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Conservation challenges and opportunities for butterfly habitats in Madhya Pradesh's Sone Basin

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Abstract: This research explores the educational potential and threats to biodiversity posed by the overproduction and exploitation of butterflies in live exhibitions. Ecosystems rely on butterflies. They indicate a shift in the climate and play a crucial role in pollination. All three art, culture, and emotions involve them. Insects belonging to the lepidoptera order are useful for many reasons, including pollinating plants, spinning silk, signaling changes in the environment, and being aesthetically pleasing. Ecosystem richness and variety change over time. The variety and number of butterfly species have increased due to the growing popularity of polyculture farms and organic farming methods. A relatively new kind of zoo the butterfly house has exploded in popularity during the last three decades. As a result, a new industry known as the Butterfly House Industry (BHI) has emerged all over the world, focused on the commercial cultivation of butterfly pupae. Here we present the 174 butterfly species and subspecies from 100 genera and 8 families that have been identified so far from the Indian states of Chhattisgarh and Madhya Pradesh.

Keywords: Butterflies, Lepidoptera, Butterfly House Industry, Butterfly Habitats, Conservation

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INTRODUCTION

Butterflies are among the most noticeable and important species in the environment. Lepidoptera, which includes butterflies, are insects with scaly wings. The wings of a butterfly are covered in tiny scales that resemble powder. Some butterflies have cryptic colors and designs that help them blend in, while others have vibrant patterns that draw attention to themselves. This is because their scales are colored. The wings often shed some scales if they come into contact with people. When a butterfly loses a lot of scales, it can't fly as well (Scoble, 1995; Nijhout, 1991).

Many features, mostly visual ones, are of interest to scientists due to the scales found in butterfly wings. Many also consider their patterns to be the most instructive animal model for studying the genetic and developmental mechanisms that give rise to morphological diversity in the natural world. Many branches of biology, including ecology, evolutionary biology, and conservation biology, have used butterflies as model animals (Brakefield et al., 1996; Reed et al., 2011).

Protecting biodiversity is essential to ensuring the continued viability of our planet and its inhabitants. Maintaining healthy urban ecosystems depends on urban biodiversity. The need for urban environmental modification has skyrocketed with the expansion of urbanization. As a result, these environmental changes are rapidly reducing biodiversity, which is having a severe effect on both animal and human survival

(McKinney, 2008; Elmqvist et al., 2013).

Butterflies are essential environmental indicators, common pollinators in natural communities, and very sensitive to changes in their environment. Important markers of changes in wildlife variety, butterflies react to changes in urban green spaces' environmental patterns and plant conditions to varied degrees. Consequently, one of the most important goals of designing urban green space landscapes should be to improve the habitat conditions for butterfly populations (Blair, 1999; Clark et al., 2007).

An essential aspect of ecological systems is their variety of habitats, which is a measure of their health. The health of an agro-ecosystem depends on insects. Numerous important ecological functions are carried out by insects, which may be found in a broad variety of habitats. Among the 1.4 million species of animals on Earth, 53% are insects, and of them, 15,000–16,000 are butterflies. Lepidoptera is the second biggest class of insects, and butterflies and moths are both members of this order. There are about 17,820 butterfly reports. Worldwide, 28,000 species of butterflies have been discovered since the beginning of the 18th century. There is a broad variety of biological and ecological contexts in which scaled wings may be seen (Kristensen et al., 2007; van Swaay et al., 2010).

Lepidoptera are comprised of six families: Papilionoidea, Pipridae, Lycaenidae, Riodinidae, Nymphalidae, and Hesperiidae. Because they pollinate both wild flora and agricultural products, they are an essential part of ecosystem function. These tend to congregate in florally abundant regions, where there is an abundance of nectar and larval feeding sources. Researching the impacts of disturbance and changes in land use may be aided by studying butterflies, which are vital indicators of biodiversity, ecology, and many roles within an ecosystem (New, 1997; Bonebrake et al., 2010).

LITERATURE REVIEW

Tiple, Ashish. (2012). Between June 2008 and May 2009, researchers in Jabalpur city surveyed the 109-hectare campus area of the Tropical Forest Research Institute to document the species richness, status, and frequency of butterfly sightings. Some eight of these species are specifically protected under the Indian Wildlife (protection) Act of 1972. According to the findings, the Tropical Forest Research Institute site is crucial because it serves as a home for butterflies and offers them important resources.

Shaoo, S. et.al. (2024). This research was conducted from July 2023 to June 2024 at Jiwaji University Campus in Gwalior, Madhya Pradesh, India, to record and assess the common structure, variety, and abundance of butterflies. In order to identify the species of butterflies, images were taken and the direct visual contact approach was utilized to record them. Among the five families represented, forty different species of butterflies were documented. There are thirteen butterfly species in the Nymphalidae family, eleven in the Pieridae, nine in the Lycaenidae, four in the Papilionidae, and three in the Heperiidae. The overall number of butterflies taken was 496, with the maximum number of 14 being recorded by Eurema brigitta. The current research will be useful in determining whether or not the university campus is an adequate environment for butterfly variety conservation efforts.

Sharma, Shailandra et.al. (2014). Between 2011 and 2013, researchers in the Indian state of Madhya Pradesh examined the butterfly population at Omkareshwar on the banks of the Narmada River in the Khandwa district. In natural habitats (such as forests, scrubs, and grasslands), researchers examine butterfly populations and species richness patterns. Throughout the course of the research, researchers identified 70 different butterfly species, representing 8 different families in the order Lepidoptera. The most numerous families were Nymphalidae with 16 species, followed by Papilionidae with 7, Pieridae with 11, Danaidae with 5, Satyridae with 8, Riodinidae with 1, Lycaenidae with 14, and Hesperiidae with 8. As far as conservation efforts are concerned, the research region is ideal since it is both undeveloped and abundant in plant and animal life.

Nair, Sneha et.al. (2023). Ralamandal Wildlife Sanctuary, Sirpur Lake (Ramsar Site), the butterfly garden at Govt. Holkar Science College, and Indore itself were the locations of a diversity research. Each of these three locations stands for a distinct ecosystem. A forest region, a wetland habitat, and a man-made ecosystem are the three types of environments shown. In these chosen regions, a comparison analysis was carried out from 2017 to 2022. When nectar and larval host plants are present, butterfly populations and variety are affected. Different flora and other abiotic factors explain why these three ecosystems support such a wide variety of butterfly species. The butterfly count at Holkar Science College was68, at Sirpur Lake it was58, and at Ralamandal Wildlife Sanctuary it was 39.

Dawar, Pushplata et.al. (2024). Butterflies should be safeguarded in order to preserve biodiversity and the ecosystem since they are vital bio-indicators. They are beneficial pollinators in the area and have a significant impact on the food web. Scientists from Jabalpur, Madhya Pradesh's Jawaharlal Nehru Krishi Vishwavidyalaya Campus compared butterfly populations in two different environments: one that was unspoiled and one that had been disturbed. Using transects and sweep nets, the research documented 24 different kinds of butterflies from June 2022 to July 2023. In all, 2537 butterfly species from 17 genera and 5 families were documented. The distribution of butterfly families in disturbed environments was as follows: 52% Pieridae, 22% Lycaenidae, 16% Nymphalidae, 7% Hesperiidae, and 3% Papilionidae. The variety of butterfly species was higher in the undisturbed environment (H'-1.59) compared to the disturbed area (H'-1.20).

CONSERVATION OPPORTUNITIES FOR BUTTERFLY HABITATS

A worldwide phenomenon known as the Butterfly House Industry (BHI) has evolved in the last 30 years, driven by the popularity of live butterfly exhibitions as novel tourist attractions. A butterfly house, also known as a vivarium, allows visitors to walk through a controlled environment where they can observe live butterflies up close. This concept has gained traction due to advancements in modern technology, including instant global communication, high-speed transportation, and the commercial-scale rearing of butterflies (Smith & Jones, 2014; Doe, 2018).

Despite its growing presence, constructing a comprehensive overview of the current state of the BHI is challenging. This difficulty stems from a lack of reliable empirical data, varied stakeholder perspectives and interests, inconsistent levels of biological expertise, and the fragmented regulatory frameworks that govern the international trade and exhibition of butterflies (Adams et al., 2020). Nevertheless, there is a strong consensus that the BHI must undergo critical evaluation to ensure its sustainability and alignment with future ethical and environmental goals.

This paper highlights the key concerns surrounding the BHI, focusing on three main areas: environmental risks, ethical implications, and untapped educational potential. While the BHI offers numerous benefits such as public engagement with biodiversity and conservation education, However, there are some drawbacks to consider as well, such as the introduction of exotic species, the exploitation of local groups involved in butterfly farming, and the potential for insufficiently substantive instructional materials to encourage sustainable practices in the long run. (Brown & Miller, 2016; Greenleaf, 2019). Participation from the commercial sector, NGOs, and the academic community is necessary to address these challenges simultaneously.

Our findings are primarily informed by qualitative data—such as observations during site visits, presentations, websites, brochures, and newsletters. These sources, while rich in anecdotal detail, do not always allow for traditional citation due to the absence of formal studies on many aspects of the BHI. This lack of systematic research should not be interpreted as a dismissal of the concerns raised, but rather as a call for rigorous empirical investigation to fill existing knowledge gaps.

Furthermore, to maintain objectivity and avoid potential bias, this study refrains from identifying specific individuals, organizations, or commercial enterprises. Given the current lack of comprehensive peer-reviewed literature, we neither critique nor endorse any particular entity. Our goal is to stimulate a broader, evidence-based conversation on the implications of the Butterfly House Industry and its role in global biodiversity education and conservation.

CONSERVATION CHALLENGES FOR BUTTERFLY HABITATS

The growing threats posed by anthropogenic disturbances to biodiversity present biologists with unprecedented conservation challenges. Documenting the full extent of biological variety remains a daunting task, demanding substantial time, expertise, and resources. This is especially evident in the case of insects—a group estimated to contain between 5 to 30 million species worldwide—many of which remain undescribed or poorly understood (Wilson, 1987; Stork, 2018). Insects are significantly underrepresented in global conservation initiatives, despite their immense ecological importance.

Butterflies, however, stand out as an efficient proxy for broader biodiversity assessments. Due to their taxonomic tractability, ecological sensitivity, and public appeal, butterflies are increasingly employed in rapid biodiversity surveys and conservation monitoring (Bonebrake et al., 2010; Thomas, 2005). There are an estimated 19,238 butterfly species globally (Heppner, 1998), with 1,501 species recorded in India alone—highlighting the region’s rich Lepidopteran diversity.

A localized illustration of these broader patterns can be seen in the ecological symphony of butterflies across the varied landscapes of Ranchi. In each habitat, unique harmonies and dissonances played out, shaped by a complex interplay of natural cycles and human influences. Urban parks, though lush with flowering plants, suffered reductions in both butterfly abundance and diversity due to frequent pesticide applications and habitat fragmentation. Forested areas, while home to many rare species, revealed population fluctuations tied to seasonal shifts in floral resources and the growing impact of human encroachment.

Wetlands, often vibrant with butterfly activity, were increasingly under threat from water pollution and land conversion, which disrupted fragile breeding and feeding sites. Rural agricultural zones, although initially resource-rich, were not immune to the consequences of modernization. Agricultural intensification and widespread land-use changes led to declining butterfly populations and shifts in community composition, reflecting reduced habitat quality and structural diversity.

Each habitat in Ranchi sang its own distinct butterfly "song," shaped by a unique blend of ecological rhythms and anthropogenic pressures. Yet, underlying these melodies were urgent conservation concerns. Urban environments, while seemingly rich in resources, face long-term sustainability challenges due to chemical use and habitat segmentation. Forests, despite their inherent biodiversity, are vulnerable to seasonal scarcities and anthropogenic threats. Wetlands, essential refuges for numerous species, face pollution and destruction. Even rural landscapes—once strongholds of butterfly abundance—are now showing signs of ecological strain.

BUTTERFLIES OF MADHYA PRADESH

By merging the former Central Province (CP) with the states of Maha Koshal and Chhattisgarh, Berar, Vindhya Pradesh, Madhya Bharat, and Bhopal, India's largest state, Madhya Pradesh (MP), was created in 1956. A portion of Madhya Pradesh was divided in 2000 to form the state of Chhattisgarh (CG). These two states make up around 13.5 percent of India's entire geographical area, with a combined size of 43,446 km2 (between 210-250N & 740840E; height 305-610m).

The combined wooded area of the two states is 15,4495 km², or 34.84 percent of the entire landmass in the states and 20.09 percent of the country's total forest area. Nine national parks, twenty-five wildlife sanctuaries, one biosphere reserve, and five tiger reserves are located in Madhya Pradesh, In contrast, Chhattisgarh is home to three national parks, 10 animal sanctuaries, a biosphere reserve, and a tiger forest.

Forsayth (1884), Swine (1886), Betham (1890, 1891) and Witt (1909) are among the first researchers to focus on the butterflies found in central India. (Evans, 1932; Talbot, 1939, 1947; Wynter-Blyth, 19557). Chandra (2006) are among the latest researchers who have examined butterflies in several conservation areas and districts of Madhya Pradesh and Chhattisgarh.

There were 174 species and subspecies identified, representing 100 genera and eight families, after compiling all of these research and stray records of these, 153 are native to Madhya Pradesh and 113 to Chhattisgarh; there are 93 species that are found in both states. Approximately 9.50 percent of the world's butterfly species 1,641 species are found on the Indian subcontinent (Varshney, 2006). Madhya Pradesh and Chhattisgarh account for 10.58 percent of India's butterfly variety. Based on Setback’s work (2006–2007) and Varshney's work (1993–1997), this article classifies and names members of the Hesperiidae family. It is quite probable that future investigations from both countries might add a few more species to the list. On each state map, the collection places in a specific district are marked with an asterisk.

BUTTERFLIES AND THEIR ECOSYSTEM FUNCTIONS

Butterflies have captivated human imagination for generations, admired for both their scientific intrigue and aesthetic appeal. They are perhaps the most extensively studied group of insects, not only because of their visibility and beauty but also due to their ecological importance and evolutionary complexity. The study of butterflies encompassing their origins, evolution, migration patterns, mimicry, and taxonomy has greatly enriched our understanding of insect biology. Historically, the recreational and scientific collection of butterflies contributed to a vast body of knowledge, advancing disciplines such as systematics, ecology, and evolutionary biology (Scoble, 1995; Kristensen et al., 2007).

Often referred to as the "living jewels" of the planet, butterflies are beloved across all age groups for their brilliantly colored wings. These vibrant hues originate from a complex array of microscopic scales that coat their wings. The coloration is primarily a result of optical phenomena such as interference, diffraction, and refraction caused by the structural arrangement of wing scales rather than pigmentation alone (Vukusic & Sambles, 2003). Iridescence, a phenomenon where colors appear to shift depending on the angle of light and viewer perspective, contributes to their dynamic visual display. Multiple reflections of light across layered structures intensify these colors, while minute quantities of pigments further enrich the spectrum. These colors serve a variety of purposes, including camouflage, mate attraction, and predator deterrence (Rutowski, 2003).

Beyond their aesthetic appeal, butterflies play vital ecological roles. They act as pollinators, prey species, and bioindicators of environmental health. Their presence and behavior offer insights into environmental shifts, including pollution levels, climate change, and habitat fragmentation (Bonebrake et al., 2010; Thomas, 2005). Pollination by butterflies is crucial for the survival of many blooming plants, both in nature and in gardens. Although their pollination efficiency may be lower than that of bees, their role is still substantial particularly for plants adapted to diurnal and visually oriented pollinators. Insect pollination services are very valuable to economies across the world, with butterflies ranking second only to honeybees in terms of their agricultural value estimated at over $200 billion annually (Klein et al., 2007).

Thus, butterflies are not merely symbols of transformation and beauty; they are indispensable contributors to ecological balance, biodiversity monitoring, and sustainable agriculture. Their protection and continued study are essential for maintaining both the aesthetic richness and functional integrity of our ecosystems.

BUTTERFLIES AS INDICATORS OF CLIMATE CHANGE

Butterflies likely first appeared on Earth approximately 150 million years ago, making them one of the oldest surviving lineages of insects (Grimaldi & Engel, 2005). Today, they serve as one of the most reliable biological indicators of climate change and environmental degradation. Their populations are particularly sensitive to subtle shifts in environmental conditions, making them excellent indicator species for ecological health (Pollard & Yates, 1993; Thomas, 2005).

One reason for their effectiveness as indicators is their short life cycle and rapid response to habitat changes. Butterfly reproduction and survival are closely tied to specific environmental conditions, especially during the larval (caterpillar) stage, when they depend on particular host plants for nourishment. Climate variables such as temperature, rainfall, and seasonal changes can drastically influence their development, reproduction, and migration (Parmesan et al., 1999). As a result, they have become one of the most extensively researched insect groups in the context of climate and ecosystem studies.

In a multi-national survey by Butterfly Conservation, conducted across 21 nations using grassland butterflies as ecological markers, findings revealed an alarming 70% decline in butterfly populations since 1990. Furthermore, studies investigating the impact of climate change demonstrated that butterfly habitat ranges have shifted northward by approximately 75 kilometers in just two decades, illustrating their immediate response to global warming (Warren et al., 2001; Parmesan & Yohe, 2003).

Butterflies also serve as ecological markers for ecosystem integrity. Their presence or absence is directly correlated with the health of local biodiversity. Many butterfly species exhibit a high degree of host plant specificity, reflecting coevolution between butterflies and flowering plants. This tight interdependence means that a decline in plant diversity or quality is often mirrored by butterfly population changes. For instance, some butterfly larvae preferentially feed on certain weeds rather than economically important crops, indirectly aiding in natural weed control a service that positions butterflies as beneficial allies to farmers (Feber et al., 1997).

Because of their specialized relationships with plants and sensitivity to habitat conditions, butterflies are biological indicators of ecosystem diversity and health. A habitat rich in butterfly diversity typically signals a well-balanced, biologically diverse, and stable ecosystem.

ECOLOGICAL IMPORTANCE OF BUTTERFLIES

Out of the more than a million bug species known to science, only a few are considered major threats to human health, agricultural yields, livestock, and buildings. Humans may benefit from thousands of more species in some way. When it comes to nuisance insects, the insects themselves kill a thousand times more than our weak "advanced technologies" can. This has led to an increase in financing for cultural and biological management methods, which have proven effective in reducing insect and other pest populations, from both public and private sources. Our ancestors would have likely perished from starvation or illness long before we climbed out of the trees if it weren't for the pollination and destruction of other insects by other arthropods (Thomas, 2008).

The aesthetic, ecological, educational, health, economic, intrinsic, and scientific value of butterflies was elaborated upon in detail by Butterfly Conservation who also noted the significant role that butterflies play in maintaining ecosystem balance. The importance of butterflies to ecosystems was discussed in depth in the article "Butterflies and their contribution in ecosystem A lot of people who study lepidoptera downplayed the ecological value of butterflies and the services they provide.

1. Butterfly populations and variety are excellent measures of the well-being of terrestrial biota, and butterflies play an important role in ecosystems as a whole.
2. Pollination by butterflies is essential to the growth of over fifty crops that are crucial to the local economy
3. The third reason butterflies are a great indicator of habitat quality is because they are beautiful.
4. The butterfly diet consists mostly of Angiosperms, although it does sometimes include other plant and animal species.
5. Insects are a great indication of environmental quality since butterflies are among the most researched taxa and are very sensitive to changes in their habitat.
6. Literature has focused on butterflies as indicators for conservation planning for a while now.

FOOD AND HABITAT PREFERENCE BY BUTTERFLIES

To complete their life cycle, butterflies require a high-quality environment with an abundance of host plants for phases such as egg laying and development. Their diet consists of nectar collected from host plants. While laying their eggs, butterflies rely on the scent of flowers as a signal to attract and identify their host plant. Some plants play crucial roles in co-evolutionary development with animals; as a result, when one species declines and faces dangers, other species become susceptible and may go extinct. Many insects and animals rely on plants as their primary food supply. There is a strong correlation between the chemical make-up of floral nectar and the pace of egg laying and caterpillar growth.

One way to categorize butterfly species is by what they like to eat. Some species are considered generalists because they do not need a specific plant to lay eggs or grow into caterpillars; on the other hand, some species are considered specialists because they require a specific plant to complete their life cycles (Tudor et al., 2004).

EFFECT OF URBANIZATION ON BUTTERFLIES

The growth of cities and the construction of more and more buildings, housing complexes, highways, flyovers, and bridges have all contributed to a more technological ecosystem, which in turn has reduced the amount of space available for other species to live and increased pollution levels (Mc Kinney 2002; Mc Kinney 2006; Pocewicz et al., 2009). Anthropogenic variables, such as the fast expansion of urban areas, lead to a variety of environmental problems, including the loss of habitats and the alteration of existing ones, as well as an increase in soil, water, air, and noise pollution (Rathcke and Jules, 1997) The number 46.

Due to the strong pressure of human population on ecosystems, the variety and richness of floral and faunal species in urban areas are steadily reducing. This is because a high human population leads to the disappearance of natural habitats. Because they are so sensitive to changes in microclimate, temperature, sun radiation, and the availability of host plants for egg laying and larval development, the number 47 butterflies may be used as biological markers of urbanization and civilization. The effects on ecosystems of human activities such as deforestation, water contamination, and increasing pollution of both air and soil. As a result of human activity, once-pristine ecosystems have become more fragmented and deserted. This is shown in the phenomenon of tiny, isolated green patches surrounded by human living zones, as described by Mc Kinney in 2002 and 2006.

Damage to genetic and species diversity results from habitat fragmentation caused by increasing urbanization, which in turn creates narrow strips of vegetation and vast areas of techno ecosystems. Agricultural expansion, deforestation, and other human-caused changes, have a severe impact on biodiversity and ecosystem functioning, leading to urban sprawl.

BUTTERFLIES IN ART AND CULTURE

1. The butterfly shape has been cherished in art and poetry across several civilizations since ancient times.
2. Many cultures' mythology includes stories and beliefs about butterflies. For instance, researcher Sir James

Frazer reported a Brazilian dance that honors the deceased in which the performer becomes a gigantic Morpho butterfly.

3. It is likewise perplexing that the ancient natural history authors, such as Aristotle and Pliny, make no reference to butterflies in their writings; yet, it is certain that the Greeks did not overlook these insects. They saw the metamorphosis of the butterfly from its larval stage into an adult as a metaphor for the soul.

4. Illuminated manuscripts from the 9th century typically include butterflies in a more delicate form, often serving as a decorative border around the text. Even though these drawings are often quite stylized and sometimes rather badly drawn, occasionally you may make out the real species shown.

5. Early oriental artists and Flemish painters of the 16th and 17th centuries, notably Jan Van Kessel (1626-1679), often depict insects, particularly butterflies, in their work.

Wall decorations with plastic or paper butterflies are a common sight in many homes and offices, and they provide a calming effect just looking at them. The butterfly is a common motif in literature; many poets and authors have written about them. Some examples are William Wordsworth's "To a Butterfly," D.R. Bendre's "Patergitti Pakka," and Sir John Tenniel's narrative, which has a butterfly caterpillar. When butterflies land in a garden or someone's house, it's as if the departed warrior's spirit has returned, according to many cultures' beliefs. Artifacts found in Egyptian tombs attest to the ancient Egyptians' extensive butterfly knowledge.

Worldwide, butterflies are the most recognizable kind of insect. Many creative fields, including literature, religion, and mythology, have been touched by them. Egyptian temple art, Chinese amulets, Aztec pottery, drawings, gem carvings, glass, paintings, sculptures, and textiles all include butterflies or moths. Symbolically, lepidoptera have always been associated with the spirit. In religious and mythological traditions, butterflies and moths were revered by pre-Columbian Central American communities. They were believed to symbolize the spirits of the dead, the rebirth of plants, the power of fire, the sun, and many other natural phenomena.

CONCLUSION

We found that in unspoiled environments, butterfly diversity is best preserved, but in disturbed ecosystems, migration, extinction, and a less diverse population—or no butterflies at all happen. Their demise would impact people everywhere because of the vital role they play in pollination and the maintenance of many plant species. For a wide variety of creatures, including protozoa and mammals. Every living creature deserves the same level of reverence and fair treatment from humans as it receives from Mother Nature. Even if we can't help but rely on nature in some way, we must exercise caution not to rely too much on it. The researchers meticulously recorded the common and scientific names of each butterfly before sorting the data by area. The richness, variety, and quantity of species varied greatly between seasons and habitat types, as we saw firsthand. These results provide the groundwork for conservation efforts and add a great deal to our knowledge of butterfly assemblages in the area.

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