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OPINION

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Revisiting global trends in freshwater insect biodiversity: A reply

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Abstract

Jähnig et al. make some useful points regarding the conclusions that can be drawn from our meta-analysis; however, some issues require clarification. First, we never suggested that there was a globally increasing trend of freshwater insect abundances, but only spoke of an average increasing trend in the available data. We also did not suggest that freshwater quality has improved globally, but rather that documented improvements in water quality can explain at least some of the trends we observed. Second, as we acknowledged, our data are not a representative set of freshwater ecosystems around the world, but they are what is currently accessible. Third, there is indeed no doubt that changes in abundance or biomass need not correlate with changes in other aspects of biodiversity, such as species richness or functional composition. Our analysis was specifically focused on trends in community abundance/biomass because it has been the subject of recent study and speculation, and is a widely available metric in long-term studies. To better understand the recent changes in freshwater insect assemblages, we encourage freshwater ecologists to further open their troves of data from countless long-term monitoring schemes so that larger and more comprehensive syntheses can be undertaken.

This article is categorized under:

Water and Life > Conservation, Management, and Awareness

KEYWORDS

arthropods, biomass, long-term, monitoring, water quality

The opinion piece by Jähnig et al. concerning our analysis of trends in freshwater and terrestrial insect abundances (Van Klink, Bowler, Chase et al., 2020) outlines the complexity underlying the changes of freshwater insect assemblages. Although we can agree with most of the points in their commentary, we disagree with some of the criticisms aimed specifically toward our article.

First, despite the phrasing in the media, we were careful to never mention a "global" increase in freshwater insect abundances. As figure 1 of our article clearly shows, the temporal trends of insect abundance and biomass were highly variable in both the terrestrial and freshwater realm. With 1,668 sites in total, most of which cover not even 1 m^2, and with the majority sampled in Europe and North America, it is impossible to discuss global trends. Therefore, we specifically only referred to the mean trend calculated from the available data. Similarly, we never suggested that water quality improvements were globally homogeneous. Instead, we indicated that the water quality improvements in Europe and North America since the 1960's (Bouraoui & Grizzetti, 2011; Keiser & Shapiro, 2019) could at least partially explain the trends we observed. However, even in these regions not all water bodies have improved in status (Vaughan & Ormerod, 2012). While there are probably multiple reasons why we found average increases in freshwater insect abundances, we believe it is reasonable to suggest that aspects of water quality improvement can explain some of these increases, as others have done (Outhwaite, Gregory, Chandler, Collen, & Isaac, 2020; Termaat, Van Grunsven, Plate, & Van Strien, 2015; Vaughan & Ormerod, 2012).

Second, the authors question the suitability of many of the data that we used, such as those about specific drivers of biodiversity change (in particular the onset or release of stressors), as their frequency in our dataset may not be representative of their global distribution. Of course, it would be ideal to have data on many insect taxa, representative of the type and magnitude of different environmental changes around the world, but such data simply do not exist. This is a well-known problem for any such large-scale biodiversity compilation and synthesis (e.g., BioTIME (Dornelas et al., 2018), PREDICTS (Hudson et al., 2017)) and these biases are an often-repeated argument against synthesis of global biodiversity time-series (Cardinale, Gonzalez, Allington, & Loreau, 2018; Gonzalez et al., 2016). However, we believe that synthesis of these biodiversity datasets is critical for developing a more complete understanding of biodiversity change, provided the limitations of the dataset are borne in mind.

Also, the issue of the baseline for assessing trends is a well-known problem for large scale syntheses of biodiversity data (Cardinale et al., 2018). To this end, we performed the subset analysis, repeating our trend estimates with increasing start year of the datasets (figure 3 in our article). Nevertheless, freshwater systems in many parts of the world have been altered by humans for centuries, if not millennia, and we only have a few decades of data. Depending on the start of the time series, it may be possible to find either an upward or downward trend. This in no way invalidates our results since we clearly stated the time frame and spatial coverage of our dataset.

The authors also raise concerns that noninsects (such as mollusks and crustaceans) could not be separated from insects in some of the datasets and may be responsible for driving the trends we found. While this problem was present in only a small subset of data we analyzed, we performed an additional sensitivity analysis to test whether this influenced our results. We obtained additional information from the authors of the original studies in order to exclude any organism not belonging to our target taxa (insects, arachnids, and springtails), and excluded all studies where we could not verify that at least 90% of the abundance or biomass consisted of our target taxa, as well as any ambiguous data (groups listed as "other taxa" which may have included both insects and noninsects). This came at the unfortunate cost of excluding data for many insects as well, and left 54 freshwater and 102 terrestrial datasets for analysis. Nonetheless, we still found an average increase of freshwater insects (+15.3% per decade CI: +4.07% to +28.03%), and a decline for terrestrial insects (−9.8% CI: −16.34% to −2.71%), both estimates well within the 80% credible intervals of our original estimates. The occasional inclusion of these other invertebrate groups did thus not affect our qualitative results.

Finally, Jähnig et al. correctly emphasize that changes in total abundance or biomass of an insect assemblage is only one aspect of change, and need not correlate with changes in other facets, such as species richness, composition, or conservation value. This is not unique to the freshwater realm and a lack of correlation in the change of different components of biodiversity is often expected (Chase et al., 2018). Regardless, we focused specifically on abundance and biomass trends because recent case studies reporting dramatic declines in these metrics in terrestrial ecosystems caused widespread concern among scientists and the wider public. There is no question that increases in insect abundances do not necessarily indicate improved habitat quality. Indeed, increased nutrient loading, sedimentation, disruption of food webs and climatic warming, can lead to increases in some groups of insects and thus of total insect abundances (e.g., Rugenski & Minshall, 2014; Shieh & Yang, 2000), as we explicitly stated.

In all, our analysis provides a necessary first step in moving beyond case studies to a broader understanding of the changes in insect assemblages around the world. We clearly agree with Jähnig et al. that much work remains to be done and we hope that our work stimulates further research on the state and trends in freshwater insect abundance and biodiversity. We share their hope for an increase in availability of data from existing monitoring schemes, as has been done in for example, Sweden (SLU, 2018) and New Zealand (Groker, 2018). Until then, the data that we compiled remain the best available and are available for further analysis (Van Klink, Bowler, Gongalsky, et al., 2020).

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CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

AUTHOR CONTRIBUTIONS

Roel van Klink: Conceptualization; writing-original draft. **Diana Bowler:** Conceptualization; writing-review and editing. **Konstantin Gongalsky:** Writing-review and editing. **Jonathan Chase:** Conceptualization; supervision; writing-review and editing.

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