Attachment G

Guidance Report on Allergens and Irritants of Trees

Guidance Material on Allergens and Irritants in the City of Sydney's Urban Environment with Particular Reference to the Allergens and Irritants of Trees

Authors: CH Katelaris AM MB BS PhD FRACP FAAAAI[#] and E Newbigin BSc(Hons) PhD* (equal contributors)

[#] Professor, Immunology & Allergy, Western Sydney University and Head of Unit, Campbelltown Hospital NSW

* Associate Professor, School of BioSciences, University of Melbourne Victoria

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1. Preamble

This document has been prepared at the request of the City of Sydney to assist with their policy review of urban tree management. The document begins with a broadscale picture of allergies in Australia and the range of allergens encountered in the outdoor urban environment. The document then focuses on what is known about the trees in Sydney's urban forest as a source of allergens and irritants, with particular attention being paid to plane trees of which the London plane (*Platanus* x *acerifolia*) is an example.

2. Introduction to Allergy and Allergens in Australia

Allergic diseases are common in Australia (see the Information Box on page 4 for some useful definitions). Table 1 shows a breakdown of the most common allergic conditions and their prevalence in the community. To put this information in context, a 2020 Australian Parliamentary Inquiry into allergies and anaphylaxis (ref [1.]), stated that allergic diseases currently affect around 4 million Australians, or nearly one in five people. Allergic diseases are now so common that many Australians have two or more allergic diseases, and many Australian families have two or more members living with an allergy. Over the past several decades the prevalence of allergic diseases has regrettably increased in Australia and elsewhere, with most experts expecting this upward trend to continue.

Table 1. Common allergic diseases - Facts & Figures

Allergic rhinitis (hay fever)	
Children 6-7 years old	One in ten
Children 13-14 years old	One in six
Adults	Two in five
Asthma	
Children	One in five
Adults	One in ten
Eczema	
Children 6-7 years old	One in six
Children 13-14 years old	One in ten
Adults	One in 14

What are Australians allergic to? Australia is home to a broad range of allergens able to trigger an allergic reaction in a susceptible individual. For instance, many foods are important causes of allergic reactions of varying severity. Food allergies most commonly occur with peanuts, tree nuts, milk, eggs, and seafood, and food allergens can trigger hives, vomiting, abdominal discomfort, and a severe, generalised allergic reaction called anaphylaxis. Because of the focus on trees, this document does not discuss food allergies and allergens.

Information Box: What is meant by terms “allergy”, “anaphylaxis” and “irritant”?

An **ALLERGY** is a chronic immunological disorder that occurs when a person's immune system mounts an abnormal response to something in the environment - called an **ALLERGEN** - that does not normally bother other people. People who are sensitised to an allergen typically develop symptoms when they encounter the allergen. Allergic diseases include allergic rhinitis (hay fever), asthma, skin conditions like eczema and food allergies.

ANAPHYLAXIS describes a severe allergic response generally involving more than one body system, for example the skin, respiratory, cardiovascular, and gastro-intestinal systems. Anaphylaxis should be treated as a medical emergency, as it is potentially life threatening.

An **IRRITANT** is a non-corrosive substance that can transiently and reversibly cause discomfort or slight inflammation when in contact with a part of the body. The body’s response to the irritant is entirely normal and not a sign of underlying disease.

Australians are also allergic to many types of airborne allergens or aeroallergens, so called because they circulate in the air and primarily trigger respiratory allergies like allergic rhinitis and asthma. Some of the common aeroallergens are listed below. Aeroallergens can be further divided into those found largely indoors, such as house dust mites, and those such as pollen that are mostly encountered in the outdoor environment.

POLLEN from various plants, including grasses, weeds, and trees. Pollen is an outdoor allergen able to trigger hay fever (allergic rhinitis), allergic conjunctivitis (inflammation of a part of the eye), asthma (inflammation of passageways in the lungs), and eczema (an inflammatory skin condition).

DUST MITES are tiny creatures that live in bedding, carpets, and upholstered furniture. Dust mite droppings can trigger allergic rhinitis, allergic conjunctivitis, asthma, and eczema.

COCKROACHES are especially common in densely populated areas. Cockroach droppings and body parts can trigger allergic rhinitis and asthma.

MOULD or fungi can be found indoors where they grow in damp environments like bathrooms, kitchens, and bedrooms. Outdoors, mould spores are released from decaying vegetation and other plant material. Mould spores can trigger allergic rhinitis, asthma, an allergic reaction to a common soil fungus called allergic bronchopulmonary aspergillosis, and allergic fungal sinusitis (an inflammation of the sinuses).

PET DANDER, the tiny flakes of skin shed by animals. Pet dander can trigger allergic rhinitis, allergic conjunctivitis, and asthma.

3. Is Tree Pollen a Major Aeroallergen in Sydney?

While trees are essential components of a city's green infrastructure and of its natural, social, and cultural life, the allergenic potential of urban trees has frequently been raised as an issue. The primary tool used to diagnose most allergic diseases is the skin prick test, a test that involves the introduction of a small amount of an allergen into a patient's skin, typically on the forearm. In a sensitised patient, a raised swelling surrounded by a flat red area called a "wheal and flare" forms at the site of the test. As well as being used to diagnose allergies, skin prick tests can also be used to understand the broad pattern of allergen sensitisation in the community.

The most comprehensive study of aeroallergen sensitisation in Sydney collated the results of skin prick tests done at three allergy clinics over a fourteen-year period[2]. All participants in the study lived in Sydney.

Table 2 shows that Sydney residents with an allergy were most often sensitised to house dust mite and grass pollen. Indeed, many patients were sensitized to both, as around 45% of those sensitised to at least one aeroallergen tested positive to both house dust mite and grass pollen. Other common aeroallergens were animal dander, cockroach, and weed pollen. Less than 16% of patients were sensitised to tree pollen. Birch pollen was the most common tree pollen allergen, with twice as many patients sensitised to it than to plane tree (*Platanus*) or pine pollen.

Table 2. Sensitisation rates for various aeroallergens in Sydney (modified from ref. [2])

Allergen	Percent sensitized (number tested)
House dust mite	63.2% (1,404)
Animal dander	39.6% (1,303)
Moulds	26.8% (1,295)
Cockroach	30% (983)
Temperate grass pollen	44.5% (1,209)
Subtropical grass pollen	37.6% (1,137)
Weed pollen	32.1% (1,207)
Tree pollen	15.9% (972)
Birch	18.8% (616)
Plane tree	7.0% (932)
Pine	5.9% (564)

A limitation of skin prick testing is that it can only be used to track allergies where the allergen is known and commercially available. But there are also allergies that are harder to diagnose where the allergen isn't known or is known but not commercially available.

4. Sydney's Urban Forest as a Potential Source of Pollen Allergens

Understanding the full pattern of tree pollen allergies is difficult because surprisingly little is known about the allergenicity of pollen from many types of trees, including many of the trees that are widely grown in urban areas. This is because only a handful of tree pollen allergens are recognised and commercially available for use in testing. Although allergenic trees are found all over the world, lists of characterized tree pollen allergens are currently dominated by European and North America species. Few pollen allergens for Australian tree species are known and commercially available.

One standard method used to get around this lack of information about the risk that urban trees pose to allergic people is to assign each tree species a *potential* allergenic value based on characters such as its pollination strategy (wind-pollinated species have a greater allergy risk than insect-pollinated species), length of time it releases pollen (based on observation and aerobiological surveys) and the allergenicity of its pollen grains (assessed by expert judgement and clinical studies). There are several such lists of urban trees and their assigned allergenicity values. But even though these lists are currently used as management and planning tools, they unfortunately often differ in their assessment of potential allergenicity. The lists are also less useful in Australia, since they are typically based on trees that occur in the urban forests of European cities.

Table 3. Street and park trees in Sydney (% stem count and number of species) in the low, moderate, high, and very high allergenicity ratings. Trees with no allergen rating are shown as 'not reported'. Allergenicity ratings are based on ref. [3].

Allergenicity rating	Total number of trees (% stem count)	Total number of species
Low	21.6%	84
Moderate	17.2%	68
High	4.0%	13
Very high	10.1%	22
Not reported	47.1%	112

With these shortcomings in mind, Table 3 shows an assessment of the trees in Sydney's urban forest based on allergenicity ratings for 150 species published by Cariñanos and Marinangeli (2021)[3]. To

increase the number of species with a rating, unless otherwise specified by Cariñanos and Marinangeli (2021), the rating they gave to a single species (e.g., *Eucalyptus camaldulensis*, the river red gum) was given to all species in the same genus (all eucalypts in this example). Even so, around 47% of the trees in Sydney's streets and parks did not receive an allergenicity rating. As expected, Australian native trees, especially those that are indigenous to the Sydney area, are overrepresented among these unrated species.

Table 3 shows that 187 of the roughly 300 tree species in Sydney's urban forest have an allergenicity rating, of which 35 species were rated as either highly or very highly allergenic. A feature common to all these species is that they are either largely or exclusively wind pollinated, which means they mainly or exclusively use air currents to transfer pollen from one plant to another. Plants that produce allergenic pollen are typically wind pollinated species.

Although the 35 highly or very highly allergenic species together represent around 14% of all trees in Sydney's urban forest, most of these species are lowly abundant and represent less than 0.5% of all trees. However, two groups of highly or very highly allergenic tree species represent more than 1% of trees in the urban forest. One group includes the six members of the Platanaceae or plane tree family, of which the hybrid London plane (*Platanus* × *acerifolia*) is a familiar example. Together, plane trees make up about 9.2% of the trees in the urban forest. The other group includes the four species of sheoaks (*Casuarina* species) and collectively represents around 3.1% of all trees.

One oddity is that birch, a very highly allergenic species identified in Table 2 as Sydney's dominant tree pollen allergen, makes up only 0.1% of street and park trees. This suggests the urban forest is an unlikely source of the most common type of tree pollen to which allergic people in Sydney are sensitised. It is more likely that people become sensitised to birch pollen while outside Sydney or are sensitised to pollen from birch trees growing on private land in Sydney. While trees on private land are part of Sydney's urban forest, they are not included on the city's tree register.

5. Plane Tree Pollen as a Cause of Respiratory Allergies

In their study, Cariñanos and Marinangeli (2021)[3.] gave plane trees (*Platanus*) a very high allergenicity rating. However, other similar lists give plane trees a much lower allergenicity rating, for example classifying their allergenicity as moderate. One driver of these divergent ratings is the differing views of the clinical relevance of plane tree pollen allergies.

In the USA and Europe, high concentrations of plane tree pollen are found in the air during spring. However, rates of sensitisation to plane tree pollen and the seasonal allergies associated with it vary considerably. For instance, sensitisation rates in Spain range from values that are in line with those seen in Sydney (e.g., 8.5% in Barcelona) to much higher values (56% in Madrid). Reasons for the different rates of sensitisation aren't known, although one possibility is that it is a consequence of the differing climatic conditions (e.g., a continental climate in Madrid vs a coastal climate in Barcelona). The high rates of sensitisation to plane tree pollen seen in some Spanish studies are one reason they are often viewed as a major cause of respiratory allergies.

6. What is Sydney's Experience with Plane Tree Allergies?

While Table 2 shows that more people in Sydney are sensitised to grass pollen and birch pollen than to plane tree pollen, it is reasonable to ask if this pattern of sensitisation is also true for residents of inner Sydney suburbs such as Darlinghurst, Paddington, and Surry Hills where there are large numbers of these trees. Indeed, during springtime these areas see high levels of plane tree pollen in the air and this is also the most abundant pollen type. But in addition to pollen, plane trees also release two other types of particles into the air – plane tree leaves release small hairs called trichomes and plane tree fruits (which are called achenes) release fine fibres as they break up. While neither leaf trichomes nor achene fibres are allergenic, they can irritate the eyes and nose.

The high season for plane tree pollen is from August to October with a peak in early September. The season for achene fibres roughly coincides with that for plane tree pollen but the leaf trichome season is later and continues until the leaves are mature in mid-summer.

In 2006/2007, one of the authors of this paper (CHK) was part of a clinical investigation in inner Sydney of plane tree aerosols (pollen, trichomes and fibres) and their relationships to plane tree sensitisation and patient-reported symptoms. The study involved 64 subjects who all lived in the area and had self-reported an allergy to plane trees[4].

In skin prick tests, 86% of subjects were sensitised to at least one aeroallergen, with 66% being sensitised to at least one type of pollen, which was predominantly grass. Despite self-identifying as having a plane tree allergy, only 23% of subjects were sensitised to plane tree pollen. All these individuals were also sensitised to grass pollen.

As well as skin prick tests, subjects also completed a daily diary of their eye and nasal symptoms. Analysis of these diaries at the end of the study found no difference in symptom scores recorded during the height of the plane tree pollen season from August to October and those recorded outside of this period. Nor was there any difference between the scores of subjects sensitised to plane tree pollen and those not sensitised to this allergen. Overall, symptom scores showed a better association with high levels of other types of pollen than with high levels of plane tree pollen.

In summary, although people in inner Sydney were sensitised to plane tree pollen, this did not appear to trigger their seasonal symptoms. It is possible that the eye and nasal symptoms the participants experienced were caused by irritation from plane leaf trichomes and achene fibres.

7. Recommendation

Despite the lack of reliable data about tree pollen allergenicity, there is still a need to develop a robust strategy for the evolution of Sydney's urban forest. For any disservice that an urban forest provides through allergen production, a mature urban forest provides a far larger number of services through its contributions to pollution removal, noise reduction, decrease in the urban heat island effect and a range of other socioeconomic benefits such as cultural heritage and a sense of community wellbeing. We recommend that the risks posed by tree pollen allergens be mitigated through the staged increase in the diversity of Sydney's urban forest. The increase can be achieved by using a diverse mix of tree species, including trees where there currently isn't a consensus on allergenicity, and by avoiding future plantings of large stands of a single type of tree.

8. Selected References

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8. Appendix

Professor Connie Katelaris is a consultant physician in Immunology and Allergy with over 40 years' experience in both clinical practice and research. She is Head of Unit at Campbelltown Hospital and Professor, Immunology and Allergy, Western Sydney University. She is a past president of the Australasian Society of Clinical Immunology and Allergy and of the Asian Pacific Association of Allergy and Clinical Immunology. Her research interests include aerobiology studies as they relate to pollen and fungal allergy, and she has published a number of papers on this research. She has conducted pollen counts in rural areas as part of her PhD work and provided detailed pollen calendars for the Sydney Olympics. For the past 16 years she has coordinated continuous pollen sampling in Sydney's southwest.

Associate Professor Ed Newbigin is an honorary member of the School of BioSciences at the University of Melbourne with 30 years of experience as a plant researcher. He has published extensively on plant breeding systems and pollen biology, and since 1998 has coordinated the Melbourne Pollen Count, a community service providing forecasts of grass pollen levels in Melbourne's air. In 2017, he set up and subsequently coordinated the Victorian pollen monitoring network which was established in the wake of the thunderstorm asthma event that hit Melbourne on November 21, 2016. He works closely with the Victorian Department of Health and Australian Bureau of Meteorology around the forecasting of epidemic thunderstorm asthma in Victoria.