Plant Biodiversity, Pollinators, Predators of Pollinators, and the Relationship Between Them

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Plant biodiversity has a positive relationship with pollinator biodiversity, meaning that when there are more species of plants, there are also more species of pollinators (National Parks Service, 2019). Plant and pollinator biodiversity also impacts the diversity and abundance of bird species and other wildlife, so it is crucial to protect and promote plant and pollinator biodiversity (National Parks Service, 2019).

Predators of bees, the most commonly observed pollinators, follow two main hunting methods; chasing their prey, a method used by dragonflies, or ambushing their prey, a method commonly used by spiders (Benoit et al., 2021)(Dukas, 2001). The hunting method that evokes the strongest response in bee behavior is the ambush predator method (Benoit et al., 2021). Ambush predators, also known as sit-and-wait predators, wait near or on flowers, as they know pollinators will be drawn in, and then they strike when the best opportunity arises. Field studies performed by a Behavioral Ecology Research Group in Canada have found that the presence of predators at flowers that the bees seek to visit harms pollinator visitation rates (Dukas, 2001). Less pollinator visitation means less plant pollination (Dukas, 2001). The impact of the bee predator on the behavior of the bee is called the Predator Effect (Benoit et al., 2020). Predators of bees have a typical success rate between 10% and 40%, so avoidance of flowers or heightened alertness near flowers that the bees think may be hiding an ambush predator could serve to save them from future attacks by an ambush predator (Dukas, 2001). Other pollinators, such as hummingbirds, also show anti-predation behaviors. Hummingbirds prefer to feed further from the ground if given the opportunity, and they have also been observed to take breaks from

feeding on flowers that obstruct their view to ensure they are not being preyed upon (Dukas, 2001).

An ambush predator has been found to indirectly interact with "Pollinator-mediated Selection on Floral Traits" (Benoit et al., 2021). The difference between an indirect interaction and a direct interaction is in an indirect interaction, the effect happens through an intermediary species (Benoit et al., 2021). The ambush predator observed in the study performed by Benoit et al., Phymata americana, is commonly known as the "ambush bug" (Missouri Department of Conservation). The study goes on to explain that typically, larger daily floral blooms are selected by pollinators, which drives plant selection for larger blooms (Benoit et al., 2021). Ambush predators select flowers that would typically attract the most pollinators, meaning flowers with the largest daily floral blooms. The indirect effect of the ambush predators is the selection for smaller daily floral blooms through the avoidance by the pollinator of where they assume the predator will be, also called a predator effect (Benoit et al., 2021). Other than daily floral bloom size, flowering time, the availability of nectar for pollinators, and the morphology, or shape, of the flowers may also be impacted by the anti-predatory behavior of pollinators (Dukas, 2001).

Other animals, like deer, can also impact plant diversity, pollinator diversity, and pollinator predator diversity. According to an article titled "What's the Buzz? How Bees Interrelate with Birds, Wildflowers, and Deer" on The National Parks Service website, fenced-in areas protected from deer have a higher abundance of insect-pollinated plants than areas not protected from deer (National Parks Service, 2019). The areas with a higher abundance of insect-pollinated plants could help support pollinator biodiversity (National Parks Service, 2019).

Additionally, many ground-nesting and brush-nesting species of birds, such as white-throated sparrows, hermit thrushes, wood thrushes, and black-throated blue warblers can experience impacts of over-grazing by deer (National Parks Service, 2019). While sparrows, thrushes, and warblers prey on pollinators, they also prey on predators of pollinators, like spiders (National Parks Service, 2019) (Audubon Guide to North American Birds). With deer populations impacting the amount of insect-pollinated plants in an area, as well as areas for ground-nesting and brush-nesting birds to nest, deer impact the nesting and feeding ability of birds that prey on pollinators and pollinator predators, impacting populations of both (National Parks Service, 2019). Deer impact plant, pollinator, and pollinator predator biodiversity through over-grazing (National Park Service, 2019).

Transitioning land use to agricultural purposes does not often occur without loss of biodiversity (Middleton et al., 2021). The diversity of pollinating insects and their predators are among those that suffer from the impacts of the shift in land use (Middleton et. al., 2021). Planting wildflowers along the edges of agricultural fields can serve to aid in the conservation of pollinators and their predators (Middleton et. al., 2021). However, the increase in pollinators in the planted floral borders does not seem to increase the presence of pollinators in adjacent fields. Although the wildflower border will not aid in crop pollination, it is still a valuable tool to offset the loss of biodiversity caused by the transition of land use. The tropical rainforest hosts the most rich diversity of plant and animal species on the planet (Middleton et al., 2021). A clear indicator of the relationship between plant biodiversity and populations of pollinators and their predators is to look at the most biodiverse areas of the world and compare them to human-dominated landscapes (Tscharntke et al., 2008). Less diversity of insect and bird predators of pollinators, as

well as the diversity of insect and bird pollinators has been found to decline with the transformation of land to agricultural land from a rainforest (Tsharntke et al., 2008).

In summary, plant biodiversity promotes pollinator biodiversity, which promotes pollinator-predator biodiversity (National Parks Service, 2019). Bees are the most commonly observed pollinator, although there are many other pollinators (Benoit et al., 2021). The predators of bees and other pollinators are either ambush predators or chase predators (Dukas, 2001). Ambush predators, like spiders, assassin bugs, and ambush bugs harm pollinator visitation rates (Dukas, 2001). In addition to decreased pollinator visitation, there were also effects on floral traits that are selected by the pollinators, such as smaller blooms, flowering time, availability of nectar, and morphology (Benoit et al., 2021). A predator effect is the impact of the predator on the behavior of the prey (Benoit et al., 2021). The predator effect also impacts hummingbirds, another pollinator, and this causes hummingbirds to prefer feeding higher up from the ground when given the opportunity and take frequent feeding breaks to look for ambush predators before returning to feeding (Dukas, 2001). Chase predators, like insectivorous birds and dragonflies, chase after pollinators and this hunting method has not been found to impact pollinator visitation rates or floral traits (Benoit et al., 2021). Other animals, like deer, impact biodiversity by over-grazing plants, reducing the biodiversity of pollinators, pollinator predators, and plants (National Parks Service, 2019). Deer also limit ground-nesting and brush-nesting bird diversity by removing nesting sites through overgrazing, and also reducing pollinator density, a potential food source (National Parks Service, 2019).

Citations

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