Received: 12 December 2022 | Accepted: 15 December 2022

DOI: 10.1111/1365-2656.13876

Journal of Animal Ecology BRITISH ECOLOGICAL SOCIETY

RESEARCH HIGHLIGHTS

The importance of a holistic approach to the factors determining population abundances

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Handling Editor: Mariano Rodriguez-Cabal

Abstract

Research Highlight: Ogilvie, J. E., & CaraDonna, P. J. (2022). The shifting importance of abiotic and biotic factors across the life cycles of wild pollinators. *Journal of Animal Ecology*, *91*, 2412–2423. https://doi.org/10.1111/1365-2656.13825. As global change and its multiple impacts continue to unfold across most of the planet, understanding how populations of wild species respond to changing conditions has become a major focus of ecological studies. Ogilvie and CaraDonna (Ogilvie & CaraDonna, 2022) focus on understanding how biotic and abiotic conditions affect bumblebee abundances. A major advance in their work is that, rather than focusing on a single measure of abundance at a particular life stage for each of the seven bumblebee species they survey (e.g. adult abundance), they focus on understanding the drivers of population abundance across the different stages of the species' life cycles. The authors specifically assess how three factors in particular, climate conditions, floral resource availability and previous life-stage abundances impact these abundances. A main finding in their study is that each of these three factors directly impacted a different life stage, showing that just focusing on a single life-stage would have resulted on a biased and incomplete picture of how abiotic and biotic factors affect bumblebee population dynamics. Studies like this one emphasize the need to focus on understanding the demographic mechanisms that determine population abundances.

KEYWORDS
abiotic, bumblebees, climate change, floral resources, life stages, pollinators, population dynamics

Mountain areas are amongst the most fragile ecosystems in the planet, experiencing some of the greatest impacts related to global change (e.g. climate change, invasive species or overexploitation; Schmeller et al., 2022). As climate change unfolds and temperatures rise in these areas, many species are shifting their distributions (Biella et al., 2017; Pyke et al., 2016; Rödder et al., 2021), others are able to change and adapt to the new conditions (Ryding et al., 2021), while some are slowly being led to extinction (Urban, 2015). While the direct effects of climate change are affecting many species globally, climate change can also show indirect impacts on species through its effects on species interactions, particularly those related to trophic interactions (Cahill et al., 2013). It is therefore important when considering the effect of climate change on species that we also consider potential indirect pathways and the cumulative effect of both abiotic and biotic conditions.

This is precisely what Ogilvie & CaraDonna (2022) have attempted to do in this study. The authors used a 7 years dataset where they studied climate conditions, floral resources and abundance of bumblebees in each life stage of the colony life in a highly seasonal mountain system, the subalpine habitats near the Rocky Mountain

Biological Laboratory in Colorado—USA. While most pollinators live in environments with changing and variable conditions, mountain areas represent extreme cases in which plant growth and pollinator activity are constrained to snow-free periods (Inouye, 2019). These periods are determined by snowmelt, which is highly dependent on temperature, and which determines the abundance of flowers in the area (CaraDonna et al., 2014). Ogilvie & CaraDonna (Ogilvie & CaraDonna, 2022) focus on understanding the drivers of pollinator abundance across the different life stages of seven bumblebee species, specifically focusing on abiotic (climatic) and biotic conditions (floral resources and the abundance of previous life stages). In the case of pollinators, their different life stages include periods of hibernation, active food search, nest foundation or mating, each of which presumably requires different conditions. In their research, Ogilvie & CaraDonna (2022) focus on three life stages: overwintered queens, workers and males which reflect periods of survival and new colony establishment, active foraging and growth, and mating respectively. They find that there is some covariation in the abundance of some of the life stages, particularly those related to growth and reproduction, while others were rather independent. Specifically, overwintered queen abundance was particularly determined by the timing of snowmelt, the earlier the more queens, as well as by floral resource availability the previous year for some of the species. Worker abundance was mostly determined by floral resources, while the abundance of males was mainly determined by the abundance of the previous life-stage, the workers.

Previous research focusing on the effect of adding flower strips within agricultural landscapes on different life stages of several bumble species have also found that overwintered bumblebee queens showed legacy effects of floral resources from the previous year (Bommarco et al., 2021). These authors did not analyse the covariation between the different life stages, but they did include one more biotic explanatory variable, the abundance of honeybee hives, which has been shown to affect wild pollinator foraging patterns (Magrach et al., 2017), and in this case has a negative effect on male abundance despite no effects on worker abundances. The authors argue that the competitive effects of honeybees might be more pronounced in males as they occur later in the season. Although Ogilvie & CaraDonna (2022) find solely effects of worker abundances on male abundances, given the relative stressor-free condition of their study area, other perturbations such as honeybee introduction within their study area could show larger effects on this male stage, adding to the life-stage specific responses they find.

Another interesting finding of this research is the contrasting effect that climate change and particularly warming could have on different life-stages. While warming could accelerate snowmelt leading to shorter winters and greater queen abundances, the lack of snowmelt water input could lead to reduced floral resources during the growing season, thus affecting worker and consequently male stages of the bumblebee life cycles (Ogilvie & CaraDonna, 2022). Such contrasting effects of climate change on different life-stages of species have been shown for other taxonomic groups ranging from trees (Ibáñez et al., 2014), to mammals (Cordes et al., 2020), or seabirds (Fay et al., 2017).

In this long-term study, Ogilvie and CaraDonna (2022) demonstrate that the conservation of these bumblebee species will require a detailed knowledge of their ecology, their seasonal demographic responses and the different responses to the biotic and abiotic environment throughout their life cycle. Knowledge of the life-stages specific responses to multiple factors that impact population abundances such as that provided by Ogilvie and CaraDonna (2022) is critical to understand the environmental changes most likely to influence wild pollinator populations.

CONFLICT OF INTEREST

The author declares no conflict of interest.

DATA AVAILABILITY STATEMENT

Data have not been archived because this article does not use data.

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How to cite this article: Magrach, A. (2023). The importance of a holistic approach to the factors determining population abundances. *Journal of Animal Ecology*, *92*, 229–231. https://doi.org/10.1111/1365-2656.13876