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Seed hairs of poplar trees as natural airborne pollen trap for allergenic pollen grains

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Abstract

The present article deals with the efficacy of seed hairs of poplar trees (*Populus* spp.) as a potent natural airborne pollen trap. Different species of *Populus* are commonly found planted along the streets in the cities of North China. The seed hairs and pericarp of poplar trees were collected from the trees and on the ground in Beijing Botanical Garden of Chinese Academy of Sciences and around Miyun Reservoir during May 2005 for pollen analysis. Different pollen spectra are recorded from different samples and are characterised by dominant occurrence of pollen grains of arboreal and anemophilous plants. In addition, pollen grains of non-arboreal plants including grasses are also found trapped. Among the 46 trapped pollen grains, 26 are known to be allergenic. This study suggests that poplar seed hairs possibly make people feel uncomfortable due to the presence of allergenic pollen trapped in the hairs.

Keywords: Airborne pollen, pollen allergy, pollen trap, *Populus*, seed hairs

Different types of pollen traps are used in studies of modern pollen rain. Lake sediments, moss and lichen cushions, bark and leaves are such common natural traps (e.g. Faegri et al., 1989; Moore et al., 1991). Spider webs are used to trap insects and provide useful environmental information on caves (Hose et al., 2002). Recently they have also proved to be an efficient natural trap of airborne spores and pollen grains (Bera et al., 2002; Song et al., 2007).

In this article we introduce the potential of poplar (*Populus* spp.) seed hairs as an efficient natural trap of airborne spores and pollen grains. The study demonstrates that the trapped palynoassemblage reliably reflects the modern flora of the studied areas, Beijing Botanical Garden and Miyun Reservoir, P. R. China.

Poplar (*Populus* spp.) is a roadside tree commonly found in North China. There are about 100 species of *Populus* growing in the world, of which 71 species occur in China (Fang et al., 1999). Twenty species grow in the Botanical Garden of the Chinese

Academy of Sciences in Beijing, according to the Catalogus plantarum cultorum of Beijing Botanical Garden (CPC, 1985), and two species grow around Miyun Reservoir. The trees flower in March and produce fruits from the end of April to the beginning of May in Beijing. When their fruits become mature and seeds spread, the seed hairs become dispersed in the air and trap the airborne spores and pollen grains. Some of these are known to cause allergic reactions in human beings.

Material and methods

Seven samples of poplar seed hairs and pericarp were collected in May 2005 from the Botanical Garden (116° 12' E; 40° 00' N), Chinese Academy of Sciences, and one from Miyun Reservoir (116° 85' E; 40° 37' N), Beijing (Figure 1; Table I). When the hairs were collected in the field, they were directly put into a sealed polythene plastic bag in order to avoid contamination. The hairs were

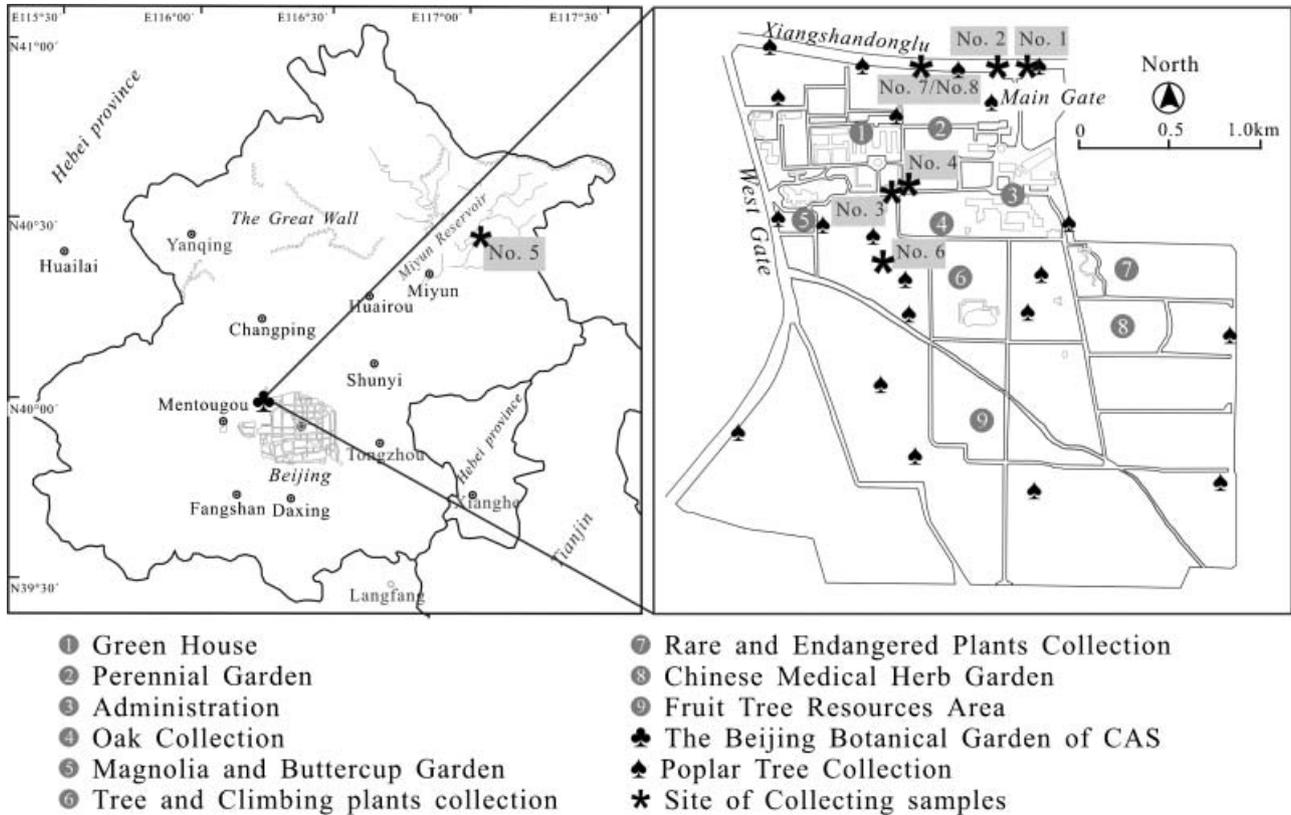


Figure 1. Sites of samples collected.

dipped in boiled water for 6 – 8 hours, filtered through a 500 μm sieve and centrifuged at 2 000 rpm for 10 min. After centrifugation the samples were acetolysed for 40 min with a fresh mixture of acetic anhydride and concentrated H_2SO_4 (9:1 v/v). Pollen grains obtained were identified using reference slides and literature (Ye et al., 1988; Wang et al., 1995; Qiao et al., 2004). A minimum number

Table I. Location of samples and pollen grains counted.

Sample No.	Material	Date	Site	Pollen grains counted
No. 1	Cotton	May 5	main gate of the Garden	364
No. 2	Cotton	May 6	main gate of the Garden	932
No. 3	Cotton	May 7	Garden	330
No. 4	Cotton	May 7	meadow in the Garden	1 453
No. 5	Cotton	May 13	Miyun Reservoir	222
No. 6	Cotton	May 14	center of the Garden	539
No. 7	Cotton	May 14	by the road out of the Garden	236
No. 8	Pericarp	May 6	by the road out of the Garden	393

of 200 grains were counted for every sample. The slides are kept at the Palaeobotanical Laboratory, Institute of Botany, Chinese Academy of Sciences, P. R. China.

Results

A total of 4 469 pollen grains belonging to 46 taxa were identified from eight seed hair samples. Of these, 3 582 (79.97%) pollen grains represented 19 anemophilous taxa, while 897 (20.32%) derived from 27 taxa were entomophilous. Three thousand one hundred and five pollen grains (69.32%) belonging to 25 taxa were arboreal, whereas 1 374 (30.68%) pollen of 21 taxa were from non-arboreal plants. Some important arboreal plants recorded were species of *Betula*, *Broussonetia*, *Juglans*, *Lonicera*, *Pinus*, *Quercus*, *Syringa*, *Viburnum*, Cupressaceae, Fabaceae, Moraceae and Rhamnaceae. The major non-arboreal plants recovered were species of *Artemisia*, *Orychophragmus violaceus*, Asteraceae and Poaceae (Figure 2).

The pollen composition was different in the eight samples studied (Figure 2). However, it was observed that the arboreal pollen grains were predominant in seven of the samples. However Sample No. 4, which was collected from the plants

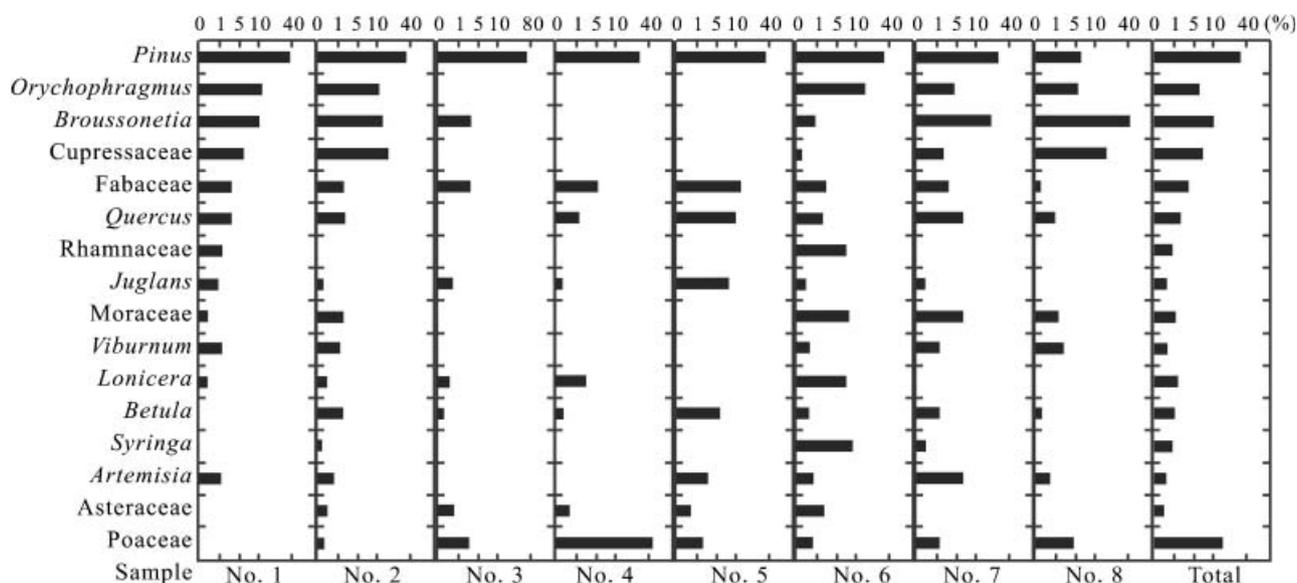


Figure 2. Frequency of palynomorphs recovered from seed hairs of poplar trees.

growing adjacent to a meadow, yielded a high frequency of grass pollen grains.

Of the 46 taxa, 26 taxa are known to be allergenic (<http://www.diagnostics.com>; Table II), comprising 88.70% of the total number of grains. Most of the anemophilous pollen grains were found to be allergenic (Figure 3).

Table II. Allergenic pollen recovered from the poplar seed hairs.

Taxa	Anemophilous/ Anthophilous	Arboreal/ Non-arboreal
<i>Acer</i>	⊙	+
<i>Betula</i>	⊙	+
<i>Carya</i>	⊙	+
<i>Juglans</i>	⊙	+
<i>Picea</i>	⊙	+
<i>Quercus</i>	⊙	+
<i>Ulmus</i>	⊙	+
Chenopodiaceae	⊙	–
Cyperaceae	⊙	–
Fabaceae	*	+/-
Moraceae	⊙	+
Plantaginaceae	⊙	–
Polygonaceae	⊙	–
<i>Artemisia</i>	*	–
<i>Broussonetia papyrifera</i>	⊙	+
<i>Ginkgo</i>	⊙	+
<i>Lonicera</i>	*	+
<i>Pinus</i>	⊙	+
<i>Salix</i>	⊙	+
Asteraceae	*	–
Cupressaceae	⊙	+
Euphorbiaceae	*	+/-
Meliaceae	*	+
Oleaceae	*	+
Poaceae	⊙	–
Rosaceae	*	+/-

⊙ Anemophilous, * Anthophilous, + Arboreal, – Non-arboreal.

It is interesting to note that no *Populus* pollen was found among the trapped pollen assemblage. By the time the seeds set in *Populus*, the flowering period is over, leaving little chance for seed hairs to trap their own pollen grains.

Discussion

Among the trapped palynomorphs, the arboreal pollen grains are found to be the most common type (69.32%). This agrees well with the modern vegetation of the garden, where more than 500 species of trees and shrubs are cultivated (CPC, 1985). The study time (May, 2005) also coincides with the flowering time of most of the trees growing here (CPC, 1985). As a natural trap, the poplar seed hairs remain on the trees before dispersing and could trap those pollen grains, which are already in the air stream.

Meteorological factors, such as temperature, rainfall, wind speed and direction usually affect the pollen concentration in the atmosphere. There is a positive correlation between the temperature and the concentration of airborne pollen. Rainfall or low temperature normally causes a decrease in pollen concentration (Kadooca & Juhász, 2002; Green et al., 2004; Peternel et al., 2004; Rodriguez-Rajo et al., 2005) resulting in a lower incidence of pollinosis (Altintas et al., 2004). In Beijing during May the mean temperature is 16 – 20°C and the mean precipitation is 50 – 70 mm, which are quite favourable for a high incidence of hay fever. In Sample No. 4, Poaceae pollen is the most prevalent type, because the hairs were collected from the plants growing near a grass meadow. In Sample

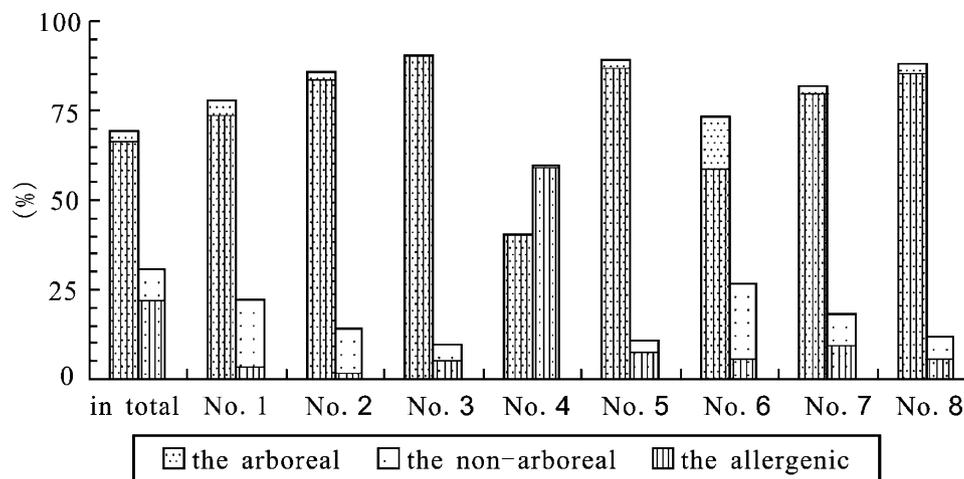


Figure 3. Percentage of allergenic pollen among the arboreal or non-arboreal pollen taxa recovered from poplar seed hairs.

No. 6, quite a large number of pollen types are recorded, as the hairs were collected from the trees growing in the central part of the Garden with a high diversity of plants. In Samples Nos. 1, 2, 7 and 8, *Broussonetia papyrifera* pollen predominates, because many trees of this species are found near the sampled poplar trees. This indicates that most of the pollen trapped in the seed hairs is of local origin.

Of the 46 taxa of trapped pollen grains, 26 are known to be allergenic (Table II). Grass pollen is a potent allergenic agent (Subiza et al., 1995; D'Amato et al., 1998), although only a few of them are recorded from the hairs. Chenopodiaceae/Amaranthaceae and *Artemisia*, also recorded from the hairs, are common allergenic pollen (Al-Dowaisan et al., 2004; Lombardero et al., 2004). The pollen of Betulaceae, *Carya* and *Broussonetia papyrifera*, which are found abundantly in the seed hairs, are also known to be allergenic (Rachmiel et al., 1996; Zanforin & Incorvaria, 2004). While the possibility that seed hairs are a potent allergen cannot be ruled out (Zhao & Wu, 2004), we suggest that the pollen trapped in the hairs is the probable cause of allergy in the people of poplar-growing regions of China. Poplar trees are abundant in the cities in North China. When the poplar trees produce their fruits in April/May, it is difficult for people to avoid contact with the seed hairs. The airborne pollen reaches its peak in April and May in Beijing (Ye et al., 1991). It may prove injurious to susceptible people exposing themselves to the seed hair-rich air especially in public places like the Botanical Garden and Miyun Reservoir. Usually, the removal of dust from a room is an effective way of avoiding pollinosis (Fahlbusch et al., 2001). Regular cleaning to remove seed hairs, public awareness and choosing a suitable time (after seed dispersal) to visit places of public interest is

suggested to avoid possible pollinosis caused by poplar hairs.

Conclusion

In the present study, poplar seed hairs were collected in order to analyse their pollen content. In total, 46 pollen taxa were found in eight samples. Of these 26 taxa are known to cause allergic reactions in human beings. As a natural trap of airborne pollen grains, poplar seed hairs can cause people to feel uncomfortable.

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