% of Lepidoptera species are carnivorous, and only a few of them are obligate carnivores, as some will eat other insects only when plant food is scarce (speciesconnect.com). Caterpillar of butterfly*Electrostrymon denarius* are known to feed on mushroom (Nishida and Robbins, 2020).

Understanding the role of various developmental stages of butterflies in the food chain is crucial for designing agroforestry systems that prevent potential losses from herbivores while also leveraging butterflies to maintain a healthy food chain, thereby healthy cropping ecosystem.

Aesthetic value of butterfly and butterfly parks as education and research labs.

Butterflies hold significant aesthetic value, captivating people with their vibrant colors and graceful movements. The bright colors also help in preventing some potential predators by suggesting bad taste or poison (Manning, 2014). Butterflies are known for exhibiting mimicry behavior in different developmental stages and it is a mechanism to survive also. Caterpillar stage of different species show different character, forms and colors, which can simply resemble a plant twig, leaf or to fungus-infected late season old oak leaf. Moreover, metamorphosis of butterfly is a fascinating phenomenon where a stunning butterfly fully develops from a chrysalis spun by a crawling caterpillar (Kumar, 2013).

Thus, butterflies provide several ecological services which can be exploited for the benefit of agroforestry systems and in turn these systems can be utilized for butterfly conservation. The mutual role of butterflies and agroforestry is represented in the figure 1.

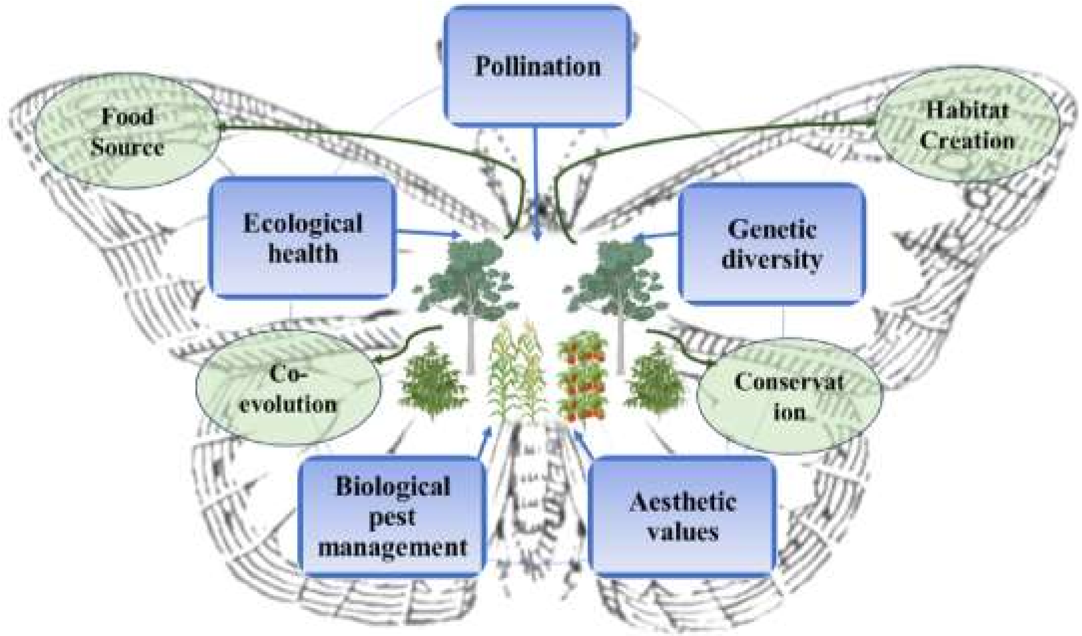

Figure 1:- Mutual role of butterflies and agroforestry ecosystems.

Butterflies benefit agroecosystem via pollination, contribute to genetic diversity, maintain ecological health, pest management and add aesthetic values to the system (Represented in blue shaded boxes and blue arrows indicate butterfly to agroforestry system). Agroforestry supports butterflies by providing suitable habitat, food source, promote co-evolution and their conservation (Represented in green shaded boxes and green arrows indicate agroforestry system to butterfly).

Considering their exquisite aesthetic values, there are ample opportunities to convert a butterfly conservation area into butterfly parks and butterfly conservatories. Both urban and wild habitat conservation, as well as the conservation breeding of threatened and endangered species, benefit greatly from butterfly conservatories. Butterfly parks/gardens serve as beautiful and tranquil environments, providing a space for visitors to appreciate these creatures up close. Additionally, these parks function as valuable educational and research labs, offering opportunities to study butterfly behavior, life cycles, and ecosystems. They promote awareness about conservation and biodiversity while encouraging scientific exploration, making them important centers for both learning and research.There are numerous such parks/gardens in Indian states like Karnataka, Tamil Nadu, Gujarat, Kerala, Uttar Pradesh, Delhi, and Haryana. By educating people about butterfly conservation and motivating them to plant host and nectar plants, butterfly gardens can play a significant role. Common nectar plants include sunflowers, marigolds, *petunias*, and *cosmos*, *hibiscus*, while curry leaves, *calotropis*, *tamarind*, cotton trees, *acacia*, *cassia*, and numerous *citrus* plants act as host plants for Indian butterflies.List of Important butterfly parks/gardens alongwith species diversity of each, in different location and agroclimatic zone are provided in the table 3.

Table 3: -Important Butterfly Gardens across India.

Sr. No.	**Name of Garden**	**Location**	**Agroclimatic Zone of the location**	**No. of species**	**Important Butterfly species**
1.	Butterfly Park in Bannerghatta Biological Park	Bannerghatta National Park, Banglore, Karnataka	Eastern Dry Zone	77	Spot Swordtail, Syrian Babul Blue, Narrow Banded Blue Bottle (Remadeviet al.,)
2.	Ovalekar Wadi Butterfly Garden	Thane, Maharashtra	North Konkan Coastal Zone	172	Transparent 6-Lineblue, Large Oakblue, Vindhyan Bob, Bevan's Swift (Kasambe, 2012)
3.	Butterfly Park (Asola Bhatti	Shooting Range Road,	Agro-ecological Subregion 4.1	56	African Babul Blue, Indian Red Flash, Banded Awl

	Wildlife Sanctuary)	Tughlakabad, Delhi			(abwls.eforest.delhi.gov.in)
4.	Tropical Butterfly Conservatory	Srirangam Taluk Road, Melur, Tamil Nadu.	Cauvery Delta Agroclimatic zone	113	Anomalous Nawab, Joker, Tamil Bush-Brown (Santhosini, 2022)
5.	Butterfly Conservatory of Goa	Ponda, South Goa, Goa	West Coast Plains and Ghat Region	144	Malabar banded peacock, southern birdwing, Tamil Lacewing, blue oakleaf, clipper and Plum Judy (gomantaktimes.com)
6.	Butterfly Park Chandigarh	Chandigarh College of Engineering and Technology, Sector 26, Chandigarh.	Trans-Gangetic Plains Region	35	Commander, Tawny Coster, Common Onyx, Common Palmfly Angled Sunbeam (www.coveringindia.com)
7.	Butterfly Park at Lucknow Zoo	Nawab Wazid Ali Shah Zoological Garden, Hazratganj, Lucknow	Central Plain Zone	62	Commander, Spot swordtail, Indian Sunbeam (Sharma et al., 2021)
8.	Thousand shades Butterfly Park, Gurgaon	Sector 52A, Gurugram, Haryana	Northern Plain and Central Highlands.	27	Mottled Emigrant, Great Eggfly, Peacock Pansy (cityflowers.co.in)
9.	Butterfly Garden, Narmada	Kevadiya, Narmada, Gujarat	Gujarat Plains and Hills agro-climatic zone	70	Common Crow, Glassy Tiger, Chocolate Pansy, Peacock Pansy, Common Rose (gujarattourism.com)
10.	Sammilan Shetty's Butterfly Park, Belvai	Beluvai, Karnataka	Northern Transitional Zone (KA-8)	100	Crimson rose, Blue Nawab (Kalleshwaraswamy, 2020)

Potential threats to butterflies and conservation of pollinator butterflies

Although it is well established that insects are essential to the health of ecosystems, insect biodiversity is under threat everywhere. Lepidopteran numbers have drastically decreased, which could result in the loss of forty percent of species in the coming decades (Sánchez-Bayo and Wyckhuys 2019). Minor changes in their habitat may lead to either migration or local extinction if the required attention is not given (Kunte, 1997) because many species require specific plants as food or sites for reproduction (Bernays, 1988). The degradation of insect habitat is the main danger that humans present to the survival of insects, especially populations of butterflies (New et al., 1995). Anthropogenic changes are affecting butterflies through the loss of plant species that butterflies depend on and direct habitat loss due to the world's population growing at an accelerated rate (Hoyle and James, 2005). Moreover, butterflies are particularly sensitive to environmental changes (Stefanescu et al., 2011), including the fast rise of industries, intense use of fertilizers and insecticides, climate change, nitrogen pollution, mono-cropping, forest fires, fragmentation, and habitat degradation, all of which make them vulnerable to extinction.

As butterflies are known to be flagship species for insect conservation (Tiple et al., 2005) any research aimed at conserving butterfly species will automatically save many other species in the area. To protect this flagship group from further population, decline and possible species extinction, studies investigating their diversity, habitat suitability and nectar plant selection are needed. The study of the relationship between butterflies and host plants has a significant impact on the conservation of not only butterfly species, but also the host plants on which they depend, as well as the plants that depend on these butterflies for pollination. Such information is necessary to develop effective conservation programs. Since there is a positive correlation between the diversity of vegetation conditions and butterfly diversity (Thomas, 1995) protecting and cultivating host plant species can help improve the conservation of butterflies in their respective ecosystems (Swarnaliet al., 2019). Similarly, diverse host plants, including cultivated species provide rich sources of nectar for butterflies (Ramesh et al., 2010).

Biodiversity decline will have direct and indirect effects on ecosystem functions and services that are poorly quantified. Over the past decade, farmers in the Himalayan region have been complaining about the decline in apple production and quality due to pollination related problems. The general observation of farmers is that, in the past, there used to be a lot of insects such as wild bees, butterflies and moths during the apple flowering season but now they have all disappeared (Uma Partap and Tej Partap, 2001). To protect and maintain the diversity of butterfly species, it is necessary to protect not only their primary habitats, but also the surrounding semi-natural environment, which often consists mainly of plants and shrubs (Shrestha et al., 2020). Thus, both forests and seminatural habitats with help of local stakeholders should be protected. Ecosystem restoration helps quickly restore insect communities that have typically declined over time (Nyafwonoet al., 2014).

Raising awareness about the importance of butterflies and other insects is essential. Proper recommendations must be generated for conservation of beneficial butterflies. Never capture a butterfly—let them fly freely. We should appreciate their beauty and inspire others to do the same. Schools should incorporate education on ecosystem and species conservation to instill a sense of responsibility from an early age. Supporting these insects' survival can be achieved by promoting organic farming, reducing the use of chemical pesticides and herbicides, adopting sustainable landscaping, and planting milkweed and other nectar-rich plants in gardens. Butterflies and other pollinators play a crucial role in maintaining ecosystems, and in turn, we depend on them for their invaluable contributions. Pollination is vital for food production and human well-being, linking wild ecosystems—where many animals find food and shelter—with agricultural systems. Without pollinators, numerous interconnected species and ecological processes would collapse (Das et al., 2018).

In agroforestry systems, chemical free farming activities must be encouraged in order to protect beneficial pollinators. Diversifying crops can further support butterfly conservation by ensuring a continuous food supply. Establishing butterfly parks alongside agroforestry can not only generate additional income for farmers but also spread awareness about the importance of butterfly conservation.

Conclusion:-

In agroforestry systems, butterflies play a vital role as pollinators and prey to important predator groups, contribute to improved crop production, pest control, genetic diversity, and improve the aesthetics of the environment. However, human activities and climate change are threatening their habitats, leading to a rapid decline in their populations. To counter this, greater emphasis must be placed on habitat conservation, sustainable land management, and the reduction of harmful pesticides. Protecting butterflies and other pollinators is crucial for maintaining food production, ecosystem balance, and economic stability. Ensuring their survival requires immediate action, public awareness, and policies that highlight their ecological and societal value. By prioritizing pollinator conservation, we can secure a healthier and more sustainable future for both nature and humanity.

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