Received: 28 November 2019 | Revised: 11 December 2019 | Accepted: 11 December 2019

DOI: 10.1111/gcb.14967

COMMENTARY

Global Change Biology WILEY

Bee body size and global change: Growing with the task?

Frank Jauker

Department of Animal Ecology, Justus Liebig University Giessen, Giessen, Germany

Correspondence
Frank Jauker, Department of Animal Ecology, Justus Liebig University Giessen, Heinrich-Buff-Ring 26-32, 35392 Giessen, Germany.
Emails: Frank.Jauker@allzool.bio.uni-giessen.de and jaukerf@gmail.com

How ecological communities of the future will be structured is of key relevance to human welfare (Hooper et al., 2005). The necessary mechanistic understanding of how global change drives compositional changes in these communities, however, addresses only one side of the coin. Phenotypic alterations at the community and population level, and ultimately their effects on biotic interactions, are a significant part of biodiversity responses to future environmental change.

Species are the natural building blocks of ecological communities and we recognize compositional changes in local communities over time as gains and losses in species. From a species perspective, potential responses to global change are thus: (a) short-term range shifts, either entering or leaving local communities or (b) long-term extirpation, leaving local communities. Because the responsiveness of a species to environmental change is ultimately trait-based, nonrandom compositional change in local communities may severely affect ecosystem functioning (Larsen, Williams, & Kremen, 2005). A third possible response of species to global change, however, is (c) mid-term adaptive modification. Associated intraspecific shifts in morphospace bear the potential to facilitate the functional response of communities to environmental change, depending on the relationship between effect and response traits (c.f. Larsen et al., 2005). Although intriguingly placed at the interface of ecology and evolution, this aspect of global change consequences is clearly the least understood.

In the current issue of Global Change Biology, Maxence et al. (2019) turn to over 150,000 records of bumblebee queens in Belgium, allowing for assessment of population trends as well as interspecific body size variation within the metacommunity over almost 100 years. Body size in pollinators is an interesting trait, because it may link the responsiveness to environmental change with ecological functioning at the community (Bartomeus, Cariveau, Harrison, & Winfree, 2018) as well as the population level (Jauker, Speckmann, & Wolters, 2016; Warzecha, Diekötter, Wolters, & Jauker, 2018). This first analysis of Maxence et al. (2019) establishes that small species showed the greatest declines and the largest species increased in abundance. These population trends seemed more related to the onset of intensive agriculture than to the consistent temperature change over the 100 years. While this adds evidence to the relevance of land-use change over climate change for body-size-driven population trends in pollinator communities, generalizations across pollinator groups regarding direction and amplitude of this effect have yet to be fulfilled (see e.g. Scheper et al., 2014).

For pollinators, we have a fairly good understanding of intraspecific body size clines along elevational, longitudinal and more recently, landscape structural gradients. While studies related to land-use change may employ space-for-time substitution for predictive interpretation, true timeline analyses of morphological modifications are still elusive. In their paper, Maxence et al. establish for four species with over 850 individuals that intraspecific body size clines follow the overall community trend. This corroborates the hypothesis of the general relevance of land-use change for body size distributions across organizational levels, especially as contrasting patterns have been shown for climatic gradients (Classen, Steffan-Dewenter, Kindeketa, & Peters, 2017). Note that the four examined species are among the most abundant bumblebees in central Europe, so that intraspecific morphological modification over time (and space; Warzecha et al., 2018) implies a strong potential for impacts on biotic interactions within communities and ecosystem functioning.

While Maxence et al. give weight to land-use change causing inter- and intraspecific body size shifts over time, the mechanisms at work need to be identified to substantiate the framework of species' responses to global change. Genetic information offers one possibility for identifying the drivers behind the observed body size clines. An unsolved question here is whether the shifts in body sizes over time are manifestations of phenotypic plasticity or selective pressures, or results of systematic replacement of large individuals within the metacommunity. While the present study provides little support for

This article is a commentary on Gérard et al. 26, 1185-1195.

the latter, it encourages further research into genetic metacommunity structure variation over time to better understand evolutionary processes at ecological time scales (Carroll, Hendry, Reznick, & Fox, 2007). Ultimately, this knowledge is a prerequisite to safeguard pollinator biodiversity, including associated services, in the light of the continuing losses in their phylogenetic diversity (Grab et al., 2019).

Maxence et al. build upon empirical tests of competing hypotheses regarding the direction of intra- and interspecific body size distributions to identify the underlying driving forces and embed their work into the general framework of species responses to global change. It thus compellingly separates global change drivers and provides evidence of pressing biodiversity threats only loosely linked to climate change. We need to recognize that species in future ecological communities may be the same as today by name, but their functional properties may not.

ORCID

Frank Jauker https://orcid.org/0000-0003-4137-9072

REFERENCES

Bartomeus, I., Cariveau, D. P., Harrison, T., & Winfree, R. (2018). On the inconsistency of pollinator species traits for predicting either response to land-use change or functional contribution. *Oikos*, *127*, 306–315. https://doi.org/10.1111/oik.04507

Carroll, S. P., Hendry, A. P., Reznick, D. N., & Fox, C. W. (2007). Evolution on ecological time-scales. *Functional Ecology*, *21*, 387–393. https://doi.org/10.1111/j.1365-2435.2007.01289.x

Classen, A., Steffan-Dewenter, I., Kindeketa, W. J., & Peters, M. K. (2017). Integrating intraspecific variation in community ecology unifies theories on body size shifts along climatic gradients. *Functional Ecology*, *31*, 768–777. https://doi.org/10.1111/1365-2435.12786

Grab, H., Branstetter, M. G., Amon, N., Urban-Mead, K. R., Park, M. G., Gibbs, J., … Danforth, B. N. (2019). Agriculturally dominated landscapes reduce bee phylogenetic diversity and pollination services. *Science*, *6424*, 282–284. https://doi.org/10.1126/science.aat6016

Hooper, D. U., Chapin, F. S., Ewel, J. J., Hector, A., Inchausti, P., Lavorel, S., … Wardle, D. A. (2005). Effects of biodiversity on ecosystem functioning: A consensus of current knowledge. *Ecological Monographs*, *75*, 3–35. https://doi.org/10.1890/04-0922

Jauker, F., Speckmann, M., & Wolters, V. (2016). Intra-specific body size determines pollination effectiveness. *Basic and Applied Ecology*, *17*, 714–719. https://doi.org/10.1016/j.baae.2016.07.004

Larsen, T. H., Williams, N. M., & Kremen, C. (2005). Extinction order and altered community structure rapidly disrupt ecosystem functioning. *Ecology Letters*, *8*, 538–547. https://doi.org/10.1111/j.1461-0248.2005.00749.x

Maxence, G., Martinet, B., Maebe, K., Marshall, L., Smagghe, G., Vereecken, N. J., … Michez, D. (2019). Shift in size of bumblebee queens over the last century. *Global Change Biology*. https://doi.org/10.1111/gcb.14890

Scheper, J., Reemer, M., van Kats, R., Ozinga, W. A., van der Linden, G. T., Schaminée, J. H., … Kleijn, D. (2014). Loss of host plants drives wild bee decline. *Proceedings of the National Academy of Sciences of the United States of America*, *111*, 17552–17557. https://doi.org/10.1073/pnas.1412973111

Warzecha, D., Diekötter, T., Wolters, V., & Jauker, F. (2018). Attractiveness of wildflower mixtures for wild bees and hoverflies depends on some key plant species. *Journal of Insect Conservation and Diversity*, *11*, 32–41. https://doi.org/10.1111/icad.12264