

Aero-allergens in canine atopic dermatitis in south-eastern Australia based on 1000 intradermal skin tests

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Objective To determine the most relevant aero-allergens involved in canine atopic dermatitis in southeastern Australia and provide information about these aero-allergens to the general practitioner.

Procedure Dogs presented to the Animal Skin & Allergy Clinic with history and clinical signs of atopic dermatitis were injected intradermally with 38 different allergens and negative and positive control. Intradermal skin tests in 1000 dogs were retrospectively evaluated.

Results One third of all patients reacted to the house dust mite *Dermatophagoides farinae*. Allergens reacting in more than 15% of the patients were wheat (*Triticum aestivum*), sweet vernal (*Anthoxanthum odoratum*), English couch (*Agropyron repens*), yellow dock (*Rumex crispus*), Mexican tea (*Chenopodium ambrosioides*), plantain (*Plantago lanceolata*), melaleuca (*Melaleuca quinquenervia*) and peppercorn (*Schimus* spp).

Conclusion House dust mites are the most common allergens in canine atopic dermatitis in southeastern Australia and *D. farinae* is involved most frequently. However, a number of grass, weed and tree pollens also are involved regularly.

Aust Vet J 2000; 78:392-399

Key words: Aero-allergens, atopic dermatitis, dogs, intradermal skin tests

Atopic dermatitis is one of the most common hypersensitivities in the dog and cat and is a condition seen frequently in small animal practice.¹⁻³ It is diagnosed by history and clinical examination as well as by excluding other pruritic skin diseases such as food adverse-reactions or scabies, which can present with similar clinical signs of facial, pedal, ventral or peri-anal pruritus or otitis externa.^{1,2} Currently, the procedure of choice to identify offending allergens is intradermal injection of specific allergen extracts and comparison of the subsequent wheal and flare reaction to a negative and a positive control. In sensitised patients, allergens cross-link preformed IgE antibodies bound to the surface of mast cells in the dermis that are specific for these allergens. This leads to mast cell degranulation and the release of inflammatory mediators causing the wheal and flare reaction.⁴ The results of the intradermal skin test, considered with the patient's history and environment, provide a basis for the selection of allergens to be included in a vaccine for allergen-specific immunotherapy, which is the treatment of choice in many dogs with atopic disease.⁵ Alternative therapies include the use of glucocorticoids, antihistamines and fatty acid supplementation. Glucocorticoids frequently cause unacceptable adverse effects, whereas antihistamines and fatty acids lead to remission in a minority of patients only.^{1,2,6-9}

The purpose of this study was to identify the major aero-allergens involved in canine atopic dermatitis in southeastern Australia and to provide some information about these allergens to the small animal practitioner. Identification of the aero-allergens was based on the results of intradermal skin tests performed in 1000 dogs in the Animal Skin & Allergy Clinic.

Materials and Methods

One thousand dogs were selected for intradermal skin testing based on history and clinical examination consistent with atopic disease. Each dog was sedated with xylazine at 0.4 mg/kg intravenously (Xylazil®, Troy Laboratories, Smithfield, NSW). This commonly used sedative was chosen because it does not inhibit skin test reactions.^{10,11} An area of approximately 15 x 10 cm was clipped with a number 40 blade. A permanent marker was used to identify injection sites. Individual allergens and a negative and a positive control were injected intradermally with 29 gauge needles. The negative control was the diluent of the allergen extracts, a solution of 0.04% potassium phosphate, 0.11% sodium phosphate, 0.50% sodium chloride and 0.40% phenol (Sterile diluent for allergenic extracts, Greer Laboratories, Lenoir, NC, USA). The positive control was histamine phosphate 0.275 mg/mL (Histatrol®, Center Laboratories, Port Washington, New York 11050, USA). Allergen extracts were obtained from Greer Laboratories (Lenoir, NC, USA). Plant pollens used are outlined in Table 1. The intradermal skin test was performed with 0.05 to 0.1 mL of allergen extract at a concentration of 500 protein nitrogen units (PNU)/mL for most allergens. House dust mite allergens were tested at two dilutions each (1:7,500 and 1:75,000 w/v). Skin reactions were evaluated 15 to 20 minutes later in a darkened room with a light source from an oblique angle. The skin reactions were graded subjectively from 0 to 4 in comparison to the negative control (graded as 0) and the positive control (graded as 4).^{1,2,4} Only reactions graded 2+ and stronger were considered positive.

Extracts of single allergens were used with two exceptions. Pine mix (*Pinus taeda*, *strobus*, *echinata*) was used, because the pollen extract of the species typically encountered in Australia (*Pinus canariensis*, *densiflora*, *insignis*, *mugo*, *patula*, *pinea* and *radiata*)¹² was not available. Cross-reactivity between the species of these genera is extensive in human allergic disease.¹³ It was hoped that pine-pollen allergic dogs would react to the mix due to similar allergenic epitopes on the pollens of pines occurring in Australia versus overseas species. A birch mix, consisting of *Betula nigra*, *lenta* and *populifolia* was used because an extract of the most common species in Australian urban areas, *B. pendula*, was not available.¹² As with pines, extensive cross-reactivity between different *Betula* spp and alders is reported in humans.¹⁴

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Table 1. Common and botanical names of plants included in intradermal skin testing

Common name	Botanical name
<i>Grasses</i>	
Paspalum	<i>Paspalum notatum</i>
Kentucky blue	<i>Poa pratensis</i>
Canary	<i>Phalaris arundinacea</i>
Oat	<i>Avena sativa</i>
Bent	<i>Agrostis alba</i>
Perennial Rye	<i>Lolium perenne</i>
Wheat	<i>Triticum aestivum</i>
Couch	<i>Cynodon dactylon</i>
Yorkshire fog	<i>Holcus lanatus</i>
Prairie grass	<i>Bromus inermis</i>
Cocksfoot	<i>Dactylis glomerata</i>
Sweet vernal	<i>Anthoxanthum odoratum</i>
English couch	<i>Agropyron repens</i>
<i>Weeds</i>	
Yellow dock	<i>Rumex crispus</i>
Rough pigweed	<i>Amaranthus retroflexus</i>
Plantain	<i>Plantago lanceolata</i>
Short ragweed	<i>Ambrosia artemisiifolia</i>
Perennial ragweed	<i>Ambrosia psilostachia</i>
Red sorrel	<i>Rumex acetosella</i>
Fat hen	<i>Chenopodium album</i>
Dandelion	<i>Taraxacum officinale</i>
Mexican tea	<i>Chenopod. ambrosioides</i>
Lucerne	<i>Medicago sativa</i>
<i>Tree pollens</i>	
Elm	<i>Ulmus pumila</i>
Eucalyptus	<i>Eucalyptus globulus</i>
Melaleuca	<i>Melaleuca quinquenervia</i>
Privet	<i>Ligustrum vulgare</i>
Pine mix	<i>Pinus taeda, strobus, echinata</i>
Casuarina	<i>Casuarina equisetifolia</i>
Birch mix	<i>Betula nigra, lenta, populifolia</i>
Wattle	<i>Acacia spp</i>
Palm	<i>Cocos plumosa</i>
Peppercorn	<i>Schinus spp</i>

Results

By far the most common positive intradermal reactions observed were to the house dust mites *D farinae* and *D pteronyssinus* (Table 2). Evaluating the lower dilution of dust mite extracts, 34% of the patients reacted to *D farinae* and 14% to *D pteronyssinus*. The most commonly encountered grass allergens were English couch, wheat and sweet vernal, reacting in 18%, 18% and 16% of the patients, respectively. The relatively common weed allergens were yellow dock (27%), rough pigweed (17%), Mexican tea (16%) and plantain (15%). The most common tree allergens were melaleuca (19%) and peppercorn (16%). Canary grass, bent grass, perennial ragweed, dandelion, casuarina and birch pollens were associated with the least number of positive intradermal skin reactions, occurring in

approximately 10% or less of patients mounting skin reactions. Moulds contributed to positive reactions in 4% to 10% of the individuals tested.

Discussion

Dust mites

The frequency of dust mite reactions in this study was in accordance with other reports concerning human allergic rhinitis or asthma and canine atopic dermatitis.^{5,15,16} House dust invariably contains dust mites¹⁷, but may also contain mould spores, animal allergens, insect debris and even pollens. House dust, therefore, is so heterogeneous that it can be regarded scarcely as a distinct allergen¹⁸ and testing for more specific allergens is strongly recommended.

Only a few of more than 50,000 species of mites seem to be related to house dust allergy. *D pteronyssinus* is the species most commonly involved in human allergy in many countries, including Australia. It requires higher humidity and is not able to survive extended dry periods as well as *D farinae*, which is the dominant species in some areas of Canada and the United States. In these areas, the relative humidity and temperature are low for substantial portions of the year.¹⁹ However, the humidity of the dust mite microclimate (mattresses and base of carpets) does not necessarily correlate well with the humidity of the macroclimate. In dogs, *D farinae* is reported as a more frequent cause of allergic skin disease.¹⁶ The results of this study confirm these findings. Thirty-four per cent of the dogs reacted to the lower dilution of *D farinae* and only 14% to *D pteronyssinus*. Storage mites such as *Tyrophagus putrescentia* and *Glycophagus domesticus* may be important allergens in tropical or rural areas.²⁰ They were not included in the allergens utilised for intradermal skin testing in this study as they were not available to the authors at the time.

The dust mite antigens in human disease have been well characterised.²¹ Evidence has been presented in several studies that the allergenic epitopes relevant for dogs are different to those causing disease in humans^{22,23} and extracts of whole dust mites are used currently in veterinary medicine. Dust mite extracts have been shown to cause 'false-positive' reactions in normal dogs at the standard dilution of 1000 PNU/ml or 1:1000 w/v, which is the standard based on the weight of the dried extract in a known volume of extracting fluid.²⁴⁻²⁶ The threshold concentration for house dust mite allergens in dogs has been shown recently to be 1:50,000 w/v.²⁶ The highest dilution used in this study was 1:75,000 w/v, so false-positive reactions with this dilution seem unlikely. In conclusion, dust mites are important allergens in canine atopy in southeastern Australia.

The major sources of mites in a household are mattresses, fabric-upholstered furniture and carpet where the mites live off debris such as human scales.^{27,28} Most of the affected dogs lived a significant part of their life indoors. Given the frequency of carpeted homes in Australia, the high prevalence of dust mite reactions is not surprising. Dust mites tend to cause perennial disease. In some cases, dust mite hypersensitivity is limited to, or is worse in, winter. This may be seen in households that, during the cooler months, use gas or blow-heaters associated with strong air movements that facilitate dispersion of dust mite allergens. Avoidance of dust mite allergens is difficult (and only achieved reliably if patients can be kept outdoors permanently without access to a kennel or shed). Allergen-specific immunotherapy is a useful treatment with a satisfactory

Table 2. Number of positive reactions of specific aero-allergens in 1000 skin tests

Allergen	2+	3+	4+	Total
<i>Grass pollens</i>				
Paspalum	43	28	41	112
Kentucky blue	56	22	37	115
Canary	48	18	32	98
Oat	52	28	33	113
Bent	56	16	31	103
Perennial rye	60	20	36	116
Wheat	105	26	46	177
Couch	69	14	31	114
Yorkshire fog	51	20	34	105
Prairie grass	50	27	50	127
Cocksfoot	67	26	39	132
Sweet Vernal	74	25	64	163
English Couch	112	36	29	177
<i>Weed pollen</i>				
Yellow dock	101	64	100	265
Rough pigweed	83	40	43	166
Plantain	94	21	38	153
Short ragweed	91	13	30	134
Perennial ragweed	48	27	26	101
Red sorrel	55	30	26	111
Fat hen	64	28	57	149
Dandelion	64	10	15	89
Mexican tea	93	25	38	156
<i>Moulds</i>				
Alternaria	27	7	6	40
Aspergillus	47	4	13	64
Cladosporium	46	3	2	51
Penicillium	72	17	12	101
<i>Tree pollens</i>				
Elm	82	17	17	116
Eucalyptus	71	17	24	112
Melaleuca	117	39	35	192
Privet	95	29	18	142
Pine	81	9	12	102
Casuarina	54	18	26	98
Birch	49	28	23	100
Wattle	66	18	23	107
Palm	60	13	31	104
Peppercorn	79	39	40	158
<i>Dust mites</i>				
<i>D pteronysinus</i> ^a	134	108	233	475
<i>D pteronysinus</i> ^b	89	25	24	138
<i>D farinae</i> ^a	95	115	430	645
<i>D farinae</i> ^b	158	87	91	336

^aAllergen extract concentration 1:7,500 W/V^bAllergen extract concentration 1:75,000 w/v

response achieved in approximately 50% of patients.⁵ This treatment allows long-term oral medications, such as antihistamines and glucocorticoids, to be decreased or discontinued in these dogs.

Environmental control of dust mites – Elimination of dust mites from the environment is extremely difficult. Maintaining low relative humidity and removing carpeting may be beneficial,²⁷ as high humidity improves the survival of house dust mites in homes.²⁹ In the authors' practice, some radical measures such as removing all carpets and replacing mattresses have not been beneficial in alleviating clinical signs of severe allergy to dust mites, even in patients with dedicated owners. Frequently cleaned households failed to show lower mite recoveries than normal households^{27,29} and house cleaning is not regarded as an effective method to decrease the dust mite concentrations in the environment. However, attempts to decrease concentration of mite antigens in the environment have been helpful in some patients. Domestic activity markedly increases the amount of airborne dust mite allergen because of the dispersal of the major source of allergen, mite faeces, into the air.²⁸ Atopic pets should be kept outdoors during cleaning activities to minimise exposure to dust mite allergens.

Energy saving measures such as installing insulation frequently raises indoor humidity and can lead to increased dust mite concentration in the environment. Application of sodium borate powder onto carpet is reported to be very effective in reducing dust mite numbers in vitro,³⁰ perhaps by causing desiccation of the local micro-environment in the carpet.

Eucalyptus oil (100 mL) can be mixed with a specific kitchen detergent concentrate (25 mL of Kit, Lever and Kitchen, Rexona) to form an inexpensive wash.³¹ The mixture should be added to 50 L of water in a top-loading washing machine and blankets soaked for 30 minutes before washing in this suspension. More than 95% of mites were killed with this procedure versus less than 5% in the control blankets washed in the detergent alone.

In another recent study, use of waterproof encasings for mattresses and pillows (DAC Allergy Covers, Allersearch®) decreased mite numbers significantly.³² The same study compared an alcohol and glycol ether-based antimite shampoo (Allerite, Vax) with a placebo in a double-blinded fashion and found no difference between the two. Spraying the environment with a combination of tannic acid and an acaricide significantly decreased house dust mite concentration after 3 days, but after 4 weeks there was no difference in mite numbers.³³

Although the number of mites may be decreased by many of these procedures, the lower residual allergen concentration may remain sufficient to cause clinical signs in severely allergic dogs. In addition, allergenic material, such as dead mites and mite faeces, is not affected immediately by most of these procedures; instant improvement, therefore, cannot be expected.

Pollens

Pollen grains are essential to the reproduction of virtually all seed plants (*Spermatophyta*). However, less than 10% of contemporary species are anemophilous (wind-pollinated) and, thus, are able to act as aero-allergens. Species relying on insects for pollination have evolved to produce large, brightly-coloured, solitary flowers and relatively scant amounts of pollen. These species are rarely involved in atopic disease. Plants that rely on wind-pollination typically produce small florets and millions of

pollen grains to compensate for the low efficiency of wind pollination. Once airborne, these pollens can be carried for many hundreds of kilometres. In general, clinical effects are correlated closely with proximity to the pollen source. However, large area sources (such as paddocks filled with certain grasses or weeds) cause allergic signs readily in susceptible dogs tens of kilometres away.^{34,35} Rapidly moving air of low humidity promotes pollen liberation by most anemophilous species. Warm, windy days and dry conditions will cause increased pollen concentrations in the air, especially during midday and early afternoon. However, evening, as well as morning, peaks are also common among the diverse grass species and these patterns may differ among regional populations. Measured pollen concentrations tend to decrease with wind speeds greater than 27 kilometres per hour. Prolonged rainfall will 'clean the air' and decrease the pollen concentration. However, if light rain advances in an area with appreciable pollen concentrations in lower altitudes, convection and air speed may be minimised, resulting in a prolonged state of high allergen levels. Complete avoidance of such ubiquitous airborne particles is impossible, but restriction of outdoor activities or even indoor confinement may help in certain patients.

Closely related plant species frequently display similarities in morphology and allergen content in human medicine, thus some appreciation of plant taxonomy may be helpful for veterinarians interested in the airborne allergies of their canine and feline patients. The two classes recognised in pollen-producing plants (*Spermatophyta*) are *Angiospermae* and *Gymnospermae* (the conifers and their allies, such as pines and cedars). Cross-reactivity of plants of the same genus or species has been reported in human allergic disease and may be relevant in some of our allergic pets.¹⁴

Pollen-allergic subjects will generally deteriorate when they are outdoors, while patients with dust mite allergy show more severe signs indoors.¹⁸ Because pollens may travel long distances airborne, removal of the plant from the immediate environment is rarely beneficial. The notable exceptions are some trees, such as wattle or pine, which produce comparatively heavy pollen that may not be carried as far as, for example, grass or weed pollens. Confining a pet indoors is not an option for many owners. Pollen hypersensitivities respond best of all hypersensitivities to allergen-specific immunotherapy, with a satisfactory response in at least 50% of canine patients.^{5,36,37} Immunotherapy, therefore, often allows control of atopic disease without the use of oral glucocorticoids or antihistamines.

When discussing the individual plants, the pollination periods shown in Figures 1-3 and mentioned frequency are for southeastern Australia as a whole.³⁸ Pollination periods in individual areas may be shorter than quoted here. These periods vary in different locations and also depend on weather conditions. Because Australian winters are more hospitable in most parts of the country than in the United States or most of Europe, pollination of some tree species can occur in the middle of winter.³⁹ Focal variations in distributions of individual plants frequently occur. A good source of information on regional conditions are local plant nurseries. Interested gardeners will also be able to comment on pollination periods. Local human allergists and pollen calendars are further sources of information. Pollens relevant to human allergic disease in Australia were summarised by Bass and Wrigley.⁴⁰

Thus, pollen allergies may be seasonal, but some plants pollinate all year round in Australia and depend on specific weather

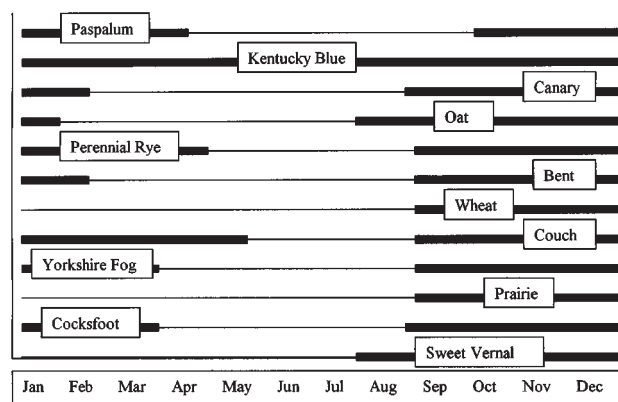


Figure 1. Pollination periods for selected grasses in south-eastern Australia.

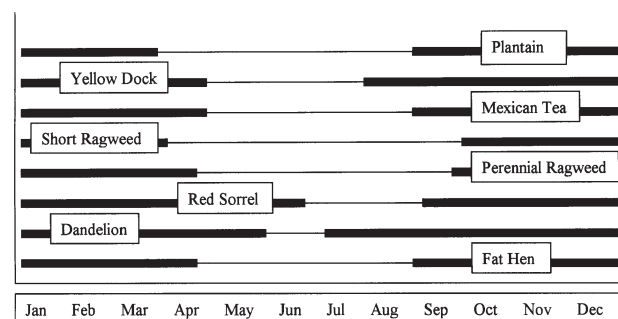


Figure 2. Pollination periods for selected weeds in southeastern Australia.

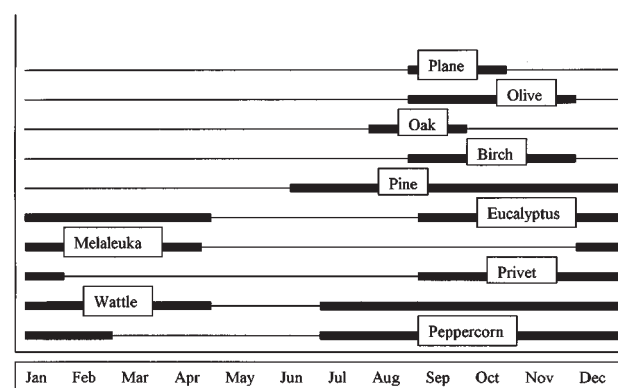


Figure 3. Pollination periods for selected trees in southeastern Australia.

conditions as much as the season. In addition, multiple allergies to grasses, weeds and trees may expose a patient to relevant allergens all year round. Many pollen-allergic patients show nonseasonal clinical signs.

Grass pollens

Grasses or *Gramineae* consist of at least 4500 species of primarily wind-pollinated plants, which produce operculate

pollen grains similar in shape and size. A peak of pollination from September to December is present in temperate areas. However, in the tropics and subtropics, airborne grass pollens may be encountered throughout the year.

In humans, cross-reactivity may occur between sweet vernal, bent, oat, cocksfoot, Kentucky blue, Yorkshire fog, rye and canary grasses. Similarly, wheat, English couch and prairie grass may cross-react and so can couch, maize and paspalum.¹⁴ In an earlier report, cross-reactivity of cocksfoot and rye grass, on one hand, and couch and sweet vernal, on the other, was documented.⁴¹ A concise summary about cross-reactivity of pollens was published by Weber.⁴² These cross-reactivities do not seem to be as pronounced in canine patients (unpublished).

The involvement of the various grass pollens in canine atopy was between approximately 10 to 20% of all dogs tested. Reactions to sweet vernal (16%), English couch (18%) and wheat (18%) were seen a little more commonly than reactions to bent (10%), canary (10%) and perennial rye grass (12%). In an American study, the most common grass pollens reacting on intradermal skin testing were couch and paspalum, in Florida, in 40% and 35% of the patients, respectively.¹⁶ In a German, a French and a Norwegian study, 12.5%, 4.1% and 11%, respectively, of the dogs tested intradermally showed positive reactions to a grass mix. Unfortunately, individual grasses were not tested, making comparisons impossible.⁴³⁻⁴⁵ A more recent German study showed intradermal reactions to cocksfoot, rye grass and Kentucky blue grass in 6.3%, 5.8% and 4.3 % of the dogs, while a French study found reactions to cocksfoot and ryegrass in 3.5% and 1.9% of the patients, respectively.^{46,47} These numbers are much lower than those observed here. Reasons for these disparities may include different pollination periods or different frequency of occurrence of allergenic plants and, thus, a different overall pollen load. As well, there may be a different genetic pool in the canine population. The number of intradermal skin tests evaluated was much lower in the American and European studies. The American study used the same allergens as the present study, but the European studies employed different allergens, which may have contributed to the lower intradermal skin test reactivities reported.

English couch (*Agropyron repens*) is a perennial grass that produces a few leafy shoots during the cooler months. In spring, these develop tall, erect or nodding stems up to 1 metre high. English couch can become a troublesome weed in orchards and cultivated areas. It is found in all Australian states but is less common in Queensland.

Wheat (*Triticum aestivum*) is an annual cereal grown in many areas throughout Australia. Pockets of this plant may be found on waste ground near farms, on fallow areas or on roadsides. It releases less pollens than most other grasses.

Sweet vernal (*Anthoxanthum odoratum*), a perennial grass with tufted, leafy stems, is native to parts of Europe and Asia. Of low palatability, it has a bitter taste and contains coumarin which gives a characteristic fragrance to hay. This species is widespread in Australia, being particularly common in poorly developed pastures in areas such as the Dandenong Ranges in Victoria. Large amount of pollens are released.

Cocksfoot (*Dactylis glomerata*) is a perennial species with numerous leafy shoots. It is native to Europe and Western Asia. While it is a common grass of improved pastures, it also naturalises along roadsides and on waste areas near towns in the higher rainfall zones of cooler temperate areas. A large amount of pollen is produced.

Prairie grass (*Bromus inermis*) is a densely tufted perennial grass. It is native of South America and is a useful pasture species because it provides some winter and spring feed to live-stock. Prairie grass is widespread in temperate Australia and is very common throughout the coastal districts of eastern Australia from southeastern Queensland to Victoria. Prairie grass releases a moderate amount of pollen.

Perennial rye grass (*Lolium perenne*) has shining leaves that are glossy and smooth on the underside. It is valued as a pasture species because of its easy establishment and prolific spring growth. Rye grass is widely distributed in Australia and produces a large amount of pollen.

Kentucky blue grass (*Poa pratensis*) is a dense perennial tussock with very long, slender leaves. This species is commonly used for lawns and pastures throughout Australia.

Couch grass (*Cynodon dactylon*) is a perennial grass with the stem rising from underground rhizomes. It is common in all Australian states and is sometimes sown as a lawn. This species produces a moderate amount of pollen.

Oat grass (*Avena sativa*) is a vigorously growing annual grass regarded as a common weed of cereal crops and waste or fallow ground throughout the agricultural areas of temperate Australia.

Paspalum (*Paspalum notatum*) is a robust perennial grass with leafy shoots spreading out from a central crown. Paspalum is a troublesome weed in lawns, summer crops and waste grounds. It is widespread throughout Australia.

Yorkshire fog (*Holcus lanatus*) is a perennial grass of loosely tufted habit, reaching a height of 50 cm or more. This plant is a native of Europe and prefers damp sites such as shady ditches where it may soon become dominant and exclude other grasses. It is also common throughout Australia and produces a moderate amount of pollen.

Bent grass (*Agrostis alba*) is an annual grass with one to several erect slender stems. It is used for lawns, bowling greens and golf courses in cooler areas and has widespread distribution. It is best developed in poorly drained sites.

Canary (*Phalaris arundinacea*) is one of the many species of the *Phalaris* genus. It is an erect annual grass with flat leaves and is found naturalised on waste grounds and roadsides throughout Australia. *Phalaris canariensis* is grown commercially as a source of canary seed. Canary grass also releases large amounts of pollen.

Weed pollens

Reactions to weeds were seen in 11 to 25.3% of the dogs in this study. Yellow dock, rough pigweed and Mexican tea were most commonly involved, with reactions to dandelion and perennial ragweed least commonly seen. Yellow dock and rough pigweed were also involved commonly in atopic dermatitis in a study in the United States, with 43% and 31% of all dogs, respectively, reacting to these allergens.¹⁶ Mexican tea was not included in the American skin test studies, but another chenopodium, lamb's quarter (*Chenopodium botrys*), was involved in skin test reactions in 33% of patients. In one German study, weeds caused positive skin test reactions in 15% of the patients, but a pollen mix was used rather than individual allergens.⁴³ Comparison of skin test reactions to individual weeds is, therefore, impossible, but the overall reactivity is similar to the one observed in this study. Other European studies reported fewer reactions (between 3.5 and 6%, respectively)⁴⁴⁻⁴⁷ to either weed mixes or to common mugwort (*Artemisia vulgaris*). One of these studies tested individually for

plantain, red sorrel and fat hen, with 6.8%, 6.8% and 3.9%, respectively, of the patients showing intradermal skin test reactions.⁴⁶ The reasons for the disparities may be the same as proposed for grass pollens.

Cross-reactivity between the weed pollens tested is not significant in human medicine except among members of the same family (for example, Mexican tea and fat hen, both *Chenopodiaceae*, and the two ragweeds, both *Asteraceae*). In veterinary medicine, cross-reactivity among weeds of the same family is not as pronounced (unpublished).

Yellow dock (*Rumex crispus*) is a member of the family comprising sorrels and docks. These are widespread and produce ample pollen. Yellow dock is a glabrous perennial herb with erect flowering stems. It was introduced from Europe and Africa and grows on waste grounds and cultivated areas. Dock is found in all States and categorised as a noxious weed in Tasmania and Western Australia. It produces a large amount of pollen.

Rough pigweed (*Amaranthus retroflexus*) is a succulent prostrate annual with yellow flowers. If eaten by stock, it can cause poisoning. It may help achieve high nitrate levels in soils and occurs most commonly as a weed of cultivation in high rainfall areas.

Mexican Tea (*Chenopodium ambrosioides*) belongs to the chenopod-amaranth complex consisting of closely related genera *Chenopodiaceae* (fat hen, Mexican tea) and *Amaranthaceae* (pigweeds). Pollen production by these species is moderate and plants are common world-wide. It is an erect, aromatic annual (sometimes perennial), growing to approximately 1 m high.

Fat hen (*Chenopodium album*) is an annual herb with an erect stem of up to 1 m. A native of Europe, it is now almost a cosmopolitan weed in waste areas. It is commonly seen around stock yards and farm buildings, where there is a high concentration of nitrogen and organic matter.

Plantain (*Plantago lanceolata*) is a perennial weed with a leafless stem. It flowers in dense narrow cylindrical spikes and is a native of Europe and Central Asia. The plantain family are modest pollen sources, but are widespread throughout most of the world, including Australia. In addition, they have the most consistent output of all weeds with long pollination periods in many parts of Australia.

Ragweeds belong to the daisy family and are important allergens in humans in the United States and Europe. Many different ragweeds show cross-reactivity in humans.⁴⁸ It has been reported that Australia is essentially ragweed-free,¹⁸ while other sources state that it is a common weed in cultivated pastures and waste areas.^{49,50} Ragweed has also been found in Victoria and South Australia by the authors (unpublished). Whether the relatively low prevalence of perennial ragweed reactions is related to lower plant numbers and, thus, smaller amounts of pollens in Australia is not known. Short ragweed (*Ambrosia artemisiifolia*) is a variably erect herb. Its pollen is notorious for causing hayfever in humans. Short ragweed is seen as a weed on roadsides and wastelands.

Perennial ragweed (*A. psilostachia*) is a hairy perennial with creeping woodstock that grows aggressively in dense patches. It is considered a noxious weed in Victoria and Queensland and is common in South Australia and the Murray River area.

Red sorrel (*Rumex acetosella*) is a plant with a slender flowering stem. A native of Europe, it can cause poisoning of stock. It is widespread in Australia and produces large amounts of pollen.

Dandelion (*Taraxacum officinale*) is a perennial herb with yellow flowers. It invades lawns and occurs in many areas, especially wastelands.

Tree pollens

Tree pollens caused intradermal skin reactions in 10 to 19% of dogs in the present study, with birch and casuarina being less and melaleuca and peppercorn more, frequently involved. Overt sensitivity to the *Gymnospermae*, such as pine, does occur but is seldom recognised in human medicine.¹⁸ In this study, reactions to pine pollen mix were recognised less commonly than to other pollen extracts. In the German study using pollen mix only, the overall skin reactivity to tree pollens was 19%, which is similar to the present findings.⁴³ Melaleuca was one of the more common allergens in southern Florida with 39% of the patients developing skin reactions.¹⁶ Palm and oak were other frequent allergens reported in that study.

Cross-reactions between tree pollens in humans are generally only significant between species of the same genera.¹⁴ Unfortunately, no data are available evaluating cross-reactivity of tree pollens in veterinary medicine.

Melaleuca (*Melaleuca quinquenervia*) is also known as broad leaf paperbark. This tree belongs to a genus of evergreen trees and shrubs. It is a strong-growing rounded tree with leaves that are elliptic and lustrous and a peeling and papery, tan-coloured bark. Small creamy white flowers are in bottlebrush-like clusters.

Peppercorns (*Schinus* spp) are evergreen South American shrubs and trees frequently found in Australia and grown mainly for their foliage and shading.

Privet (*Ligustrum* spp) is a mainly deciduous evergreen shrub with small whitish flowers that often are quite heavily perfumed. It grows 3 to 5 m tall, contains a poisonous glycoside and is considered a noxious weed in some states. It is found throughout Australia as a hedge or pruned to specific shapes in parks and gardens. The pollen is fairly heavy and is not as mobile as many others, perhaps making avoidance possible.

Elm (*Ulmus* spp) is a deciduous, 12 to 15 m tall, spreading, and sometimes shrubby, tree. It has oval leaves that are toothed around the border. It is commonly found in older suburban areas of Australian cities.

Eucalypts are a diverse group of over 800 species with a wide variation in size and shape. The species used in intradermal skin testing and most allergen-specific IgE serum tests in Australia, *Eucalyptus globulus*, or southern blue gum, is a tall tree growing to approximately 45 m. It is a valuable shade tree for cooler climates but also grows well in coastal areas. Its greyish-green leaves are oval in shape when juvenile and lance-shaped when mature. Eucalypts bear cream flowers in spring and summer. They are highly allergenic and commonly involved in human allergic disease.⁴⁰

Wattle (*Acacia* spp) is highly allergenic and is involved commonly in human allergic disease in Australia.⁴⁰ Based on this study, wattle causes hypersensitivity in small animals less commonly. There are more than 1000 *Acacia* species, 650 of them found in Australia. Acacias range from ground covers and small shrubs to tall trees. The flowers are usually golden or creamy white.

The cocos palm (*Cocos plumosa*) is a stately tree growing to approximately 15 m and is an evergreen native of coastal areas in warmer climates.

Pines (*Pinus* spp) comprise 80 evergreen conifers originating from the northern hemisphere. They grow up to 60 m high. Their leaves are cylindrical needles clustered in whorls of two to five. The flowers develop into seed-bearing cones. Pollen production is ample.

Birch (*Betula* spp) is 20 to 25 m high. It is a deciduous tree with young, softly haired branches and is originally a tree of temperate and arctic regions. However, it is now seen in urban areas of southeastern Australia and releases copious pollens.

Casuarina (*Casuarina* spp) is a common native with 45 species in eastern Australia. All are evergreen shrubs or trees growing to between 5 and 10 m. Flowers are reddish-brown, in slender spikes, and occur from winter to spring. Leaves are reduced to small triangular scales. Casuarinas are highly wind resistant and very suited as a hedge or wind-break. They are also grown for their excellent shading ability. They produce copious pollens but, due to long and irregular pollination periods, correlation with outbreaks of clinical disease is difficult.

Oak (*Quercus* spp) is a fast growing deciduous spreading tree up to 30 m high. It is very hardy, with large oblong leaves that are dark green and glossy in texture. Oaks are planted in suburban areas of Australian cities.

Olive (*Olea communis*, var *europaea*) is a slow-growing evergreen tree that becomes gnarled with age. The narrowly oblong leaves are grey to green on the top and silvery underneath. Flowers are white, small and fragrant. Olives are common in South Australia and are found occasionally in New South Wales and Victoria. They produce a large amount of pollen.

Plane tree (*Platanus racemosa*), also known as a sycamore tree in North America, is a deciduous spreading tree with ornamental flaking bark. The leaves are bright green and sharply lobed. Skin reactivity to pollens of the plane tree is wide-spread and it is planted in many urban areas.

In the current study, selection of plant allergens was originally based on extrapolation from data about allergens more commonly involved in human allergic disease. It is highly likely that there are other important allergenic plants we have not included in this study for technical reasons. The evaluation of plant allergens involved in canine atopic dermatitis is a topic of ongoing research in our clinic and in other institutions.

Moulds

Typically fungal spores are responsible for airborne allergies to moulds in humans.⁵¹ Spore dispersion in dry conditions is typical of the moulds more commonly involved in allergic disease such as *Cladosporium*, *Alternaria*, *Aspergillus* and *Penicillium*. *Aspergillus* and *Penicillium* are less prominent in outdoor air. The spore release of *Cladosporium* and *Alternaria* increases with decreasing humidity, reaching a maximum during sunny afternoons.¹⁸

Penicillium are abundant in enclosed spaces. Hypersensitivity to the spores does not increase the risk of adverse responses to penicillins or to adverse food reactions to specific cheeses.¹⁸

Aspergillus are widely prevalent spoilage organisms and are recovered often from within domestic and commercial interiors, where the concentration frequently exceeds that in outdoor air.

Cladosporium spores commonly outnumber all other airborne biologic particles. These fungi include prominent saprophytes on composting vegetation and parasites on vegetables.

Alternaria reach greatest abundance in grain-growing areas and peak in late summer and autumn.

In southeastern Australia, mould spores do not seem to be

involved as commonly in canine atopic disease as pollens. The response to allergen-specific immunotherapy in dogs was minimal in a recent Australian study.⁵ Mould extracts are known to contain proteases that may decrease potency of companion extracts by up to 80%.^{52,53} It is possible, therefore, that the degrading of pollen allergens in an immunotherapy vial containing multiple allergens could result in a subsequent decrease in potency of the whole extract. This may explain the low response rate in a recent study.⁵ Research to formulate allergen vaccines with moulds separated from the other extracts in an attempt to avoid this deterioration is currently being undertaken by the authors. However, dogs with hypersensitivities to moulds may not respond well to immunotherapy for other reasons and the separation of the different allergen groups is yet to be proven beneficial.

In conclusion, there seem to be similarities in the frequency of allergenic skin reactions in different studies, but also clear differences. Results of one study evaluating allergens cannot necessarily be applied to another environment. This study is useful because it demonstrated that dust mites are the most important allergens in canine atopy in southeastern Australia and *D farinae* is involved most often. A number of common grass, weed and tree pollens also are involved regularly

Acknowledgments

We would like to thank Gillian Melrose for her help in gathering data about the plants and Jennifer Tsohalis who inspired this work when inquiring about solid data regarding aero-allergens. We also want to extend our gratitude to all the veterinarians contributing to this work through referring the patients involved in this study and to Fay Low for proof-reading the botanical facts of the article.

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(Accepted for publication 3 November 1999)

ERRATUM

Ten Tips to ease the transition from student to veterinarian by Trevor Heath *Aust Vet J* 200;78:329-330

The boxed table on page 329 of the above article was printed incorrectly. The correct version is printed here.

THE TIPS

1. Get experience dealing with people in a service or leadership role
2. Develop competence with interpersonal skills, basic technical skills, common conditions
3. Arrange to keep personal readjustments to a minimum
4. Make contacts that may lead to a good job
5. Select boss with great care
6. Get it in writing
7. Make clear that you are prepared to learn
8. Consider the feelings of others
9. Take steps to maintain mental and physical health
10. Think and act as a professional person