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Editorial: Anthropogenic stressors and animal–plant interactions: Implications for pollination and seed dispersal

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Editorial on the Research Topic
Anthropogenic stressors and animal–plant interactions: Implications for pollination and seed dispersal

Angiosperms have dominated most terrestrial ecosystems since around the Cretacous (Herendeen et al., 2017). Their success is largely attributed to their two most distinctive characteristics: flowers and fruits, which facilitate efficient transfer of one gametophyte to the other (pollination) and dissemination of the early-stage sporophyte (seed). Multiple strategies evolved to support both processes, but the most successful one is undoubtedly animal mutualists. By attracting biotic vectors sessile plants reduce the random component in pollination by directing it to conspecific flowers, or increase it by preventing accumulation of seeds under the mother tree. Thus, in contemporary systems a great majority of plants rely on pollination and seed dispersal by animals (Herrera, 2002; Ollerton et al., 2011).

Biotic pollination and seed dispersal show multiple parallels (Valenta et al., 2017). For example, both flowers and fruits are under selection to attract mutualists *via* communication channels like scent or color. But they also show marked differences, particularly because successful pollination depends on consecutive visits to conspecifics, which is neutral to counterproductive at the seed dispersal stage. These similarities and differences offer a unique opportunity to contrast the two processes to further understand both, but they are rarely studied together (Valenta et al., 2017).

Anthropogenic disruption to ecosystems is threatening the integrity and functioning of systems worldwide (Martínez-Ramos et al., 2016), with potential large synergistic interaction between stressors. For instance, habitat loss is usually coupled with other stressors like hunting or fire, yielding damage that is greater than the sum of its parts.

These can have devastating consequences to pollination (McFrederick et al., 2008) and seed dispersal interaction networks (Fricke et al., 2022), with downstream effects not only on biodiversity but also on a variety of ecosystem services, including food security. Yet here too, the effects of anthropogenic disruptions are rarely addressed together. This is a missed opportunity not only because of the insights contrasting the two may offer, but primarily because seed dispersal is inherently downstream of pollination because fruits develop from flowers. As such, for purposes of conservation, they are not independent and cannot be studied separately.

The objective of the current issue is to promote integration of pollination and seed dispersal research. A common understanding of the factors shaping these interwoven processes is essential to understand and mitigate the effects of anthropogenic disruptions to ecosystem functioning and their downstream effects. The issue covers a wide range of disruptions to both processes, from local disruptions to the global scale. Coutant et al. use camera trap data to show the effects of road construction on fruit removal, highlighting an overall reduction in seed dispersal which also disproportionately affects some animals, especially large ones, thus changing the dispersal network. Similar effects are also apparent in plant–bird networks in which deforestation reduces the size and complexity of the networks as shown by Menezes Pinto et al. Applying a network approach, White et al. demonstrate how human activity leads to increased species turnover and thus shapes pollination networks. These studies illustrate the effects local and regional disturbances can have on ecological communities: reduced resiliency can lead to rapid change, and disrupted interactions lead to the emergence of a simpler community. Worse, this can lead to irreversible changes, preventing future restoration, which is clearly exemplified by Assis et al., who show how in ecological stress areas (i.e., fragmented and ecotones) the phenotypic and genetic variation among frugivorous birds decrease, leading to loss of evolutionary potential. Once locked in, some restoration is possible, as demonstrated by Gao et al., who show that protection from grazing by cultivated animals can lead to some recovery, but also that pollination networks do not rapidly return to the old equilibrium.

Abdallah et al. discuss the effects of invasive species on pollination networks, showing that native and invasive species tend to share a relatively low proportion of pollinators. This may seem as an encouraging result, implying that at least at the pollination stage invasive species may not directly compete with native ones. However, as demonstrated by White et al. and Menezes Pinto et al., understanding the system requires understanding the network, and as shown by Assis et al., predicting future responses requires looking at these networks *via* an evolutionary lens. In this case, it is not impossible that even with low pollinator overlap, the introduction of invasive species would lead to an increased niche to their pollinators who might compete with pollinators of native plants in other ways (e.g., nesting sites), thus indirectly leading to a change in the network and reduced pollination potential for native species.

Beyond more local and regional disruption, pollination and seed dispersal networks will also be affected by global change. Gallagher and Campbell show how changes in phenology and water availability lead to fewer, shorter, and less nectar-rich flowers in a model species. This leads to lower visitation rate and reduced seed mass, highlighting the inherent connection between pollination and seed dispersal. Fruit quality is affected by pollination (Wietzke et al., 2018), and thus disruptions leading to decreased pollination are likely to also affect seed dispersal and frugivore communities.

These articles demonstrate a sadly unsurprising reality: anthropogenic disruptions change flower and fruit traits, interaction networks, and community structure. These disruptions tend to act in concert, and a disruption to pollination has downstream effects on seed dispersal networks, creating a multiplier effect. This goes back to our initial motivation in editing this volume: pollination and seed dispersal are often studied separately, but they are inherently linked. This missed opportunity is also highlighted in this volume, as most articles did focus on either pollination or seed dispersal, and rarely touched the common themes and physiological dependence of the two. As such, while it becomes increasingly clear that understanding and mitigating the effects of human disturbances requires joint approaches, the picture we currently have is still too vague and too qualitative. We hope that this issue will inspire scientists to understand pollination and seed dispersal as a functional unit that requires common understanding and solutions.

Author contributions

ON wrote the initial draft. All authors edited and redrafted the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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Publisher's note

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