

London Plane Tree bioaerosol exposure and allergic sensitization in Sydney, Australia

Jason K. Sercombe, BSc, GDip Biomed Eng*†; Brett J. Green, BSc (Hons), PhD‡; Janet Rimmer, MD*; Pamela K. Burton, RN, CNC, CRC§; Constance H. Katelaris, MD, PhD§; and Euan R. Tovey, MSc, PhD*

Background: Exposure to London Plane Tree (*Platanus*) bioaerosols in Sydney, Australia has been anecdotally linked to respiratory irritation, rhinitis, and conjunctivitis.

Objective: To determine the relationships between *Platanus* bioaerosol exposure, allergic sensitization, and symptoms.

Methods: Sixty-four subjects with self-reported *Platanus* symptoms were recruited from inner-urban Sydney. Allergic sensitization was determined by skin prick test (SPT) to 13 allergens. Airborne concentrations of *Platanus* pollen, trichomes, and achene fibers, and other pollen and fungal spores, were measured over the spring and summer of 2006–2007. Subjects' allergic symptoms were monitored concurrently. The Halogen immunoassay (HIA) was used to measure subjects' immunoglobulin E (IgE) reactivity to collected bioaerosols.

Results: *Platanus* pollen constituted 76% of total pollen between July 2006 and April 2007. Airborne concentrations of *Platanus* pollen peaked from August until October. Non-*Platanus* pollen peaked from July to December. Elevated concentrations of trichomes and achene fibers occurred from September to December and August to October, respectively. As determined by SPT, 85.9% of subjects were sensitized, 65.6% to any pollen tested, 56.3% to *Lolium perenne*, and 23.4% to *Platanus*. Higher mean daily symptom scores were only associated with high counts of non-*Platanus* pollens. HIA analysis demonstrated IgE binding to *Platanus* pollen in all *Platanus* sensitized subjects. Personal nasal air sampling detected airborne trichomes that were capable of being inhaled. *Platanus* trichomes or achene fibers did not bind IgE from any subject.

Conclusions: *Platanus* bioaerosols exist in high concentrations between August and November in inner-urban Sydney but were not associated with seasonal symptoms. *Platanus* trichomes are inhaled and may constitute a respiratory irritant.

Trial Registration: Clinicaltrials.gov Identifier: NCTXXXXX.

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INTRODUCTION

The London Plane Tree (*Platanus x acerifolia*; 'Platanus') is a fast-growing deciduous tree, a hybrid of the Oriental Plane Tree (*Platanus orientalis*) and the American Sycamore (*Platanus occidentalis*),¹ and is commonly planted in many cities around the world. Associations between exposure to *Platanus* and allergic respiratory morbidity have been previously reported.^{2,3} The prevalence of *Platanus* pollen sensitization among subjects with seasonal respiratory allergies in Europe

varies between different locations studied: 8.48% in Barcelona, Spain,³ 11.4% in Cova da Beira, Portugal,⁴ and 56% in Madrid, Spain.⁵ Using in vitro assays, serum IgE from allergic rhinitis patients has been demonstrated to bind to proteins purified from *Platanus* pollen,^{6,7} including the major allergen Pla a 1, a secreted 18-kDa protein.⁷

Platanus pollen (Fig 1) is observed in high airborne concentrations during spring in some regions of Europe,^{6,8} North America,⁹ and Australia.¹⁰ *Platanus* accounts for more than 62% of the total airborne pollen present during the month of March in Cordoba, Spain,⁶ and *Platanus* pollen is the most prevalent airborne pollen during spring in an Australian locality with a high population of the trees.¹⁰ In contrast, *Platanus* represents approximately 3.5% of total annual airborne pollen in Washington, D.C., where *Platanus* is also commonly planted.⁹ In addition to pollen, *Platanus* trees also produce 2 other bioaerosols with the potential to provoke respiratory and ocular symptoms: irritant leaf hairs, known as trichomes,¹¹ and achene fibers.¹² No published data exist on the airborne concentrations, temporal relationship to symptoms, or allergen content of these nonpollen *Platanus* bioaerosols.

In inner-urban Sydney, *Platanus* has been planted in more than 20% of streets.¹³ Residents have reported seasonal exacerbations of respiratory irritation, rhinitis, and conjuncti-

Affiliations: * Woolcock Institute of Medical Research, Sydney, NSW, Australia; † Infectious Diseases and Immunology, The University of Sydney, Sydney, NSW, Australia; ‡ Allergy and Clinical Immunology Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Morgantown, WV; § University of Western Sydney and Campbelltown Hospital, Sydney, NSW, Australia.

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Figure 1. *Platanus* pollen grains (P).

tis, which many attribute to *Platanus*. Currently, little information is available on exposure to *Platanus* bioaerosols in this locality relative to exposure to other seasonal allergen sources. The objective of this study was to longitudinally assess bioaerosol exposure from 3 Inner-Sydney sites with a high density of *Platanus* plantings, and relate this to allergic sensitization, determined by skin prick test (SPT), and reported symptoms in a local population. We also used the halogen immunoassay (HIA) to enable the identification of specific allergen sources relevant to individuals, and nasal air samplers (NAS) to demonstrate personal exposure to *Platanus* bioaerosols.

METHODS

Study Location and Population

The study was conducted in the inner-urban localities of Darlinghurst, Paddington, and Surry Hills in Sydney, Australia, where *Platanus* is a common street tree. Subjects were recruited via a public campaign. Entry criteria included a self-reported history of seasonal rhinitis, possibly attributable to *Platanus*, and local residence. Seventy subjects responded to the recruitment campaign, and 64 subjects (27 male; aged 23–87 years; median age, 51 years) took part in the study. Six subjects chose not to proceed. The study was approved by the University of Sydney Human Research Ethics Committee (ACTR# 12606000251527). Written informed consent was obtained.

Determination of Allergic Sensitization

Skin prick testing (SPT): Skin prick testing was conducted to 13 common allergens as previously described.¹⁴ The ex-

tracts were London Plane Tree (*Platanus x acerifolia*), *Cupressus* spp., *Cynodon dactylon*, *Lolium perenne* (Staller-Genes SA, Antony, France), *Plantago* spp., *Eucalyptus* spp., *Acacia* spp., *Casuarina* spp., *Melaleuca* spp., cat hair, house dust mite, soybean, and peanut (Hollister-Stier Laboratories, Spokane, Washington). Positive (histamine 10 mg/mL) and negative (50% glycerol/normal saline) controls were included. A wheal reaction of at least 3 mm mean diameter measured after 15 minutes was considered a positive result.

In vitro tests: Serum was collected from 10 subjects who were SPT positive to *Platanus*, from 10 subjects SPT negative to *Platanus* but positive to other aeroallergens, and from 4 subjects who were SPT negative to all aeroallergens tested. Individual sera were used to test for binding of each subject's serum IgE to *Platanus* pollen, nonpollen particulates, and other aeroallergen sources (see section: 'Halogen Immunoassay Identification of Allergen Containing Particles and Subject Symptoms'). Specific immunoglobulin E (IgE) to *Platanus* was quantified using the Immulite 2000 system (Seimens Healthcare, Erlangen, Germany), with sensitization defined as a concentration of at least 0.35 kU_A/L.

Symptom Surveys

Subjects used a diary to record a daily total nasal and ocular symptoms score ('daily TSS').^{15,16}

Bioaerosol Sampling

Three Burkard 7-day volumetric spore traps (Burkard Manufacturing Co., Rickmansworth, United Kingdom) were located approximately 0.5 km apart within the study region, being within 3 km of where all subjects lived or worked, and were positioned in accordance with Australian Standard DR 6502¹⁷ on rooftops, at an average height of 15 m. Two samplers operated from 24 July 2006 to 2 April 2007 and the third from 23 August 2006 to 20 December 2006. Each sampler was equipped with 2 parallel tapes, each 10 mm wide. One tape was Melenex, coated with Sylgard 527 adhesive grease (Dow Corning Corp., Midland, Minnesota). This tape was stained with Calbera's solution and examined under 400× magnification. Pollen were morphologically identified¹⁸ by standard methods, and pollen, plant fragments, and fungal spores were quantified by counting 12 transects of the tape for each 24-hour period and converting this to a mean concentration per cubic metre.^{19,20} Airborne pollen concentrations were averaged between the sampling sites. The second tape was coated with a proprietary adhesive, suitable for the Halogen immunoassay (HIA).

Nasal Air Samplers (NAS) (Woolcock Institute of Medical Research, Sydney, Australia) were used by 8 subjects to sample personal inhaled exposure. NAS are worn immediately inside the nares and have been shown to collect more than 95% of inhaled pollen¹⁴ onto a grease-coated impaction surface. The NASs were worn for 30 minutes at a time that subjects experienced symptoms. Particulates collected by each NAS were identified and quantified by light microscopic examination of the entire collection surface.

Symptom Survey and Bioaerosol Exposure Analysis

After examination of the bioaerosol data, exposure was categorized into high and low seasons for exposures to 4 types of bioaerosol: (1) *Platanus* pollen; (2) non-*Platanus* pollen; (3) trichomes; and (4) fungal spores. High season was defined as the period containing 7-day rolling average concentrations of at least 5% of the highest observed 7-day average concentration of that bioaerosol. This method was adapted from that used by Dahl and Strandhede²¹ for defining the season for birch pollen exposure, to allow for a limited period of bioaerosol sampling.

For analysis of the relationship between exposure and symptoms, the mean daily TSS symptom scores for each subject in the high exposure season and in the low exposure season of each bioaerosol was calculated, and differences tested by paired *t* tests. The comparison of mean high- and low-season mean symptom scores was performed to allow for missing symptom data, and the use of paired significance tests negated intersubject variation. The primary analysis was performed for all subjects regardless of their sensitization status. Secondary analyses were performed separately for only those subjects who were SPT positive to *Platanus*. The seasonal mean symptom differences reported by the *Platanus* SPT-positive and *Platanus* SPT-negative groups were compared using independent *t* tests.

Halogen Immunoassay Identification of Allergen Containing Particles and Subject Symptoms

Halogen immunoassay (HIA) allows the immunostaining and visualization of individual pollens that function as allergen sources.²² The sampled particles were collected onto an adhesive-coated tape and laminated with a polyvinylidene fluoride protein-binding membrane. Allergens were eluted in borate buffer, resulting in a zone of allergenic proteins bound to the membrane in close proximity to the source particle. Samples were then immunostained using an individual subject's serum as the source of primary antibody and anti-human IgE conjugated to alkaline phosphatase (KPL Inc., Gaithersburg, Maryland) as the secondary antibody. Color development with nitro-blue tetrazolium and 5-bromo-4-chloro-3'-indolylphosphate substrate (Pierce Chemical Co, Rockford, Illinois) allowed particles binding IgE to be identified by a surrounding 'halo' of purple staining, visible using light microscopy.

Because of constraints of the volume of human serum available, testing all Burkard samples from all sampling periods was not feasible. The 24-hour samples corresponding to the daily maximum and minimum symptoms for each of the 24 (10 + 10 + 4) subjects from whom serum was collected were analyzed. No maximal or minimal symptom days coincided between subjects. In all cases the subjects had spent at least 8 hours of the day within 3 km of at least 1 of the Burkard spore traps.

The relationships between the percentage of *Platanus* pollen grains showing positive HIA immunostaining with each subject's IgE, and the subject's SPT reaction to *Platanus*

extract and serum concentration of *Platanus*-specific IgE were both tested by regression analysis. The extent of IgE binding to allergens associated with *Platanus* pollen, trichomes, and achene fibers, plus other non-*Platanus* pollens, and fungal spores on each of the high and low symptom days were examined for the subject groups who were SPT positive to *Platanus* and for those SPT negative to *Platanus*.

RESULTS

Allergic Sensitization of Subjects

The SPT results for the 64 subjects who reported seasonal symptoms are shown in Table 1. Of these, 55 (85.9%) were sensitized to at least 1 of the allergens tested, 42 (65.6%) were sensitized to at least 1 pollen extract, and 15 subjects (23.4%) were sensitized to *Platanus*. All subjects sensitized to *Platanus* were also sensitized to other common aeroallergens, including *Lolium perenne*. Seven of the 64 subjects were SPT negative to all allergens tested, and 2 were deemed indeterminate because of negative reaction to the histamine positive control.

Airborne Pollen, Fungi, and Other Bioaerosols

Figure 2A shows the daily airborne concentrations of *Platanus* pollen, non-*Platanus* pollen, and fungal spores. *Platanus* pollen was the most abundant airborne pollen collected during the bioaerosol sampling interval (24 July 2006 to 2 April 2007) and constituted 76% of the total pollen collected (Table 2). *Platanus* pollen counts from the 3 sampling sites were strongly correlated to each other ($r^2 = 0.64$, $P < .01$). The maximum *Platanus* concentrations occurred on the 2nd and 3rd of September at all 3 sampling locations (2,098, 1,017, and 1,183 grains/m³).

Airborne concentrations of 2 other bioaerosols originating from *Platanus* are shown in Figure 2B. The peak concentration of achene fibers (7.09 particles/m³) derived from the previous season's fruiting bodies roughly coincided with the peak airborne concentration of *Platanus* pollen. The peak concentration of trichomes (21.2 particles/m³) followed the peak of *Platanus* pollen, continued until mid-summer, and then decreased with the maturation of *Platanus* foliage.

The contribution of pollen from different plants to the total pollen count over the entire sampling interval, and the maximum daily pollen count for each species, is shown in Table 2. The most frequently occurring non-*Platanus* pollen were *Cupressus*, *Eucalyptus*, and Poaceae species. Poaceae pollen accounted for only 3.9% of the total pollen count, and the maximum observed airborne concentration was only 20 grains/m³. The airborne concentration of fungal spores observed during the sampling interval was heterogeneous and did not show any seasonality (Fig 2A).

Symptoms

Sixty-four subjects returned data for an average of 44% of the total time points for the daily TSS survey. To compare symptoms during periods of high and low concentrations of

Table 1. Sensitization of Subjects as Determined by Skin Prick Test Using Allergen Extracts

Allergen extract giving positive SPT	<i>Platanus</i> positive subjects (n = 15)	<i>Platanus</i> negative, other allergen positive subjects (n = 40)	All subjects (n = 64)	% of All subjects (n = 64)
<i>Lolium perenne</i>	15	21	36	56.3
House dust mite	9	23	32	50.0
<i>Cynodon dactylon</i>	8	18	26	40.6
Cat hair	8	9	17	26.6
<i>Platanus</i>	15	0	15	23.4
<i>Plantago</i>	4	8	12	18.8
<i>Alternaria</i>	5	5	10	15.6
Peanut	5	4	9	14.1
<i>Acacia</i>	4	4	8	12.5
<i>Casuarina</i>	3	5	8	12.5
<i>Eucalyptus</i>	3	5	8	12.5
Soybean	4	0	4	6.3
<i>Cupressus</i>	2	1	3	4.7
<i>Melaleuca</i>	2	0	2	3.1
SPT negative			7	10.9
Indeterminate			2	3.1

the different bioaerosol components, the study interval was divided into high and low seasons for *Platanus* pollen, non-*Platanus* pollen, trichomes, and fungal spores. The duration and timing of these defined seasons are shown in Figure 2C.

Figure 3 shows the differences in mean symptom scores for daily TSS surveys, between high and low exposure seasons, for 4 bioaerosols. Data were paired so that each data point represents the difference in the mean symptom scores between the relevant high and low bioaerosol season for each individual subject. All mean daily TSS scores tended to be higher, on average, in high exposure seasons for all bioaerosols measured. However, no significant difference was seen in the daily TSS scores between the high and low exposure seasons for *Platanus* pollen (Fig 3) ($P = .2484$, $n = 27$). Significantly higher symptoms were observed in the daily TSS ($P = .0358$, $n = 17$) during the non-*Platanus* pollen high exposure season compared with the non-*Platanus* pollen low exposure season. The daily TSS scores showed no significant difference between the high and low exposure seasons for trichomes ($P = .6548$, $n = 36$) or fungal spores ($P = .5036$, $n = 25$). The secondary analyses of only subjects SPT positive to *Platanus* showed no significant differences between any of the defined high and low exposure seasons for *Platanus* pollen ($P = .0700$; $n = 5$), non-*Platanus* pollen ($P = .0945$, $n = 5$), trichomes ($P = .7422$, $n = 8$), or fungal spores ($P = .0918$, $n = 6$). Moreover, the seasonal mean symptom differences reported by subjects who were SPT positive to *Platanus* did not significantly differ from those reported by subjects who were SPT negative to *Platanus*.

Halogen Immunoassay

The percent binding of IgE from the 10 *Platanus* SPT-positive subjects to *Platanus* pollen occurred over a wide range (25th–75th percentiles: 2–91%) with a geometric mean of 11.2% and an average of 40.4% of *Platanus*

pollen grains on their respective samples. The IgE from all *Platanus* SPT-positive subjects bound to at least some *Platanus* pollen. Immunoglobulin E from one of the *Platanus* SPT-negative subjects bound to 4% of *Platanus* pollen. A positive correlation was seen between the percentage of *Platanus* pollen grains that bound IgE in the HIA and the mean diameter of a subject's SPT to *Platanus* ($r_s = 0.80$, $P < .0001$). Similarly, a positive correlation was observed between IgE binding of *Platanus* pollen in HIA immunostaining and the subject's concentration of *Platanus* specific serum IgE ($r_s = 0.75$, $P < .0001$).

No IgE immunostaining was observed of either the trichomes or achene fibers using *Platanus* SPT positive sera, although immunostaining of pollen occurred. Examples of the HIA immunostaining reaction of bioaerosols collected by a Burkard spore trap are shown in Figure 4. Serum IgE from 10 *Platanus* SPT-negative subjects, who were SPT positive to other allergens, bound to a geometric mean of 1.8% (25th to 75th percentiles: 0–34.2%) of airborne non-*Platanus* pollen grains, predominantly comprising *Cupressus*, *Pinaceae*, and *Poaceae* genera, but also not to trichomes or achene fibers. As previously mentioned, serum IgE from one *Platanus* SPT-negative subject did bind to 4% of *Platanus* pollen grains.

A geometric mean of only 0.1% (25th–75th percentiles: 0.0–0.3%) of fungal spores displayed IgE binding in the HIA. However, only limited interpretation can be drawn because optimal detection of fungal allergens requires a different HIA method²³ not applied here.

Inhaled Bioaerosols Measured Using Nasal Air Samplers

The bioaerosols inhaled over 30 minutes by the eight subjects using NAS are shown in Table 3. Although *Platanus* pollen were the most common, non-*Platanus* pollens, including those from *Poaceae*, *Cupressus*, and *Pinaceae* species, con-

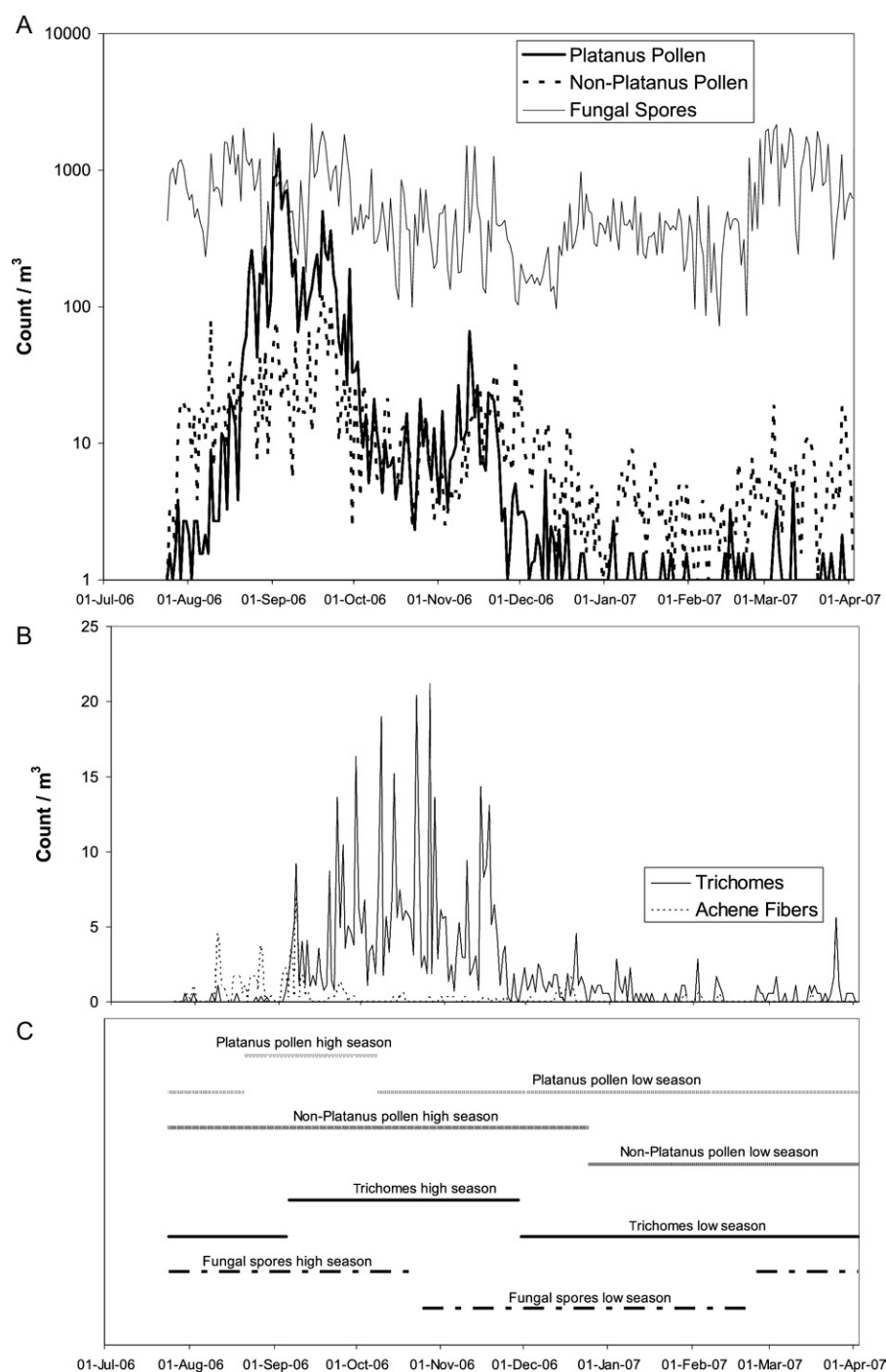


Figure 2. (A) Airborne concentration of *Platanus* pollen, non-*Platanus* pollen, and fungal spores (count/m³). Mean counts from 2 sampling sites between 24 July 2006 and 2 April 2007, mean counts from 3 sampling sites between 23 August 2006 and 20 December 2006. Note logarithmic scale. (B) Airborne concentration of trichomes and achene fibers (count/m³). Mean counts from 2 sampling sites between 24 July 2006 and 2 April 2007, mean counts from 3 sampling sites between 23 August 2006 and 20 December 2006. (C) The duration and timing of the defined high and low seasons for *Platanus* pollen, non-*Platanus* pollen, trichomes, and fungal spores.

Table 2. Maximum Counts of Airborne Pollen and Fungi, and Percentage Breakdown of Pollen Species Observed during the Study Interval

Genus	Percentage of all airborne pollen	Maximum count (pollen grains/m ³ or (spores/m ³))
<i>Platanus</i>	76.2%	1,419.1
<i>Cupressus</i>	5.7%	63.3
<i>Eucalyptus</i>	4.4%	36.4
All Poaceae	3.9%	20.2
Pinaceae	3.5%	43.7
Unidentified pollen	2.6%	17.9
<i>Casuarina</i>	1.7%	12.5
<i>Plantago</i>	0.8%	13.0
<i>Populus</i>	0.6%	7.4
<i>Liquidambar</i>	0.3%	3.0
<i>Alnus</i>	0.2%	6.8
<i>Acacia</i>	0.1%	1.7
Fungal spores	—	2,238.2

stituted 64% of the total pollen in NAS samples. Trichomes, as shown in Figure 5, were collected in six of the eight NAS samples and were inhaled at an average rate of 8.5 trichomes per 30-minute sample. *Platanus* achene fibers were also inhaled by three of the eight subjects.

DISCUSSION

This study explored possible links between exposure to outdoor bioaerosols and nasal and ocular symptoms in a popu-

lation who attributed their symptoms to *Platanus* bioaerosols. Although causal links were not established, the study demonstrated that *Platanus* constituted 76% of the total pollen exposure over the study period and was the most common airborne pollen between August and December. Pollen from Poaceae genera were present in relatively low airborne concentrations, consistent with previous reports.²⁴ However, sensitization to *Lolium perenne*, as determined by SPT, was twice as prevalent as that to *Platanus* (56.3 vs 23.4%). Symptoms occurred over a longer temporal interval than the peak *Platanus* pollen season and were related to the period when there was both *Platanus* and non-*Platanus* pollen, as well as *Platanus* trichomes, present in the bioaerosol load. Whether the symptoms can be attributed to non-*Platanus* pollen, *Platanus* trichomes, or both cannot be determined. We also showed that *Platanus* trichomes were not a source of allergens; however, these particles could possibly contribute to symptoms via an irritant effect.

We did not demonstrate a clear association between the TSS and the period of high *Platanus* pollen count, and the symptoms of both the *Platanus* SPT-positive and *Platanus* SPT-negative groups, analyzed together, were more closely related to the longer high exposure period of non-*Platanus* pollen. However, because of the predominance of *Platanus* pollen, even in the 'low' *Platanus* exposure season *Platanus* pollen concentrations were frequently higher than those of non-*Platanus* pollen during its 'high' season. A more rigorous analytical approach was not possible, because only 23.4% of subjects were sensitized to

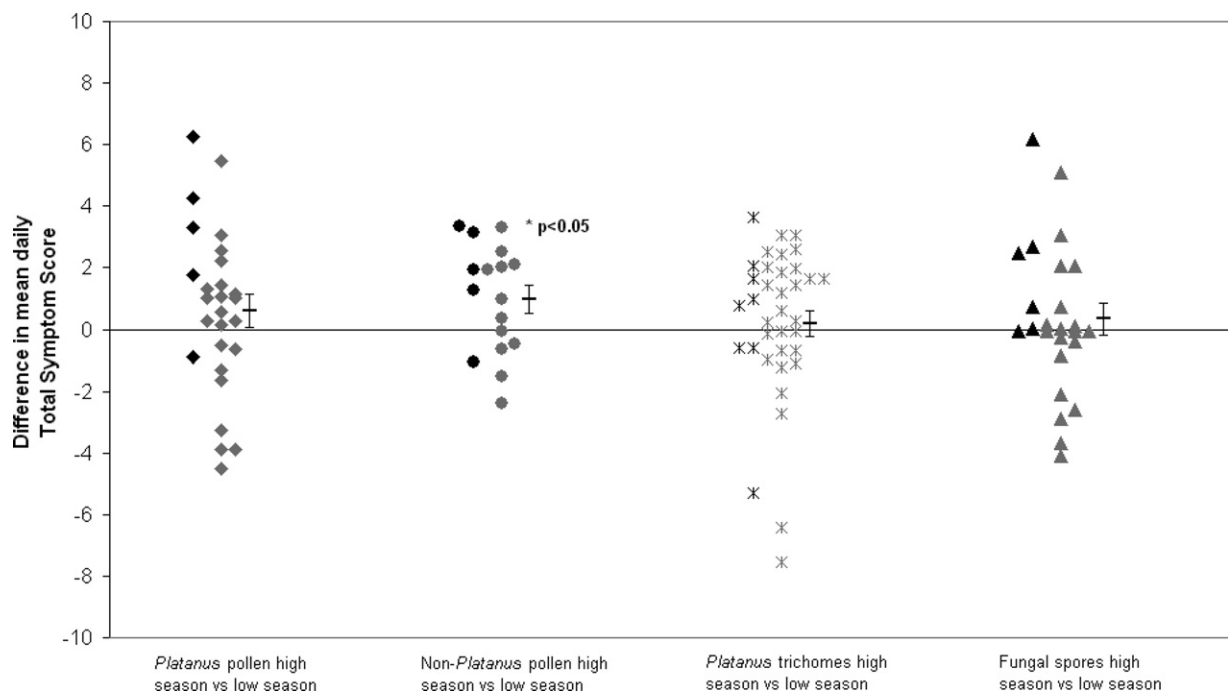


Figure 3. Differences in mean daily Total Symptom Score between high and low exposure seasons for *Platanus* pollen, non-*Platanus* pollen, trichomes, and fungal spores. Black markers indicate *Platanus* SPT-positive subjects. Gray markers indicate *Platanus* SPT-negative subjects. Bars indicate mean differences in symptom scores for all subjects $\pm$ 95% CI.

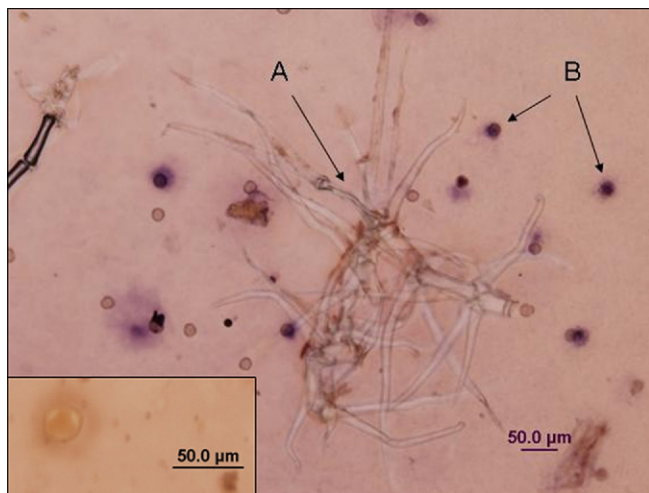


Figure 4. HIA immunostaining of *Platanus* trichomes (A) and pollen in a sample of bioaerosols. Binding of human IgE from a subject SPT positive to *Platanus* is indicated by zones of purple staining (B). Inset: High-magnification image of HIA-immunostained *Platanus* pollen.

Platanus, as determined by SPT, and symptom data were only available for 44% of time points. No relationship was seen between a subject's rate of survey return and their severity of symptoms; therefore, no self-selection of subjects occurred based on symptoms.

Previous studies have reported *Platanus* allergy and symptoms but have predominantly used small groups or groups with a high proportion of *Platanus*-sensitized subjects. Subiza et al⁵ described symptoms in 3 patients in Madrid whose symptoms correlated to local daily *Platanus* pollen counts. Furthermore, 56% of 187 subjects displayed positive SPTs to a *Platanus* extract, whereas 92% were SPT positive to grass pollens and 63% to *Olea europaea* pollen.⁵ Varela et al² showed that average 24-hour rhinitis symptom scores of 39 patients were significantly correlated with *Platanus* pollen counts. A study of airborne *Platanus* pollen concentrations in relation to respiratory symptoms of 19 subjects in Cordoba,

Spain,⁶ concluded that allergic pollinosis was associated with *Platanus* exposure. Subsequently, these authors identified *Platanus* as a hazard for urban residents in areas where the trees were extensively planted.

Using the HIA, we demonstrated that the percentage of *Platanus* pollen grains that displayed positive IgE immunostaining with subjects' serum was related to the serum concentration of specific IgE. Observations of the different staining reactions of individual pollen grains suggest that their allergen content may vary. This is the first study to our knowledge to demonstrate such differences in allergen content of individual pollen grains collected at the same time.

An advantage of the HIA method is that it detects IgE capable of selectively binding to allergenic particles to which exposure is occurring, including binding attributable to allergenic cross-reactivity. Cross-reactivity between *Platanus* allergens and plant-derived food allergens has been demonstrated in SPT and RAST inhibition tests,²⁵ and cross-reactivity with non-*Platanus* species has been suggested as the mechanism responsible for 65% of allergic subjects residing in the Ohio region of the United States being sensitized to *P. occidentalis* despite low airborne concentrations of the pollen.²⁶ In the present study, the observed predominance of *Platanus* pollen suggests that sensitization to *Platanus* would be more likely.

Although we were able to detect binding of IgE from *Platanus* SPT-positive subjects to the *Platanus* pollen, we were not able to demonstrate binding to the *Platanus* trichomes, which have been previously implicated in respiratory irritation of arborists.¹¹ Although in the current study only 8 samples were collected by subjects using NAS, they demonstrated that 6 subjects actually inhaled *Platanus* trichomes, in locations where symptoms were experienced. The NAS sampling also demonstrated that *Platanus* pollen was capable of being inhaled.

In conclusion, this study of bioaerosol exposure and allergy in a self-identified sample population could not isolate *Platanus* as the causal agent responsible for symptoms. However, the complexity of the pollen exposures, and exposure to

Table 3. Bioaerosols Inhaled by Subjects (n = 8) in 30 Minutes whilst Wearing Nasal Air Samplers in Self-Selected Inner-Sydney Locations

Environment sampled	Streets	Home garden	Home garden	Streets	Park	Streets	Home garden	Streets	
NAS samples (particles inhaled)	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Subject 7	Subject 8	Mean
<i>Platanus</i> pollen	0	24	7	2	2	2	0	2	4.9
<i>Platanus</i> trichomes	1	8	2	0	2	38	0	2	6.6
Achene fibers	0	0	6	0	0	1	1	0	1.0
All Poaceae pollen	0	11	2	1	5	2	1	14	4.5
<i>Cupressus</i> pollen	0	0	0	0	0	0	0	14	1.8
<i>Casuarina</i> pollen	0	4	0	0	0	0	0	0	0.5
<i>Eucalyptus</i> pollen	0	0	1	0	0	0	0	0	0.1
<i>Pinaceae</i> pollen	0	12	0	0	1	0	0	0	1.6
All other pollens	0	1	0	0	0	0	0	0	0.1
Fungal spores	23	128	12	2	17	8	4	4	24.8

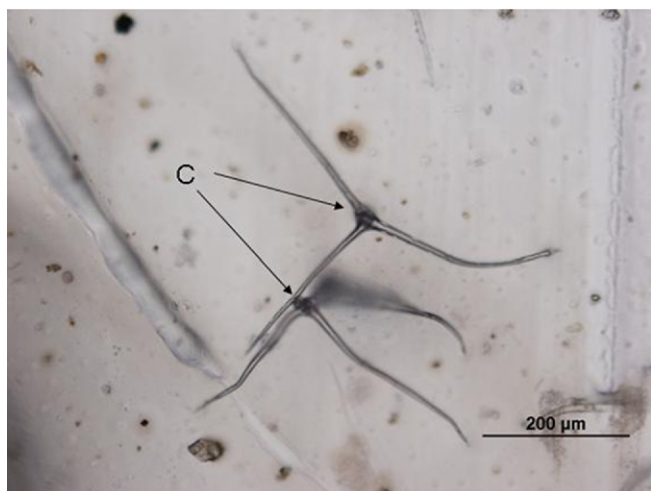


Figure 5. *Platanus* trichomes (C) collected in a Nasal Air Sampler worn by a subject walking along a street in Inner-Sydney.

possibly irritant *Platanus* trichomes, may provide an explanation for ocular and upper respiratory symptoms and warrants further investigation. Definitive characterization of the clinical effects of exposure to *Platanus* pollen and trichomes may require controlled exposure challenge studies.

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Requests for reprints should be sent to:

Jason K. Sercombe
 Infectious Diseases and Immunology
 Rm 630 Blackburn Bld D06
 The University of Sydney,
 NSW 2006
 Australia
 E-mail: jason.sercombe@sydney.edu.au