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Inadvertent implications of climate change for butterflies

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Abstract: Climate change is one of the leading challenges of this century with an impending threat to wipe out more vital butterfly species than ever before. Climate shift has the potential to affect their life cycles, flight times, essential bio-interactions, and ultimately survival. As the first such study in India, this case study highlights the inferential discussion on the importance of butterflies in maintaining the earth's fragile ecological balance and consequently the impact of climate change upon them with inadvertent implications. Due to the shifting climate, a number of butterfly species are now migrating to newer places in their search for comfortable temperature and availability of food, as the reduction/loss/change of habitat lowers the diversity of microclimates and availability of food plants for larvae and adult butterflies. Consequently, the butterflies become even more vulnerable to natural perturbations and susceptible to predators and local extinctions.

Keywords: climate, survival, interactions, species, balance, ecological

1. Introduction

Butterflies belong to the kingdom of Animalia, the phylum Anthropods, and the class Insecta. The anatomy of a butterfly consists of antennae, compound eyes, proboscis, six segmented legs, and sense organs [1, 2].

The families are mostly classified into Papilionidae (swallowtails), Nymphalidae (brush-footed), Pieridae (whites and yellows), Lycaenidae (blues), and Hesperiidae (skippers) [3, 4]. A butterfly has mainly 4 stages in its life cycle. The early stage is the egg stage, wherein they are the size of a pinhead and are mostly fixed to the leaf with an adhesive substance which hardens rapidly so that eggs can withstand the roughest winds and rains. This stage lasts for about

4 days, provided the weather conditions are favourable. The second stage is the caterpillar stage, wherein they first feed on their eggshells and then on the leaves, flower buds, and even fruits of the larval host plant [5]. This stage lasts for one to six weeks. Further, the caterpillar sheds its skin and gets transformed into the pupa, which is soft at first, and it later hardens, which process may last for one to six weeks. Thereafter, the caterpillar gets its wings and body parts and becomes an adult butterfly. In the last stage, the butterfly emerges with its wings which are wet, soft, and crumpled [6]. Compilations under *Plate 1* and *Plate 2* represent the various life stages for Common Jezebel (*Delias eucharis*) and Peacock Royal (*Tajuria cippus*) respectively.

Plate 1. Different life stages of Common Jezebel

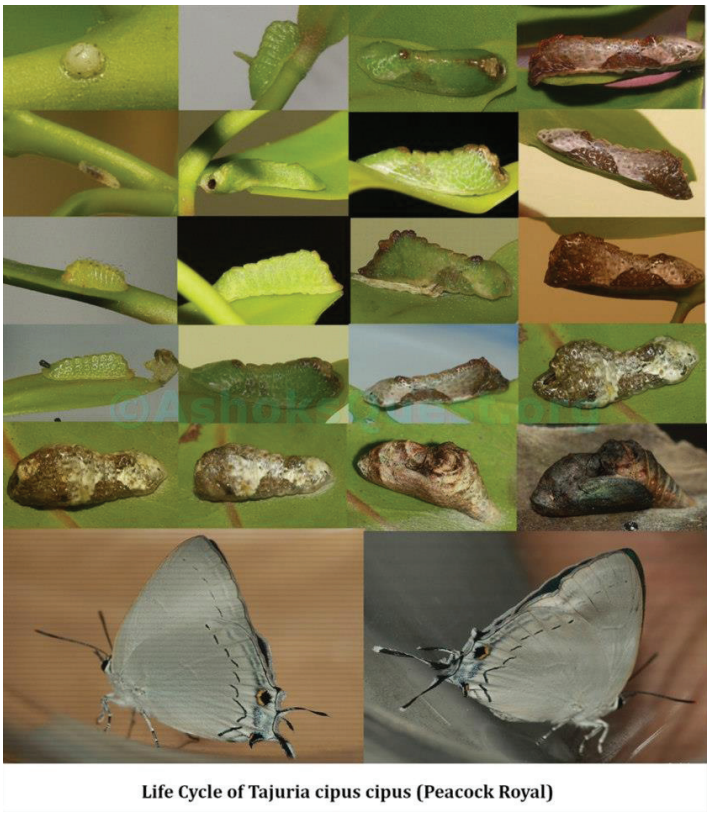

Plate 2. Different life stages of Peacock Royal

Once emerged, the butterflies fly to find nectar, mate, and continue their lifecycle. This is very commonly observed in Indian Peacock Royal (*Tajuria cippus – Plate 3*) and Gaudy Baron (*Euthalia aconthea – Plate 4*). While most butterflies, such as Common Jay (*Graphium doson – Plate 5*), feed on nectars, certain other butterfly species, such as Crimson Rose (*Pachliopta hector – Plate 6*) or Common Jezebel (*Plate 7*), also feed on tree sap, dung, pollen, and rotting fruit. Field visits even confirm that the families of Rajahs and Nawabs, including Common Nawab (*Polyura athamas – Plate 8*) and Black Rajah (*Charaxes solon – Plate 9*), also feed on dead and decaying prawns and crabs, while certain other species, such as Metallic Cerulean (*Jamides alecto – Plate 10*), are attracted to bird droppings, sweat, and blood [7].

To satisfy their need for sodium, butterflies, such as Common Lime (*Papilio demoleus – Plate 11*), are often seen together feeding on small puddles on the ground or wet areas on leaves and plants [7].

Plate 3. Indian Peacock Royal

Plate 4. Gaudy Baron

Plate 5. Common Jay

Plate 6. Crimson Rose

Plate 7. Common Jezebel

Plate 8. Common Nawab

Plate 9. Black Rajah

Plate 10. Metallic Cerulean

Plate 11. Common Lime

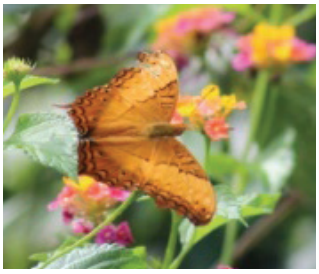

Plate 12. Cruiser

Plate 13. Adonis Blue*

Plate 14. Silver-spotted Skipper*

Plate 15. Brown Argus*

Plate 16. Monarch*

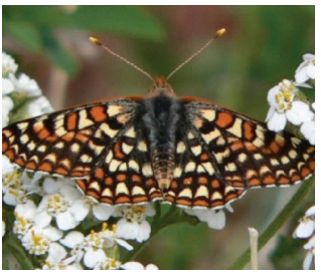

Plate 17. Variable Checkerspot*

Butterflies are known to perform various ecological functions, including effective pest control and pollination. For instance, cruisers (*Vindula arsinoe – Plate 12*) provide assistance for genetic variations in the plant species as they collect nectar from a variety of plant species as they travel over long distances. This helps the plants fight against diseases and gives them a better survival chance. Hence, the depreciation of butterfly biodiversity can subsequently impact the natural environment, wherein their presence suggests a vital and healthy ecosystem, and their absence indicates a serious decline of the ecosystem.

For example, their action of shifting bases or their absence can result in an upslope movement of the flora and also in time-lag scenarios, as floral species migrate comparatively slower, consequently resulting in the decline of their population. The limited dispersal ability, larval food plant specialization, and close reliance on weather and climate make many butterfly species sensitive to fine-scale changes [8]. This is a vicious cycle, as the scarcity of plant resources (host and larval plants) can lead to loss of species due to territorial conflicts.

Sparsely available literature on research conducted outside India highlighted the impact of climate change on various aspects (feeding habits, distribution, etc.) at large spatial scales with regard to butterflies such as Adonis Blue (*Polyommatus bellargus – Plate 13*), Silver-Spotted Skipper (*Hesperia comma – Plate 14*), Brown Argus (*Aricia artaxerxes – Plate 15*), Monarch (*Danaus plexippus – Plate 16*), and Variable Checkerspot (*Aricia agestis – Plate 17*). Temperature as a parameter was found to be an important factor for all these species on account of shifting to higher latitudes and elevations. While Adonis Blue showed variation in its associations with different grassland habitats according to seasonal variations in weather [9], the Silver-Spotted Skipper expanded the range of locations where it lays its eggs in response to increased ambient temperatures, and it colonizes in the cooler regions [10]. Brown Argus butterflies, a British butterfly species, have already made climate change history by becoming the first known animal of any kind to lose the ability to eat one of two plants in their diet and lay eggs in a climate-related move, as global warming forced them to move to a new environment and adapt their behaviour [11].

While climate change is also a potential threat to the annual migration pattern of the Monarch butterfly by affecting weather conditions in both wintering grounds and summer [12], Variable Checkerspot, due to the mismatched timing with their caterpillar host plants, is directly threatened by climate change and thus habitat destruction due to the butterfly's sensitive reliance on meadows [13].

In contrast with the above cited foreign literature, Indian studies highlighting impact of climate change have focussed less upon distribution patterns and habitat associations of butterflies [14, 15, 16]. The present study attempts to fill this gap in the literature by analysing the basic feeding/migratory/survival behaviour of a few common species of butterflies and the subsequent implications on account of the climate change phenomenon. The research methodology included primary data collection. This was achieved by undertaking monitoring at Butterfly Parks in Kendriya Vidyalaya No. 1, Bannerghatta National Park, and Sammilan Shetty's Belvai Butterfly Park. The exercise was also extended while carrying out surveys at Arkavathi RF, Shendurney WS, Munnar WS, Namdapha NP, Hessaraghatta Grasslands, Horagina Betta Peak, Jnana Bharathi Campus, and GKVK. Further, credible secondary data was also referred.

2. Observations and inferences

Blue Tigers (*Tirumala limniace – Plate 18*) and Dark Blue Tigers (*Tirumala septentrionis – Plate 19*), known to roost and migrate extensively during the monsoons in southern India, sometimes travel longer distances to and from areas which are only suitable at certain times of the year. By doing so, they try to avoid unfavourable circumstances, including extreme weather, food shortage, or overpopulation. They breed in the mountains, and the progeny migrate back to the plains following the monsoon season [17]. It is understood that this species is trying to avoid heavy rainfall so as to facilitate breeding. Under these circumstances, it is important to realize that climate change is bringing about unpredictable bursts of intense rainfalls and erratic behaviour, also in terms of approach and delays. This may have a significant impact on butterflies during migration, alter migratory routes, disturb breeding grounds, and wash out or destroy eggs.

Common Emigrant (*Catopsilia Pomona – Plate 20*) and Common Albatross (*Appias albina – Plate 21*), known to have strong migratory habits, can be seen flying in dozens, mud-puddling, travelling up and down the rivers (migration corridors), linking their high and low elevation breeding sites.

During these migrations, both sexes, but especially the male, can be observed puddling in large groups on sunlit river banks and sandbars, where they settle for long periods to imbibe mineralized moisture [18]. In this context, it is important to realize that climate change has a significant impact on the flow patterns of rivers, resulting in both extreme cases, i.e. drying up of river beds and flooding.

Plate 18. Blue Tiger roosting

Plate 19. Dark Blue Tiger

Plate 20. Common Emigrant

Plate 21. Common Albatross

Plate 22. Common Crow

Plate 23. Orange-tip

Plate 24. Common Palmfly

Plate 25. Common Rose

Plate 26. Red Admiral

Both of these physical transformations can have disastrous consequences for butterflies. While drying can result in loss of the natural migratory path, greater threat of predators, and natural competition along newer migratory routes, flooding can lead to the destruction of banks that otherwise would have served as puddling grounds rich in minerals.

During summer, adult Common Crows (*Euploea core – Plate 22*) live for about 1-2 months, but a Crow butterfly that has overwintered can live as long as 9 months. While overwintering, these butterflies are in a state of reproductive dormancy, and their life is on hold as they do not eat or drink very much; and the fat content of their bodies declines steadily from around 18-25% for over about a month. Also,

despite the fact that they are all together in one spot, they do not breed during the aggregation [19]. Even after reaching Sahyadri, they continue to remain in reproductive diapause for the first few weeks before mating [20]. This behaviour of a very commonly found butterfly such as Common Crow proves that, as an indicator of climate change, they themselves are extremely sensitive to even the minute changes in the environment. Under these circumstances, it is important to realize that climate change presents unexpected, untimely, and sometimes prolonged climatic alterations; and these potentially have the power to wipe out rare or endangered species among butterflies which may fail to keep up. Also, prolonged reproductive diapause and timings can become complicated based on climate-dependent aspects such as availability of mates, host and larval plants.

Orange-tip Butterflies (*Anthocharis cardamines – Plate 23*) are high-altitude butterflies, which are known to move to places more suitable to them. This is because climate change holds the potential to introduce the total transformation of any location's microclimate, which can result not only in the loss of breeding grounds but also in the permanent shifting of base of butterflies. This change of bases can also directly impact the floral population, as butterflies are also pollinators, eventually resulting in the denudation of soil or the loss of a specific plant species, which, in turn, can result in the loss of a potential host plant or larvae plant for this particular as well as some other butterfly species.

If Common Palmfly (*Elymnias hypermnestra – Plate 24*) and Common Rose (*Pachliopta aristolochiae – Plate 25*), which is a major pollinator of both wild and cultivated plants at higher altitudes, migrate completely or become extinct, then a significant decline in viable seed production may occur.

Red Admirals (*Vanessa atalanta – Plate 26*), which generally prefer warmer climate, now are seen to regularly migrate due to increasingly non-favourable conditions [11]. This is because climate change has apparently altered the seasons in terms of their occurrence, arrival, and ending time. Consequently, most species started to appear progressively earlier in the year; hence, this leads to a chaotic feeding pattern followed by usual and newer predators, which can wipe out entire species on account of prey scarcity.

Birds plan their whole breeding season around when caterpillars will be most abundant. If butterfly and caterpillar numbers are depleted, there will be no sufficient food for birds, and plants would be affected because of the reduced numbers of birds to pollinate them. Also, butterflies are essentially prey for several other species in the food chain, such as crab spider (Plate 27) or robber fly (Plate 28), which solely depend on them. In this context, as the populations of butterflies diminish, predator populations decrease as well, alongside the essential ecological functions they perform [21].

Plate 27.
Crab spider's prey

Plate 28.
Robberfly's prey

4. Conclusions

A prime concern is that different species of butterflies respond to climate change differently, and also within the same species the responses will be manipulated by the characteristics of the location. This will lead to territorial conflicts and inter-/intraspecific competition behaviours.

Several butterfly species have ceased to be spotted in Bangalore proper, and this subsequently has impacted essential ecological functions, thereby impairing ecological balance. The present research urges increased awareness in conservation plans and guidelines for common, rare, and endangered species among butterflies.

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The photographs (*Plates 13–17) were secured from Google Images, for which the authors wish to extend their humble gratitude for using the non-copyrighted photographs. All the remaining photographs have been snapped by the authors during their course of study on the field.

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