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Biodiversity on the ground and in the air: Gene flow in trees

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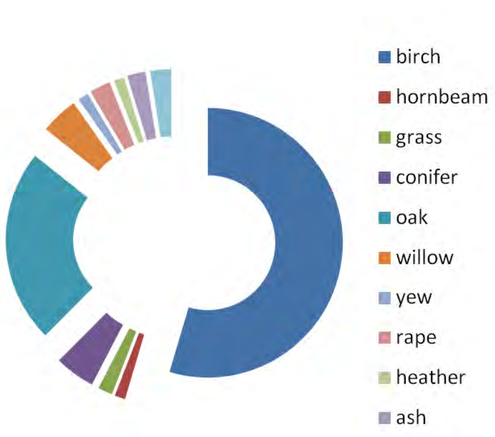
Introduction

Pollen movement is a basic biological process, impacting on the population genetics and the adaptability of plant populations, and affecting human health through the triggering of allergic rhinitis and asthma in susceptible individuals. A pollen monitoring station has been operating at SCRI for 20 years, feeding data into the UK national network for forecasts for hay fever sufferers. These data have recently illustrated the potential for gene flow on a European scale in catkin-bearing trees, with implications for their adaptability to shifting climate zones.

Observations

Airborne pollen monitoring at SCRI

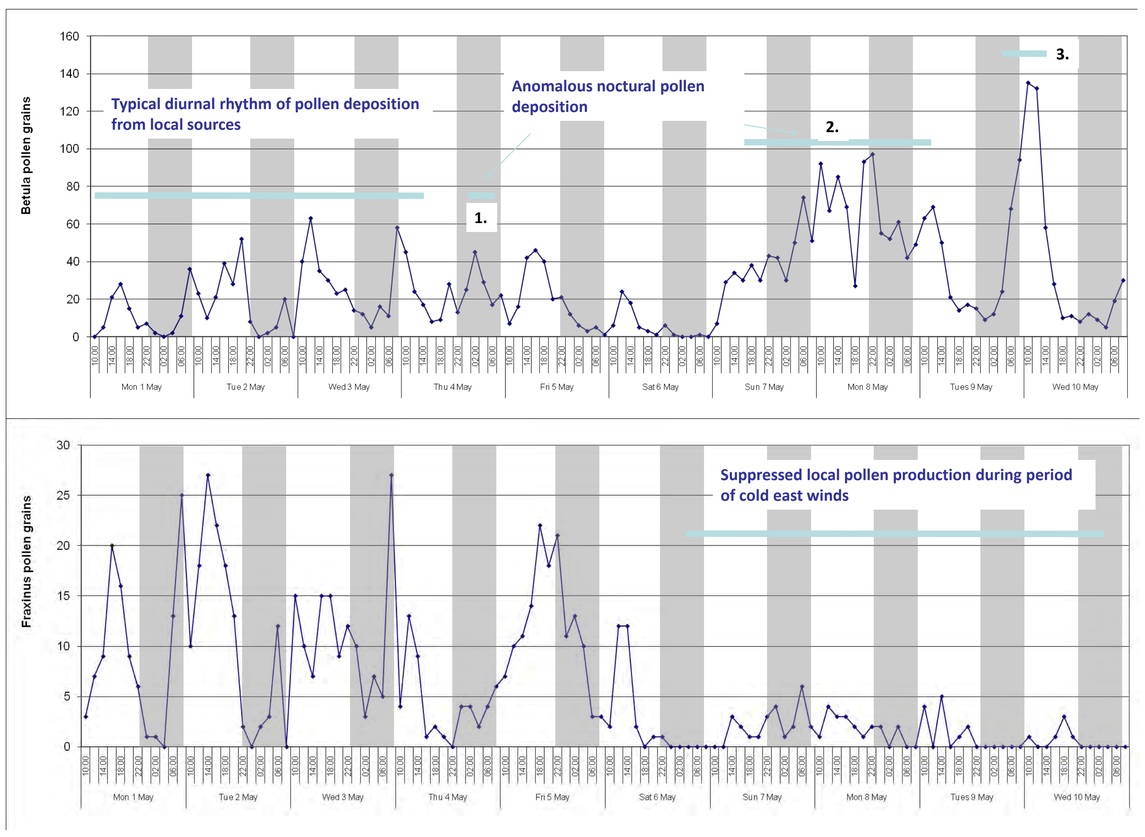


Pollen types in one week in April 2009

A Burkard 7-day Volumetric Spore Trap is used to sample air continuously on a flat roof at SCRI from March to August at a rate of around 10 l min^{-1}. Pollen is, in most cases, identified to genus.

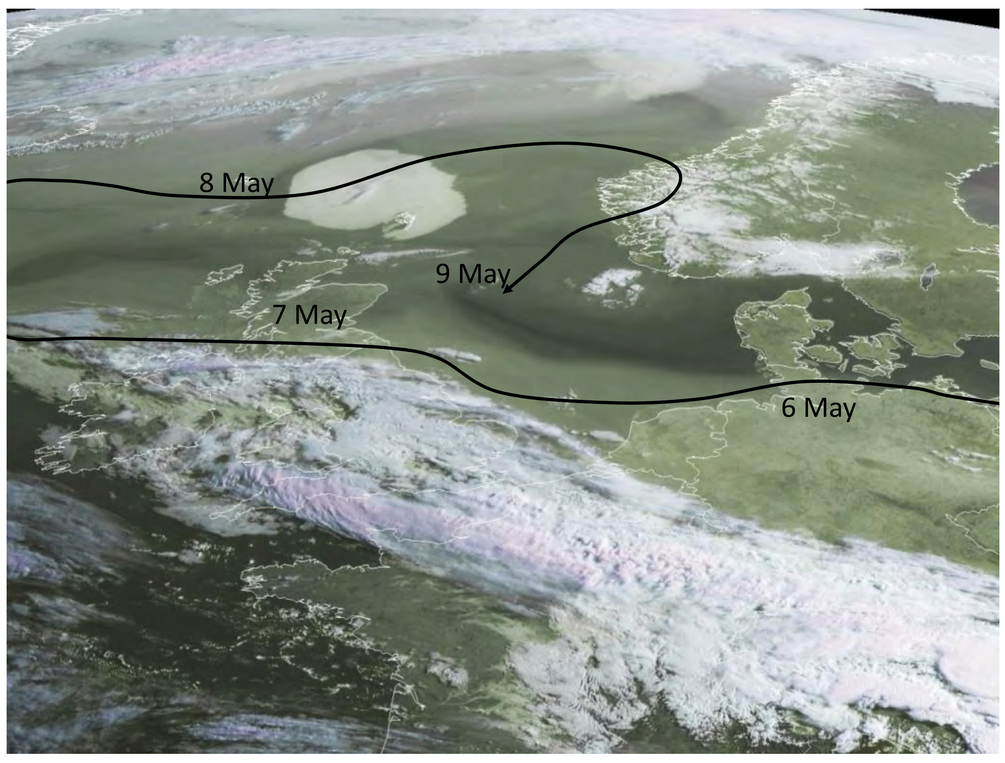
During April the diversity and quantity of pollen rises with around nine types regularly recorded (see above). The major pollen type across northern Europe in spring is birch, a pollen type which causes allergies in significant numbers of people, and the Scottish pollen flora is dominated by this type for 1-2 weeks in late April or early May.

Pollen of all types typically follow a diurnal rhythm, with pollen release taking place through the day as the air warms, limited transport of that pollen by air currents, and a progressive removal of that pollen by settling out and impaction on surfaces through the day.



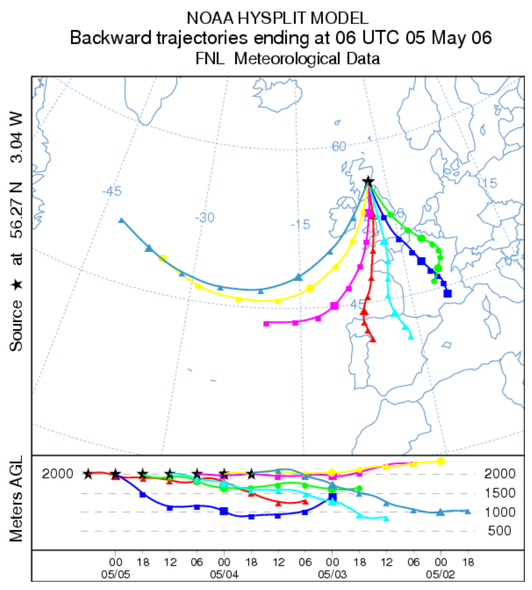
Pollen profiles in May 2006 showing typical diurnal patterns plus minor and major influxes of continental pollen, primarily birch, overnight on 4-5 May and 7-10 May.

In 2006 the spring was characterised by a late and synchronous start across Europe triggered by a strong anticyclone passing from France to W Russia during 3rd to 9th May. The cool SE winds reaching E Scotland on 7th May suppressed local pollen production (see *Fraxinus* above) yet produced anomalous data for some other tree genera, particularly *Betula.* The sustained high levels of pollen outside the normal diurnal rhythm were unprecedented, as was indeed the existence of any significant pollen count at a time of mists and breezes coming off the North Sea.

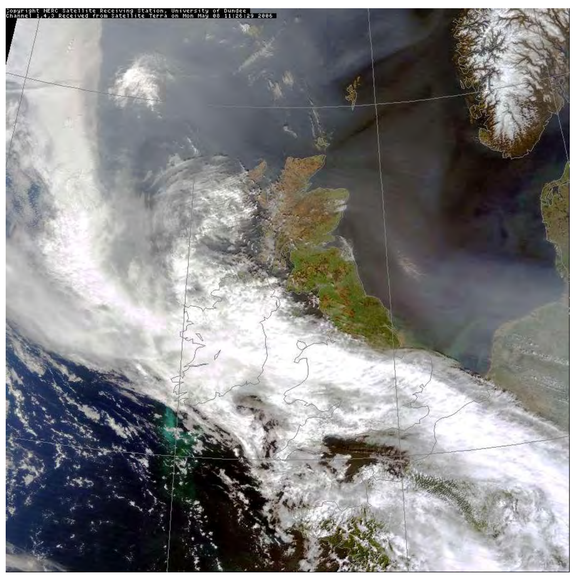


Meteosat image of dust and pollen-laden air originating from W Russia and tracking across Scotland, reaching Iceland, and returning to Scandinavia and Scotland.

Inspection of Meteosat (above) and MODIS (below) data indicated a stream of dust and associated pollen moving down the Baltic, across Denmark, the North Sea, Scotland, and the Atlantic to Iceland, from where it returned to Scandinavia and again towards Scotland, matching with periods of peak detection of pollen (2. and 3. on the pollen profiles).



Rising air over central France (dark blue line) arriving Dundee midnight 4 May.



MODIS coloured satellite image showing detail of continental dust cloud returning.

A further smaller spike of birch pollen (1.) in the middle of the night of 4/5 May matched perfectly with a rising air event over central France 24 hours earlier.

Implications

Remarkable long distance pollen dispersal events show the potential for gene flow on a continental scale. This dispersal event brought elevated levels of European pollen of several of the spring flowering trees. Even though the viability of such pollen has not been demonstrated, the smaller event bringing French *Betula* pollen to Scotland on 4 May took only 24 hours to reach Scotland and such pollen is likely to be viable. The later event may have brought approaching one third of the annual count of *Betula* pollen to the trap site from continental sources. Such events – and the smaller ones less readily detected – may impact on the population genetics of trees with airborne pollen, bringing geographically isolated forests into genetic contact , and permitting the relatively rapid adaptation of populations to new pressures.

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