LETTER

Reply to Gange et al.: Climate-driven changes in the fungal fruiting season in the United Kingdom

The first comprehensive study of phenological changes in wild fungi (1) revealed a significantly earlier start and later end of the fungal fruiting season than nowadays, based on a dataset collected in a small area (30-mile radius) in southern England during 1950–2005. To determine whether these interesting results were reflected on a larger scale, we analyzed nationwide datasets from Austria, Norway, Switzerland, and the United Kingdom (2). Our analyses confirmed that, for the United Kingdom, the fruiting season has widened over the last half century. Like Gange et al. (1), we hypothesized that these changes are mainly driven by climatic variation. We are, therefore, surprised that Gange et al. (3) now oppose our, as well as their own (1), interpretation. Also, their arguments (3) ignore some of our results, which clearly demonstrated that in the United Kingdom, autumnal frost events (crucial for ending the fruiting season) arrive later now than several decades ago (2).

Gange et al. (3) illustrate their new interpretation with a new analysis of their dataset, but neither provides information about the data nor the statistical methods applied, which precludes meaningful scientific discussion. However, we query whether they have performed analyses identical to ours. For example, we used the yearly 2.5 and 97.5 percentiles to represent the start and end of the fruiting season (2), whereas Gange et al. previously (1) used first/last fruiting observations, which is an important difference. Furthermore, differences in species-specific responses have to be expected when nationwide data are compared with trends in a local dataset, because the latter will reflect specific, local, ecological processes, and conditions, whereas broader-scale studies generalize patterns over a wide range of climatic conditions. The new results (3) are, therefore, not necessarily incompatible with our interpretation of trends over a larger region. However, we acknowledge the suggestion by Gange et al. (3) that a complex set of factors may account for the observed changes, including habitat change, atmospheric deposition, and recorder behavior. Our main point is that fruiting patterns accord with expectations under a climate change hypothesis, not that they are fully explained by climate change.

Gange et al. (3) point out that national datasets suffer from various biases, including insufficiently rigorous sampling. Similarly, the Gange dataset was recently criticized for possible biases attributable to systematic changes in sampling behavior (4), although these were refuted (5). Our analyses were carefully planned to correct for tentative local and regional biases (2). Clearly, the size of the area over which data are collected, the sampling intensity and rigor, and other properties of different types of datasets and different methods of analysis, can influence results. To draw valid conclusions on changes in fungal phenology from long-term datasets, there is an urgent need for carefully planned, statistically sound, in-depth exploration of the different biases and pitfalls associated with nationwide data and intensively and comprehensively sampled local datasets. This will have implications not only for fungal climate change research but also that of other organisms that use these types of datasets.

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