Did Cryptic Invasion of North America by Common Reed Change Exposure to Pollen Allergens?

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Common reed, *Phragmites australis.* Photograph by David J. Schimpf, 25 September 2010.

Abstract

Common reed, *Phragmites australis* (reed), is a very tall grass that spread greatly to occupy large areas near many eastern North American cities over the past century. Its aerially dispersed pollen is known to incite allergic reactions, and possibly asthma, in some persons, but is not distinguished from that of any other grass in routine pollen monitoring. We hypothesize that this regional expansion by reed has increased late-season exposure to grass-pollen allergens in parts of these metropolitan areas. The information available indicates that reed's geographic location, high abundance, small pollen size, release of pollen relatively far above ground, substantial pollen productivity, pollen allergen composition, and late season of pollen release all point to its potential importance for a large number of persons whose health may be degraded by grass pollen. If the other common late-flowering grasses in the same area have larger pollen grains, it may be possible to visually distinguish reed pollen captured by monitoring devices. If not, ratios of stable isotopes of carbon in the pollen may permit differentiation. Otherwise, analytical techniques based on molecular differences need further development in order to estimate local population exposure to allergens from reed. Some 90 million North Americans may live close enough to large tracts of reed to be exposed to substantial concentrations of its pollen, so much more attention to this situation seems warranted. If reed pollen were found to be a health hazard for a particular metropolitan area, removal of the pollen sources may be more feasible than is the case for many other species.

Introduction

Common reed (reed), *Phragmites australis,* is a very tall perennial grass (Poaceae) of mostly wet habitats that is native throughout much of the world, including North America. Molecular analysis (Saltonstall 2002) revealed that throughout the 20th century non-native lineages of this species cryptically and gradually invaded North America, probably from Eurasia. Eurasian reed has been ecologically much more successful in North America than has native reed, greatly increasing the spatial extent of the species while partly replacing the native members (Meyerson et al. 2009). The greatest increase of Eurasian reed has taken place on the Atlantic coast of the United States from Virginia to southern New England, with continuing expansion westward in Canada and the United States (Meyerson et al. 2009).

Grass pollen is capable of allergic sensitization of perhaps 20% of the general population, and reed is one of the species in about 20 genera regarded as the main sources of grass pollinosis (Andersson and Lidholm 2003). Reed pollen has three of the allergen groups important for grass pollinosis (Andersson and Lidholm 2003, Grote et al. 2005, Niederberger et al. 1998). Pollen from a wide variety of grass genera, including *Phragmites,* is morphologically very similar, and counts of ambient airborne pollen sampled for the purpose of allergen monitoring have not distinguished among the different grasses. Lewis et al. (1983) described reed as "… not yet implicated in North America as an offender …", yet this species has been viewed as significant for pollinosis in western Eurasia (Andersson and Lidholm 2003, Driessen et al. 1988, Gutmann 1950). Airborne grass pollen is also suspected to induce or exacerbate asthma (Dales et al. 2004, Heguy et al. 2008). Pollen grains, including those of grasses, may generate multiple separate allergenic aerosols that are small enough to penetrate to the airways where asthma is manifested (Taylor et al. 2007).

Pollen of most of the grass species that are allergenically important in the northern United States and Canada is shed from about mid-May through mid-July (Lewis et al. 1983, Platts-Mills and Solomon 1993), whereas reed pollen becomes airborne in late summer or early autumn (Lewis et al. 1983). Where reed pollen is abundant, it can extend the season of respiratory distress from grass pollen, or add to the late-season severity.

The Virginia-New England region of greatest increase of reed coincides with a human population of some 50 million (Lang and Dhavale 2005), much of it perhaps close enough to reed stands to be significantly exposed to the pollen. For example, in 1970 reed dominated at least 30 km^2 along the lower Hackensack River in New Jersey, even though the species seems to have been rare there in the 19th century (Sipple 1971/72). That area is about 10 km west of New York City, within which high concentrations of ragweed *(Ambrosia)* pollen were inferred to have originated west of the state boundary with New Jersey (Walzer and Siegel 1956). Reed dominates several hundred km^2 near Delaware Bay and Chesapeake Bay (Meyerson et al. 2009). It appears that reed has also increased greatly near the North American Great Lakes (Saltonstall 2002), a region with at least 27 million residents in the coastal counties of the United States (U. S. Census Bureau 2009). Furthermore, Eurasian reed has become common in the St. Lawrence River valley (Lelong et al. 2007). At least 15 million Canadians live from Quebec City to Windsor near the St. Lawrence or Great Lakes (Statistics Canada 2006). Research about reed's invasion has concentrated on its ecological aspects; we propose that the proximity of invaded sites to North American cities should raise concern about human health implications.

A hypothesis, and its plausibility

We hypothesize that people in the major metropolitan areas of the northeastern United States and eastern Canada are exposed to significant levels of late-season airborne grass-pollen allergens from Eurasian reed, including whole pollen grains and perhaps pollen fragments. Reed's North American expansion may have increased regional exposure to grass-pollen allergens late in the season or blunted what otherwise would have been greater declines in that exposure because of urbanization. Our hypothesis has apparently not been presented in the literature.

In order for this hypothesis to be correct, high numbers of reed pollen grains or fragments would have to be moved by air from the plants to places of high human density. Reed pollen grains are at the low end of the size range for grasses (Wodehouse 1935) and are shed 2-4 m above ground, much greater than the height for most other grasses. A combination of smaller size and more elevated release should cause pollen to remain airborne for comparatively long times and lateral distances (Niklas 1994), although the great height of reed plants is offset by their frequently low positions on a landscape. The threshold wind speed for pollen liberation (Niklas 1985), which affects the distance that pollen is dispersed, has apparently not been measured for reed. Pollen productivity per unit land surface for Eurasian reed (White 2009) is in the upper part of the range reported for multispecies assemblages or monotypic stands of grasses in other plant communities (Aboulaich et al. 2009, Anttila et al. 1998, Prieto-Baena et al. 2003, Smart et al. 1979). Reed pollen's importance as an allergen in Europe is an indication of its potential to be blown to built-up locations. Thus, what is known is consistent with the occurrence of possibly significant levels of reed pollen allergens in urban areas of eastern North America, but direct evaluation of such exposure there would be preferable.

How could the hypothesis be tested?

Ambient reed pollen may be captured by standard instrumentation for monitoring airborne pollen and spores (e.g., Platts-Mills and Solomon 1993). If there prove to be metropolitan areas where all other common late-flowering grasses have pollen grains that are larger than those of reed, it should be possible to estimate the number of reed pollen grains in air sampled there by measuring diameters of instrument-captured pollen that has the characteristic grass-morphology. If other grasses in the area are releasing abundant pollen similar in size to reed's pollen at about the same time of year, detection from morphology alone is infeasible. Most other late-flowering grasses can be expected to have a ratio of stable isotopes of carbon different from that of reed (Sage et al. 1999), and such differences are measurable in pollen (Amundson et al. 1997). Bermudagrass *(Cynodon dactylon)* is reputedly the main cause of late-season grass pollinosis in this region (Lewis et al. 1983), and its pollen is larger than reed's and differs in isotope ratio. Tailoring immunodetection techniques (Razmovski et al. 2000) specifically to reed pollen grains appears to be another option. The methodology for collecting, characterizing, and counting allergenic pollen fragments is much less well-developed (Taylor et al. 2007). New analytical approaches based on genomic distinctions may be possible, as may immunodetection of fragments of various sizes (Razmovski et al. 2000).

Because these allergens move by turbulent airflow from the point of pollen production, the concentrations to which humans are exposed can be expected to vary greatly across metropolitan space and time. The distances that reed pollen or its fragments travel are poorly known, so sampling should be spatially stratified across the densely populated area under study. Existing sampling stations may not be in the best places for intercepting reed pollen. A reed stand releases essentially all of its pollen within a few weeks (White 2009); sampling could begin about one week before reed stands in the vicinity start to shed pollen, continuing until a few weeks after shedding was completed.

Thoroughly testing this hypothesis will require work coordinated among multiple metropolitan areas of the northeastern Atlantic seaboard, Great Lakes, and St. Lawrence valley. This is beyond the scope of what an individual investigator's laboratory can accomplish. Sampling in multiple years will be needed because of interannual vagaries in wind velocity during the short period of release of reed pollen, and because weather conditions are also thought to strongly influence the fragmentation of pollen (Taylor et al. 2007).

Implications of the hypothesis

Grass pollen has long been common in the human environment, and thus the emergence of widespread grass pollinosis during the past two centuries (Emanuel 1988) and the explosive increase in asthma in recent decades (Selgrade et al. 2006) were surely not caused solely by changes in the prevalence of grass pollen. Nevertheless, a sizable reduction in regional pollen release from reed might lessen late-season allergenic morbidity. If reed pollen were found to be a health hazard in a metropolitan area, options to reduce reed abundance (Blossey 2003) may be considered. Reed's tall stature and highly aggregated spatial pattern make it logistically easier to locate and control than would be the case for many other plants with allergenic pollen. One method is cutting down the reeds in the airshed when the inflorescences begin to appear. If cutting were found to have acceptable environmental impacts, the expense of doing it could be offset by marketing the cut herbage for biomass energy (e.g., Hansson and Fredriksson 2004) or other raw material use. In what may be a happy coincidence for the members of the regional population who suffer from grass pollen, Smil (1983) viewed stands of reed as one of the most promising types of vegetation for producing biomass.

A large literature on the ecological effects of reed invasions of North America has developed in the past few decades (reviewed in Meyerson et al. 2009), but little consideration of possible direct effects on humans has found its way into print. While all of the variables that we were able to address are consistent with the occurrence of possibly significant levels of reed pollen in eastern urban areas, connecting these dots is not quite enough; a more direct form of evidence is needed. A significant amount of reed pollen is potentially encountered regularly by some 90 million North Americans. Because of this massive scale, we believe that the human health facet of this plant's invasion deserves focused investigation.

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