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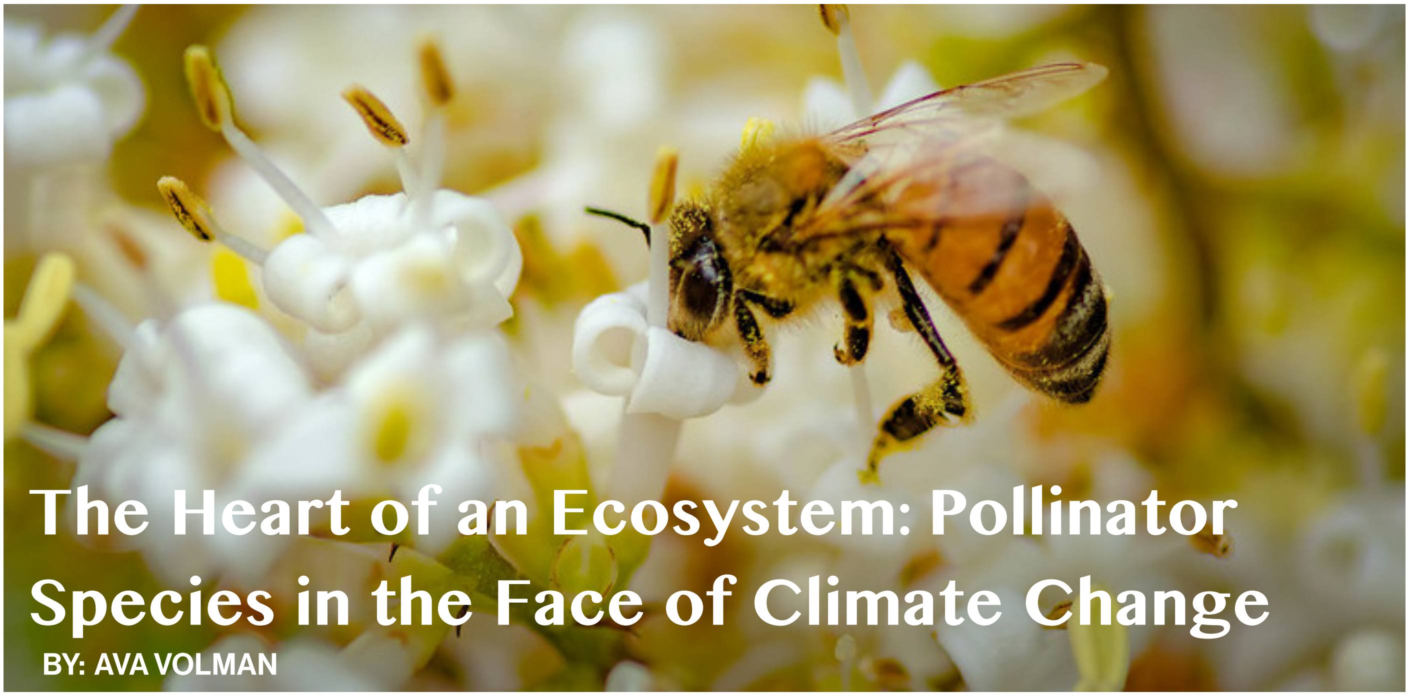

The Heart of an Ecosystem: Pollinator Species in the Face of Climate Change

BY: AVA VOLMAN

It is easy to become captivated by California's natural "big picture": towering redwoods, bubbling creeks, and expansive coastlines. However, the complexity of these ecosystems is dependent not only on their outwardly apparent organisms, but on the inconspicuous organisms as well. Whether they are buzzing, crawling, or flowering, pollinator species are a driving force behind ecosystems. In the face of climate change, pollinator species play a key role in preventing extreme habitat or species loss; yet, the detrimental impacts of climate change might prevent them from preserving these natural ecosystems.

WHAT ARE POLLINATOR SPECIES?

Pollinator species are defined as any organism that assists in the transfer of pollen from one plant to another, thus enabling reproduction between the two plants.[1] These pollinators can be distinguished into two typologies: native and non-native pollinators.

Native pollinator species have coexisted with local flora over thousands of years, resulting in specific adaptations that cater to the needs of those plant species. For example, the yellow-faced bumble bee, one of many native pollinator species in California, has adopted the specialized pollinating technique of sonication, or buzz pollination. The bumble bee vibrates its flight muscles to shake loose pollen from plants that typically cannot be easily pollinated by other species. Due to their specialized adaptations, these species are crucial to preserving an ecosystem's native species.

Conversely, non-native pollinator species are artificially introduced into an ecosystem, whether inadvertently or intentionally for agricultural purposes. These non-native pollinators find their ecological niche in sustaining crop growth, which is essential for the provision of food security. However, they also take on the role of a generalist species in pollination; this means they are capable of pollinating a variety of plants, and are not exclusive to a specific species. However, due to the non-native nature of these species, their introduction can result in a detriment to the native pollinators, as they compete for the same plants to pollinate.

> *"Pollinator species have not only influenced speciation and adaptation in the flora they pollinate, but they have also undertaken several adaptations themselves to develop a stronger resistance to changing environmental conditions."*

POLLINATOR SPECIES AS A DIVERSE COMMUNITY

Pollinators can be found in many different forms, from insects to vertebrates to plants themselves. It is crucial to have a diverse pollinator community within an ecosystem, as this lessens the chances of catastrophic pollinator loss in a natural event. Each species has adapted in a variety of different ways, and these differences are what permit them to pollinate a wide variety of plants in many ways, and thus sustain more plant diversity.[2]

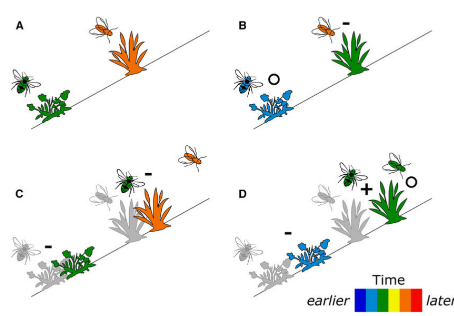

Figure 1: How phenological shifts influence adaptation and speciation.

POLLINATOR SPECIES AND INFLUENCING ADAPTIVE EVOLUTION

Pollinator species can act as mediators for evolutionary changes, which result in productive divergence among plant species, creating resilience through adaptive traits. The Grant-Stebbins model, developed by Oxford scientists, suggests that pollinators are the driving force behind speciation.[3]

Speciation is defined as the splitting of a species' genetic lineage through a defining event—in this case, the pollinator selectively pollinating specific plants within a species.[4] Through pollinator-directed speciation, plants have developed variety within their lineages to the point of creating new species or subspecies.

POLLINATOR SPECIES AND SHIFTING ENVIRONMENTAL CONDITIONS

Pollinator species have not only influenced speciation and adaptation in the flora they pollinate, but they have also undertaken several adaptations themselves to develop a stronger resistance to changing environmental conditions.

For example, in California almond orchards, changing wind speeds has impacted the pollination process carried out by a diverse host of species. At low wind speeds, honey bees pollinated towards the top of the flowering almond tree. However, as wind speeds increased, the spatial preferences of the honey bees shifted, favoring the lower portions of the tree, which provided more coverage and protected them from being disrupted by the wind. This adaptation demonstrates how pollinator species can adjust in the face of a climatic change, enabling them to continue supporting the growth of almond trees.[5]

Figure 2: A cabbage white butterfly engaging in pollination behavior.

Butterfly species throughout lowland California have also demonstrated resilience as they have adapted their pollination and migration patterns to align with phenological shifts, or changes in seasonal patterns. One study found that over the past 31 years, the average first spring flight across 23 species of butterflies has shifted earlier in the year by an average of 24 days.[6] A specific example can be seen in the Californian species Pieres rapae, or the cabbage white butterfly, whose first flight shifted approximately 19.53 days earlier.[6] The shift in the start of butterfly activity to earlier in the year demonstrates an adaptation to rising temperatures, allowing these species to continue their crucial role in pollination without detriment to their populations.

"With the acceleration of a changing climate, the ability of pollinator species to both influence plant adaptations as well as adapt themselves becomes crucial to ecosystem survival."

THREATS TO POLLINATORS FROM CLIMATE CHANGE

Unfortunately, climate change poses several threats that pollinator species cannot anticipate nor avoid. Climate change results in extreme phenological shifts, defined as changes in seasonal patterns that impact the life cycles of organisms. These impacts manifest themselves in causing plants to flower earlier in the year, or causing pollinators to emerge earlier. If this were to happen in tandem for both the pollinators and plants in a relationship, the impact would be minimal. However, even a slight difference in the biological rhythm of the two organisms would lead to a disconnect in flowering events and pollinator emergence.[7] This would result in reduced time for pollination events, therefore causing starvation for pollinators and a depression in plant reproduction.

Furthermore, rising temperatures also pose a threat to the quality of pollinators' food sources. The sugar content of flowering plant nectar has been shown to decrease with an increase in temperature. Thus, these plants no longer contain the nutritional content required to sustain these pollinators, resulting in a decline in their health and population size, which directly impacts their effectiveness.[8]

While plant-pollinator relationships are notably gaining resilience to a shifting environment, climate change is rapidly worsening, with the global average temperature rising 0.2°C per decade.[9] As a result, rapid adaptation from both pollinators and the plants they pollinate becomes increasingly significant.[10]

Within the intricacies of Earth's ecosystems, pollinator species are the heartbeat behind maintaining ecosystem health and biodiversity. With the acceleration of a changing climate, the ability of pollinator species to both influence plant adaptations as well as adapt themselves becomes crucial to ecosystem survival. However, at climate change's current progression, these species might not be able to keep up the pace with such changes. Recognizing the significance of pollinator species and looking for ways to preserve them may be the key to augmenting our ecosystems.

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