Pollen dynamics sets the tempo of fruiting pulses in oak tree populations

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Abstract

In many perennial wind-pollinated plants, the dynamics of seed production, commonly known to be highly fluctuating from year to year and synchronized among individuals within populations, dramatically impacts forest regeneration and biodiversity. However, the proximate causes of such seeding dynamics, called masting, are still poorly understood, making any accurate forecasting virtually impossible. Combining long-term surveys of airborne pollen amount and acorn production over large-scale field networks and a mechanistic modeling approach, we investigated the role of pollen dynamics and limitation on the acorn production of temperate oak trees that are widespread and abundant in Northern hemisphere forests. From this novel approach, we found that pollen dynamics displays masting-like pattern reflecting resource depletion and limited pollen production the year following large pollen release, yet with dampened inter-annual pollen fluctuations compared to those of acorns. Both the airborne pollen amount and acorn production are positively related, according to a logistic function, to increasing temperature and decreasing rainfall in spring. By coupling field and simulated data, we found that the dynamics and limitation of pollen are key drivers of oak masting. Mechanisms at play involved both synchronized internal resource dynamics and depletion among trees, limiting pollen production at the population scale, and spring weather conditions that affect pollen aerial diffusion. The sensitivity of airborne pollen amount (then

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acorn production) to spring weather should make oak masting highly sensitive to climate change. Thus, with the ongoing warming climate, we predict that the fruiting dynamics, initially unpredictable, should keep highly fluctuating (because of resource depletion mechanisms) yet with much more deterministic variation, which should markedly affect the whole forest biodiversity through cascade effects.