

HIGH LEVELS OF PHENOLOGICAL ASYNCHRONY BETWEEN SPECIALIZED POLLINATORS AND PLANTS WITH SHORT FLOWERING PHASES

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Study Description

Species phenology is a key determinant of mutualistic interactions, such as those between plants and pollinators. However, little is known about how species phenology and patterns of interactions are interrelated. Here, we analyzed the relationship between species phenology and pollinator specialization in plant–pollinator networks in Costa Rica. Our results show that more ecologically specialized pollinator species were more asynchronous and visited plant species with shorter flowering phases compared with generalized pollinator species. These patterns suggest that specialized pollinators may be more vulnerable to mutualistic disruptions because they depend primarily on short-lived resources and have a high risk of phenological mismatch.

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Photo 1: Los Quetzales National Park, located at 3.020 m a.s.l. in the Pacific slope of the Talamanca Mountain Range, Costa Rica. This area includes the Cerro de la Muerte with the largest extent of paramo ecosystem in the country, which is a grass- or shrub-dominated ecosystem in the cool and wet upper slopes of Neotropical mountains. Photo credit: María A. Maglianesi.



Photo 2: The honeybee *Apis mellifera* visiting *Vaccinium consanguineum*. This bee species is among the three most common insect pollinators in the paramo ecosystem; it showed a low level of specialization in the three studied sites and visited plant species with relatively long flowering phases, that is, more than eight months. Photo credits: Emanuel Brenes.



Photo 3: The fiery-throated hummingbird (*Panterpe insignis*) is endemic to Costa Rica and western Panama. This species showed a relatively high temporal matching with the plant species it visited where the absolute asynchrony was in average five days. Photo credit: María A. Maglianesi.



Photo 4: Among the most visited plant species by pollinators were (A) *Vaccinium consanguineum* and (B) *Comarostaphylis arbutoides* (Ericaceae), as well as (C) *Bomarea hirsuta* (Alstroemeriaceae) and (D) *Hypericum irazuense* (Hypericaceae). These species represented between 30 and 44% of all visitation at the three study sites. Photo credits: María A. Maglianesi (A, C) and Emanuel Brenes (B, D).



Photo 5: *Catasticta cerberus* visiting *Gaillardetia punctatum* (Loranthaceae). This butterfly occurred at low abundance in two of the three studied sites in the paramo and showed a medium level of specialization. Photo credit: Alejandro Castro.

These photographs illustrate the article “High levels of phenological asynchrony between specialized pollinators and plants with short flowering phases” by María A. Maglianesi, Paul Hanson, Emanuel Brenes, Gita Benadi, Matthias Schleuning, and Bo Dalsgaard published in *Ecology*. <https://doi.org/10.1002/ecy.3162>.