

GRASS POLLENS

The allergen riddle

An assessment of the taxonomic composition of airborne pollen using targeted high-throughput sequencing may help in understanding environmental and human drivers of the grass pollen season and in allergy prevention and management.

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Respiratory allergies associated with grass pollen and other allergens affect up to 20% of the world's population. However, unresolved complexity in this major aeroallergen hampers efficient prevention and treatment. The nearly ubiquitous grass family (Poaceae) comprises more than 11,000 species occurring in savannahs, prairies, pastures, alpine meadows and cereal production, as well as in residential lawns, sports fields and grass verges along roads. A considerable share of these species may be allergenic, and they have largely differing flowering times and allergen profiles¹. In addition, cultivars and hybrids of mostly allergenic taxa are grown as forage grasses. And yet, in airborne pollen monitoring, grass pollen grains are not routinely identified below the family level, except for *Secale* (rye). Consequently, cumulative Poaceae pollen seasons extend from mid-spring to late summer and often exhibit several peaks that cannot be assigned to specific species. The novel metabarcoding approach described by Brennan et al.² in this issue of *Nature Ecology & Evolution* provides unprecedented insight into the complex mixtures of aerial grass pollen during one season at six sites across Great Britain.

Using a high-throughput analysis of two taxonomic DNA marker genes, the authors first characterized individual genera contributing to the grass pollen season. *Alopecurus* and *Holcus* dominated the early season, while *Festuca*, *Poa* and especially *Lolium* dominated the later pollen season. *Phleum*, *Anthoxanthum* and *Dactylis* were less prevalent, exhibiting specific narrow peaks. This list of genera largely matches the global picture for the temperate zone as reported for example by surveys of flowering grasses in Finland, Germany and Austria³ as well as New Zealand⁴. The biggest step forward by Brennan et al., however, is their time-resolved semiquantitative approach, permitting analyses of spatial and temporal variation in taxonomic composition. Their study revealed that, despite high persistence and mobility of grass pollen, composition was not uniform in space and time as

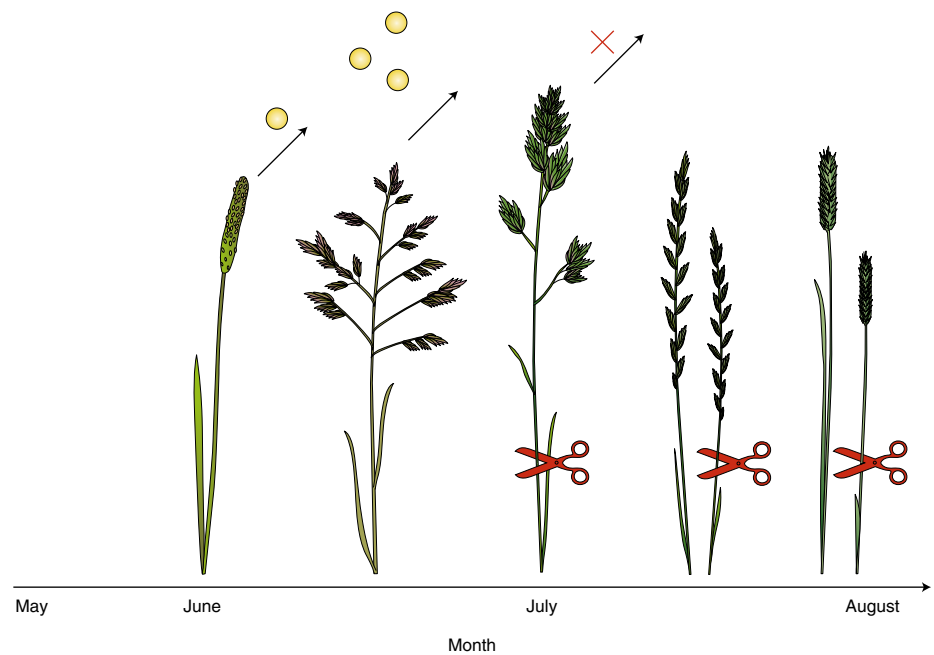


Fig. 1 | Diversity determinants. The taxonomic composition of airborne grass pollen over the course of a European summer, here depicted using the examples of *Alopecurus*, *Holcus*, *Dactylis*, *Lolium* and *Phleum* (from left to right), is largely determined by different flowering dates and cutting dates. Temperate grasses are typically cut before flowering, such that the pollens of early-flowering species would be expected to dominate.

was hypothesized. Instead, it followed observed local grass flowering seasonality and differed geographically across study sites, indicative of taxon-specific responses to regional environmental conditions. However, the huge potential of this approach goes far beyond these somewhat intuitive findings and becomes even more evident when relating allergic symptoms against specific pollen peaks, as has been previously suggested⁵, or discussing potential trends in grass pollen allergy load owing to changes in climate and land use.

Climate warming both advances and prolongs the pollen season, whereas a higher atmospheric carbon dioxide concentration stimulates pollen production, and higher pollution aggravates pollen allergenicity.

But what if the grass pollen allergen load is determined by the abundance and diversity of numerous species? Without this information, can we disentangle climate change impacts from effects of land-use or land-cover change, or various agricultural and horticultural practices? There is evidence from the United Kingdom that grass is now greener for longer periods of time, and the cutting season of lawns is prolonged⁶. Agriculture has widely switched from hay to silage production, leading to higher intensities in terms of earlier and more frequent cuts. This is probably the reason that, despite increasing annual loads of many pollen species across Europe, those of Poaceae have not increased⁷. Since forage quality drops rapidly as grasses

mature, temperate grasses are typically cut before flowering, often even before head emergence. Given this common management strategy in intense permanent grassland systems, early flowering species should then prevail in taxonomic grass pollen profiles, a hypothesis that could easily be tested using the authors' new molecular method (Fig. 1). Since earlier mowing threatens plant and insect biodiversity, as well as ground-breeding birds and young fawns, various agri-environment schemes, including some of the European Union's Common Agricultural Policy mechanisms, encourage later cutting of grass. Is this the reason for the divergent advance of grass flowering and hay cutting dates reported for Germany⁸?

The authors' method could also permit the identification of single pronounced pollen peaks, such as the famous Melbourne thunderstorm asthma event of November 2016, which was postulated to include high concentrations of *Lolium*⁹. However, linking human symptoms to pollen counts is complex, even in less prominent events, since this would depend not only on species composition (which metabarcoding could assist in determining), but also on levels of

pollen allergenicity as well as individual-level severity of sensitization and cumulative allergen exposure. Under these terms, the riddle of grass pollen allergen diversity becomes even more complex since species of the Poaceae family may contain at least ten groups of allergens. Group 1 and 5 allergens (such as the allergens Phl p 1 and Phl p 5) dominate in terms of prevalence and potency, although group 5 allergens are restricted to species of the subfamily of temperate grasses (Pooideae)¹. Recent studies have revealed that allergen 5 content in cultivated species varies considerably between and within cultivars¹⁰; even the ranking between cultivars differed in a second study year.

Brennan et al. focussed on facilitating the assessment of taxon-specific exposure of harmful grass pollen allergens. In this sense, their work is a milestone toward disentangling the taxon-specific phenology of airborne grass pollen, which, in the future, will assist in answering questions on the effects of climate change, land use and/or agricultural practices as well as atmospheric transport on pollen amounts and timing. However, although the first step toward genera-specific pollen research is done, the

riddle is not yet fully solved since far more information is needed on how to relate this to levels of aeroallergens and thus to human allergen exposure and health outcomes. □

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Competing interests

The author declares no competing interests.