

Late summer and fall (March–May) pollen allergy and respiratory disease in Northern New South Wales, Australia

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Background: Many people in the subtropical Northern Rivers area of New South Wales, Australia, blame the pollen of *Tibouchina* tree, which flowers at the same time as ragweed, Bahia grass and Bermuda grass, for hayfever and asthma exacerbations during fall between March and May.

Objectives: To determine whether *Tibouchina* pollen is allergenic. To determine whether airborne ragweed pollen is present in this region for sufficient length of time and concentration to cause fall respiratory symptoms, and to determine if Bahia grass and Bermuda grass are associated with fall respiratory symptoms.

Methods: Pollen and *Alternaria* spores were monitored using a Burkard 7-day spore trap. Two hundred and six volunteers in the Northern Rivers area filled in questionnaires before skin prick tests (SPT) were performed with a panel of skin testing extracts.

Results: One hundred fifty-three (74.3%) subjects were atopic and reacted to one or more aeroallergens. Seventy were SPT positive to ragweed, OR 3.36 (CI 1.03 to 12.15) and 11 to *Tibouchina* (OR incalculable). Fifty of the 70 ragweed-positive subjects had fall hayfever or exacerbations of hayfever and/or asthma, OR 23.4 (CI 8.90 to 64.00). Eleven subjects were SPT positive to *Tibouchina* extract. There was a statistical association between Bermuda grass and hayfever, but not asthma OR 13.44 (CI 1.85 to 27.04).

Conclusions: Ragweed pollen was present for a sufficient length of time and concentration to sensitize and provoke fall hayfever and asthma exacerbations. *Tibouchina* pollen is an aeroallergen causing mild-to-moderate allergic symptoms in a few people. There is an association between Bahia grass and asthma in children, and between Bermuda grass and allergic rhinitis in adults.

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INTRODUCTION

Ragweed (*Ambrosia* spp.) is an important allergen in North America, but is not generally considered to be a significant allergen in other parts of the world including Australia. On the other hand, short ragweed (*Ambrosia artemisiifolia*) was first recorded

growing in Southern Queensland, Australia in the 1930s¹ and is now widely distributed in the Northern Rivers area of New South Wales close to the Queensland border (Fig 1). Ragweed was noted as a cause of hayfever by Morrison in 1962,² and dermatitis in 1963.³ Scattered localized stands of Western ragweed (*Ambrosia psilostachya*) in other parts of New South Wales, Victoria, and South Australia have been associated with contact dermatitis.^{4,5}

Ragweed is a well-documented cause of seasonal allergic rhinitis and seasonal asthma in the United States and Canada,^{6,7} and is an important cause of morbidity. Ragweed hayfever

sufferers have significant impairment of health related quality of life (HRQL).⁸ In contrast, many people in Alstonville (28° 80' S 153° 20' E), a town in the Northern Rivers district 16 km inland from the east coast of Australia, blame the pollen of *Tibouchina* trees, not ragweed, for the cause of their fall hayfever. The spectacular purple flowers of *Tibouchina* trees bloom between March and May, at the same time as the less obvious ragweed and grasses. *Tibouchina lepidota* cv. Alstonville, developed by an Alstonville nurseryman, is a cultivar of *Tibouchina lepidota* (Family Melastomataceae),⁹ a native of South America. Most of the public parks and roadside nature strips were planted with this tree in the late 1970s, and each household was given a tree to plant in the garden in the early 1980s.

This cultivar of *Tibouchina* grows to a height of 3.0 m with a 2.5 m spread. It has a single trunk, hairy branches and 9.0 cm lanceolate dark green hairy leaves with five prominent veins. The bright purple flowers are arranged in terminal panicles, 5 cm in diameter with five petals. The 10 stamens bear prominent long narrow hook-like anthers. Pollination is both by wind and insects (amphiphilous) and the main flowering period is March through to early June, however spot flowering may occur throughout the year in mild coastal climates. The pollen was studied using an Olympus light microscope at $\times 400$ and $\times 1000$ magnification. The pollen grain is 3 colporate with 3 additional colpi. There are three main longitudinal furrows each with a $\pm$ prominent/large pore at the equator, and three subsidiary, often less pro-

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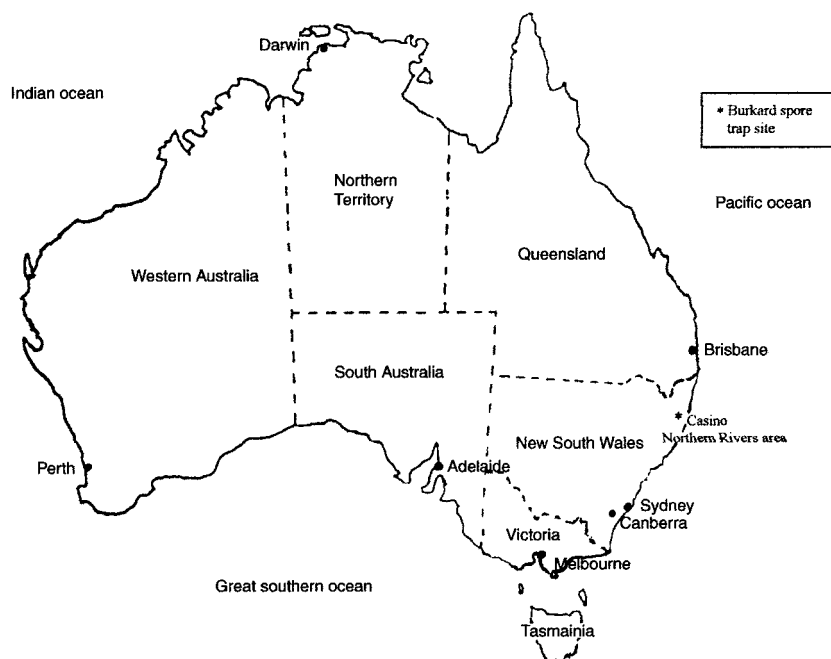


Figure 1. Map of Australia showing Northern Rivers Area of New South Wales and site of Burkard spore trap (*).

nounced furrows without pores. The pollen grain is isopolar, radially symmetrical, small, 18 to 20 μm , mostly spheroidal to oblate and oval in equatorial view, and broadly rounded hexagonal in polar view with apertures between the angles; the pores are usually lolate, square to oblong or irregular in shape and confined within the colpi margins; the colpi have acute to obtuse apices at the polar regions with a $\pm$ smooth colpi membrane (except at open pores); the exine surface pattern is striate-rugulate.

The principal industries in and around Alstonville, population 5,000, are horticulture and macadamia nut production plantations. Casino (28° 90' S, 153° 90' E), population 9,900, is a further 30 km inland from Alstonville and is primarily a cattle fattening district with supporting rural industries. Casino was chosen as the second study area because representation by Casino council, to have ragweed declared a noxious weed, had been rejected by the New South Wales Departments of Agriculture and Health previously, because it was said, that there was no evidence that ragweed

impacts on human health. Our study compared patterns of atopy in residents of these two towns.

METHODS

This study was approved by the Ethics Committees of Concord Repatriation General Hospital, Sydney and the North Coast Area Health Service and was funded by the Asthma Foundation of New South Wales.

Airborne pollen and the *Alternaria* spores were monitored in Casino, using a Burkard 7-day spore trap. The Burkard spore trap was mounted on an unobstructed platform constructed at the corner of the sloping roof and supporting walls of Casino Municipal Council swimming pool amenities building 6.0 m above ground level. The orifice was 80 cm above roof level. The swimming pool amenities block is the only two storey building in the vicinity. The Burkard spore trap was powered by mains electricity from November 1996 through to December 31st 1997, apart from a power failure between January 29th and February 5th 1997. Prior to installation, a scientific instrument engineer calibrated the

mechanical clock, running at 2.0 mm per hour. The air intake was measured weekly using a Burkard flow meter.

The site was adjacent to the Richmond River and close by residential properties, the main highway and some undeveloped land. River She-oaks (*Casuarina cunninghamiana*) and sedge (*Cyperus* spp.) line the riverbank. The swimming pool had closely mown Bermuda grass (*Cynodon dactylon*) together with shade trees, (*Eucalyptus* type species, palms (*Archontophoenix cunninghamiana*), *Bougainvillea glabra* and *Hibiscus* hybrid shrubs. Street tree plantings were mainly *Jacaranda mimosifolia*, *Eucalyptus* type species, including Bottlebrush (*Callistemon viminalis*) and *Melaleuca* spp. Near by domestic gardens were grassed mainly with Bermuda grass, together with ornamental shrubs and flowers including *Hibiscus* spp., *Acacia* spp., *Grevillea* spp., and *Bougainvillea glabra*. The exposed drums were mailed to Sydney each fortnight with the exception of two drums with tapes exposed between June 18th to July 1st, which were lost in the mail. The Melinex tape was divided into 24-hour portions and stained with 2% saffranin O in glycerol jelly (2nd European Course Assessment of Airborne Pollen Concentrations, Leiden 1995). Three 48 mm traverses (200 μm diameter field) were viewed by light microscopy under $\times 400$ magnification. Pollen and *Alternaria* spores were identified and counted by one of us with the counts multiplied by 5/3 to enable the count to be expressed in grains per cubic meter.¹⁰

Study Population

Volunteers were recruited for the study, by offering free allergy testing for residents. This offer was advertised through pharmacies and health food stores in Casino and Alstonville and through the media. To avoid selection bias no mention was made of ragweed or *Tibouchina* during the recruitment, which took place approximately 2 months after the flowering period of these plants. Skin testing was conducted on weekdays July 21 to 25, 1997. Validated questionnaires¹¹ were

filled in, prior to testing, by 206 volunteers who fulfilled the study criteria. Pregnant and breast feeding women and severe unstable asthmatics were excluded from the study. Anyone who had taken an antihistamine or tricyclic antidepressants, in the preceding 48 hours, or in the case of Astemizole, the preceding 6 weeks was also excluded. Other exclusion criteria were children under the age of 5 years and adults over the age of 80 years.

Extracts for skin testing, supplied by Hollister-Stier Bayer Pty. Ltd., were Standardized mite DP 30,000 AU/mL, Standardized mite DF 30,000 AU/mL, Standardized Cat pelt 10,000 AU/mL, Cockroach mix (American and German) 1:20 wt/vol, *Alternaria tenuis* 1:20 wt/vol, rye grass 1:20 wt/vol, Bermuda grass 1:20 wt/vol, Bahia grass 1:20 wt/vol, Plantain weed 1:20 wt/vol, ragweed mix (False, Giant, Short Western) 1/20 wt/vol, in-house Tibouchina pollen extract, no commercial Tibouchina extract being available, negative control (glycerol saline) and positive control (histamine 10 mg/mL). Bermuda grass (*Cynodon dactylon*) and Bahia (*Paspalum notatum*) grass extracts were chosen for the panel, as they are two of the predominant grasses in the subtropical climate of this area.

The stamens of flowers from single Tibouchina trees in Sydney and Alstonville were dried and the pollen sieved through a 63- μ sieve (Endecotts Ltd., Lombard Road, London SW193 BR England). The pollen was extracted in distilled water overnight, centrifuged, and the supernatant dialyzed in Selby dialysis tubing at 4° C for 24 hours, then filtered through a 0.2- μ m Millipore membrane. The protein content determined,¹² was 7.5 mg/mL for the Alstonville Tibouchina and 2.3 mg/mL for the Sydney Tibouchina. The reason for the difference in protein content is not known.

Bayer Quintest skin test device was used for the standard allergen panel and negative control on the volar surface of the right forearm. Separate Medipoint Blood Lancets (Medipoint Inc. 72 E 2 St. Mineola New York 11501)

were used for pricking through ragweed, Tibouchina (Sydney and Alstonville) extracts and positive control on the volar surface of the left arm. The wheal and flare responses were read at 15 minutes and recorded by circling the wheal and flare response with a fine pointed black pen and transferring the outlines to Cellotape. The wheal response was recorded by measuring the longest diameter (D) and shortest diameter (d) of the wheal and dividing by 2 ($D + d/2$). Serum samples were obtained from 36 subjects, who had positive skin prick tests to ragweed and or Tibouchina, who consented to have blood taken. RAST was carried out using Bipharco ragweed RAST discs. The Tibouchina extracts were coupled to 6 mm discs, cut from a nitrocellulose membrane¹³ using an office punch and washed three times in TAPS buffer (0.5% Tween 20, 0.5% BSA in PBS). Discs were incubated with 50 μ L human serum at room temperature, followed by three washes of TAPS, and then incubated with ¹²⁵I-anti-human IgE. Non-atopic serum and cord blood was used as control. Results were expressed as % uptake with non-atopic serum and cord blood showing 0.3% uptake.

Statistical Analysis

Data was analyzed by the statistical programme Epi-Info-Version 6.0. Confidence intervals for prevalence estimates were obtained by the standard approximation or an exact method if numbers were small. The χ^2 test was used to assess the association between categorical variables.

An asthmatic was defined as any person who replied positively to the question, "Have you ever been told by a doctor or at a hospital that you have asthma." There was a high correlation for asthma in those that reported wheeze, an asthma attack or had used a nebulizer in the past 12 months. Hay-fever was defined as the presence of any of the following symptoms, running, sneezing, itching, and blocking of the nose and/or running, itchy, red eyes. A positive skin test was defined as a wheal score $\geq$ 3 mm.¹⁴

Atopy was defined as one or more positive skin prick tests to specific allergens.

Fall symptoms were defined as hay-fever, asthma or asthma exacerbations occurring predominantly between the months of March and May.

RESULTS

Ragweed pollen appeared consistently¹⁵ each day from March 1st with daily counts ranging from 2/m³ at the beginning of the week to 20/m³ at the end of the first week. Airborne ragweed pollen peaked on April 6th with a count of 483 grains/m³ and gradually declined until May 30th, after which ragweed pollen no longer appeared consistently. The season therefore lasted 13 weeks (Fig 2) (Table 1). Fireweed (*Senecio madagascariensis*), an Asteraceae pollen, was seen sporadically between July and September. *Casuarina* spp. pollen was dominant in late May, *Pinus* spp. in August, and *Cyperus* spp. pollen from August through to October. Myrtaceae pollen, which includes Eucalyptus type species, *Melaleuca* spp. and Bottlebrush appears throughout the year but peaked in late September and early October, and cypress pine pollen in October. Grasses flowered throughout the year with the main flowering season between December and March. Airborne *Alternaria* spores were present in concentrations ranging from under 100 spore/m³ between July and late August to peaks in early March, late April, and September. There was no aeroallergen monitoring in Alstonville, however, Tibouchina pollen was monitored using a Burkard spore trap in a domestic garden in Sydney, with concentrations reaching 50 grains/m³ during March and April (D. Bass unpublished data).

Two hundred six subjects were recruited, 101 from Alstonville and 105 from Casino (Table 2). Gender differences were greater among adults (129 women and 48 men) than children (13 girls and 16 boys) ($P \leq .005$). Ages ranged from 5 to 77 years (mean 43.6 years, mode = 41 years, SD = 18.2). Seventeen adults (23.9%) were current smokers.

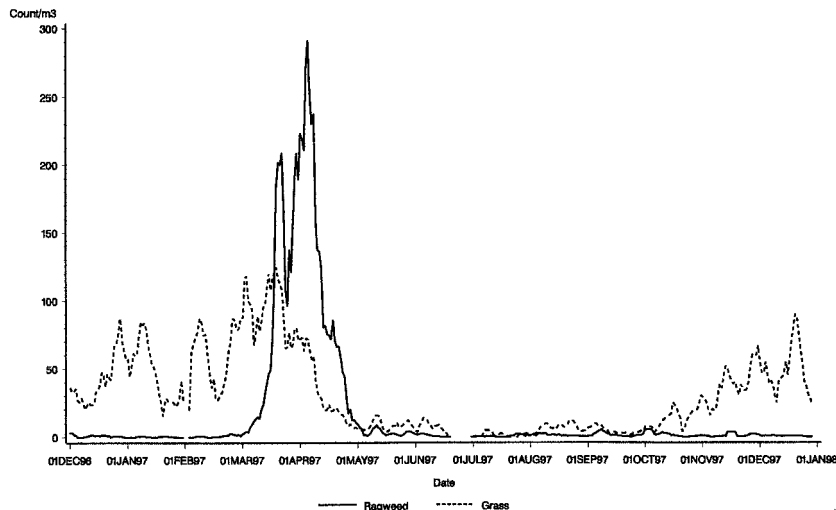


Figure 2. Five day average Grass and Ragweed pollen counts monitored in Casino from December 1996 to December 1997.

The pattern of skin sensitization for all subjects is shown in Table 3. One hundred fifty-three (74.3%) subjects were atopic, with 132 (74.5%) adults and 21 (72.4%) children having one or more positive skin prick tests. Dust mite was the principal allergen sensitizing both adults and children (58.7% of total). Ragweed sensitization was demonstrated in 70 (34%) subjects, 62 adults (35%) and 8 children (27.6%). Forty-six ragweed sensitized subjects lived in Casino and 24 in Alstonville. Seasonal symptoms of ragweed positive and ragweed negative subjects are shown in Table 4. Tibouchina sensitization was demonstrated in 11 subjects (5.3%), of whom 9 (5.1%) were adults and 2 (6.9%) were children, and all lived in Alstonville.

There was a statistical association between Bahia grass and reported asthma in children, OR 12.00 (CI 1.06 to 315.54) and between Bahia grass and reported hayfever in all the subjects, OR 14.47 (CI 1.99 to 298.210). There was a statistical association between Bermuda grass and hayfever, but not asthma, OR 13.44 (CI 1.85 to 27.04) and between ragweed and hayfever, but not asthma, OR 3.36 (CI 1.03 to 12.15).

A further questionnaire was issued in May 1998, which was 1 year after the initial testing, to 72 subjects who

were skin test positive to ragweed and or Tibouchina. Seventy (97.2%) subjects returned these questionnaires. The two nonresponders were females, one aged 12, who had perennial rhinitis with multiple sensitivities including Tibouchina and one aged 64 who was sensitive to dust mite and ragweed, with symptoms unrelated to the ragweed flowering season. Questionnaires were returned from 46 females and 24 males with an age range between 6 and 67 years. The results of the initial and subsequent questionnaires were combined. Fifty subjects (71.4%) reported symptoms only in the ragweed season or a significant increase in symptoms during the ragweed season. Eight of these subjects were allergic only to ragweed. Six of these eight had fall hayfever coinciding with the ragweed pollinating season, one had fall asthma but no hayfever and one was asymptomatic. Twenty-five (35.7%) of the 50 ragweed skin prick test positive subjects only had fall hayfever, 10 (14.2%) had spring and fall hayfever, 5 (7.2%) had rhinitis symptoms for 6 months of the year and 10 (14.2%) had perennial asthma and rhinitis with fall exacerbations as shown in Figure 3. Ten subjects had perennial symptoms with no relationship to the ragweed season. Ten subjects, one whom was

mentioned previously, were entirely asymptomatic.

Eleven subjects were sensitive to Tibouchina. One subject who was allergic to Tibouchina and dust mite but to no other aeroallergens had hayfever symptoms only during the Tibouchina flowering season but not during the rest of the year. Four of the eight subjects who were allergic only to Tibouchina and ragweed were symptomatic in the fall and four had perennial rhinitis symptoms. One subject who was allergic to Tibouchina and both indoor and outdoor allergens but not to ragweed was asymptomatic.

Subjects with perennial rhinitis symptoms and no fall exacerbations tended to have smaller ragweed skin prick wheals than subjects, who were symptomatic only during the ragweed flowering season, although this did not reach statistical significance (T-test/NPar). The Tibouchina wheal size, in the eleven subjects sensitive to Tibouchina, ranged from 3.0 to 8.00 mm. RAST demonstrated circulating ragweed-specific IgE in 28 of 36 sera of the ragweed-sensitive subjects with high scores in 26 sera.¹⁶ Two of 6 subjects with positive skin prick tests to Tibouchina had weak positive Tibouchina RAST.

DISCUSSION

Monitoring of pollen at one site for only 1 year does not provide sufficient data to predict the beginning and end of the ragweed flowering season, nor average pollen concentrations for the flowering season in the Northern Rivers area. The start and finish of the ragweed flowering season together with ragweed pollen concentrations in Casino (S 28° 90') show that the duration and concentration of ragweed pollen, between March 1st and May 30th 1997, is similar to the pattern of airborne ragweed pollen that has been demonstrated in Houston¹⁷ (N 29° 76') and Corpus Christi¹⁸ (N 27° 46'), Texas, USA. Airborne ragweed pollen starts in Houston on September 1st, and has a peak pollination of nearly 500 grains/m³ on October 11th $\pm$ 6 days (1985–1992). In 1988 the rag-

Table 1. Weekly Pollen Counts in Casino Between January 1st and December 30th 1997

Month/Week	Jan 1	Jan 2	Jan 3	Jan 4	Feb 1	Feb 2	Feb 3	Feb 4	Mar 1	Mar 2	Mar 3	Mar 4	Apr 1	Apr 2	Apr 3	Apr 4	May 1	May 2	May 3	May 4	Jun 1	Jun 2	Jun 3	Jun 4
Poaceae	400	515	231	220	203	482	202	539	691	632	883	725	488	213	133	98	39	82	49	88	75	46	0	0
Ambrosia spp.	0	0	0	0	0	4	4	12	40	152	1015	1485	1798	815	488	264	32	43	16	24	17	2	0	0
Asteraceae	0	4	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amaranthaceae	6	4	6	6	4	5	0	21	11	5	5	12	7	2	0	2	0	0	0	4	0	2	0	0
Casuarinaceae	49	66	27	4	0	38	22	26	51	9	24	191	245	19	72	726	627	366	115	301	254	263	0	0
Cupressaceae	2	2	0	0	0	0	3	2	8	0	0	0	0	0	0	2	0	5	2	9	0	0	0	0
Myrtaceae	31	45	20	5	7	60	41	61	68	22	60	48	43	45	19	19	0	35	30	87	19	20	0	0
Other	54	90	50	19	34	99	49	108	122	67	82	87	72	39	55	38	10	27	23	27	36	21	0	0
Total	542	726	337	256	248	688	321	769	991	887	2069	2548	2653	1133	767	1149	708	558	235	540	401	354	0	0
<i>Alternaria</i>	119	98	135	188	73	340	312	753	514	149	388	453	525	118	187	410	21	127	344	483	157	135	153	0

Month/Week	Jul 1	Jul 2	Jul 3	Jul 4	Aug 1	Aug 2	Aug 3	Aug 4	Sep 1	Sep 2	Sep 3	Sep 4	Oct 1	Oct 2	Oct 3	Oct 4	Nov 1	Nov 2	Nov 3	Nov 4	Dec 1	Dec 2	Dec 3	Dec 4
Poaceae	2	27	10	10	26	54	52	79	57	34	23	26	43	86	119	166	161	277	268	452	339	265	479	339
Ambrosia spp.	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	0	3	0	13	18	8	8	6	14	20	6	7	30	20	4	4	3	6	4	13	7	4	6	2
Amaranthaceae	0	0	0	0	0	2	4	0	3	2	0	6	4	9	12	2	0	7	6	7	2	5	4	7
Casuarinaceae	85	50	58	39	59	67	53	80	55	108	37	8	17	15	12	15	2	14	4	17	36	27	44	29
Cupressaceae	2	16	2	9	16	66	68	159	388	194	201	468	197	948	1072	110	72	247	367	79	46	0	7	19
Myrtaceae	12	0	11	40	29	49	32	59	71	51	75	180	234	234	93	186	160	198	231	358	338	168	289	93
Other	6	60	168	467	518	610	502	535	305	146	123	656	348	216	198	433	159	145	126	100	116	101	202	66
Total	109	156	249	578	666	856	719	918	893	555	465	1351	873	1528	1510	916	557	894	1006	1026	884	570	1031	556
<i>Alternaria</i>	12	53	77	68	74	121	45	63	256	133	80	299	122	437	209	336	296	460	389	395	508	282	523	300

Table 2. Atopic Status and Geographic Location of Subjects

	Alstonville		Casino		Total Subjects	
	n	(%)	n	(%)	n	(%)
Atopic	70	(69.3)	83	(79.0)	153	(74.3)
Non atopic	31	(31.7)	22	(21.0)	53	(25.7)
Total subjects	101	(100.0)	105	(100.0)	206	(100.0)

Table 3. Prevalence of Sensitization to Allergens in the Northern Rivers Area of New South Wales

Allergen	All (n = 206)	Adults (n = 177)	Children (n = 29)
Sensitive to one or more allergens	153 (74.3%)	132 (74.5%)	21 (72.4%)
<i>Dermatophagoides pteronyssinus</i>	101 (49.0%)	84 (47.5%)	17 (58.6%)
<i>Dermatophagoides farinae</i>	93 (45.1%)	85 (48.0%)	8 (27.6%)
Total dust mites	121 (58.7%)	85 (48.0%)	19 (65.5%)
Cockroach	57 (27.7%)	49 (27.7%)	8 (27.6%)
Cat dander	45 (21.8%)	40 (22.6%)	5 (17.2%)
<i>Alternaria</i>	42 (20.4%)	33 (18.6%)	9 (31.0%)
Ryegrass (<i>Lolium perenne</i>)	75 (36.4%)	65 (36.7%)	10 (34.5%)
Bermuda grass (<i>Cynodon dactylon</i>)	63 (30.1%)	55 (31.1%)	7 (24.1%)
Bahia grass (<i>Paspalum notatum</i>)	65 (31.6%)	56 (31.6%)	9 (31.9%)
Plantain (<i>Plantago lanceolata</i>)	44 (21.3%)	39 (22.0%)	5 (17.2%)
Mixed ragweed	70 (34.0%)	62 (35.0%)	8 (27.6%)
Tibouchina collected in Sydney	11 (5.3%)	9 (5.1%)	2 (6.9%)
Tibouchina collected in Alstonville	10 (4.8%)	8 (4.5%)	2 (6.9%)
Histamine	201 (97.5%)	175 (98.9%)	26 (89.7%)

* Wheal size >3 mm.

weed season started in Corpus Christi in late August and peaked in the week September 30th–October 6th with the highest count of 495/m³ on October 4th. If the months are transposed by 6 months from March to September, the timing and duration of ragweed pollen counts in Casino (28° 90' S) in 1997 are similar to the ragweed flowering season in Houston USA (N 29° 76') where climatic conditions almost perfectly match those of Casino.¹⁹

The rate of sensitization to ragweed in the general population of Corpus Christie¹⁸ is 27%. In this study in the Northern Rivers area of New South Wales, 47.5% of atopic subjects demonstrated ragweed sensitization, a level similar to atopic subjects in Quebec, Canada.²⁰ There are three distinct pollination seasons in Quebec with intervals between tree and grass pollination and grass and ragweed pollination and as there is no other pollen in the air at the time of ragweed flowering, ragweed pollen allergy is a well-recognized cause of fall hayfever and asthma in Quebec.²⁰ In the subtropical climate of the Northern Rivers area

Table 4. Seasonal Symptom Differences between Ragweed-Positive and Ragweed-Negative Atopic Subjects

	Fall Symptoms				n	(%)
	Present	(%)	Absent	(%)		
Ragweed SPT positive	50	(86.2)	20	(21.1)	70	(45.8)
Ragweed SPT negative	8	(13.8)	75	(79.9)	83	(54.3)
Total	58	(100.0)	95	(100.0)	153	(100.0)

Persons with ragweed sensitivity were more likely to have fall symptoms than those who did not (OR = 23.4, CI 8.90 to 64.00).

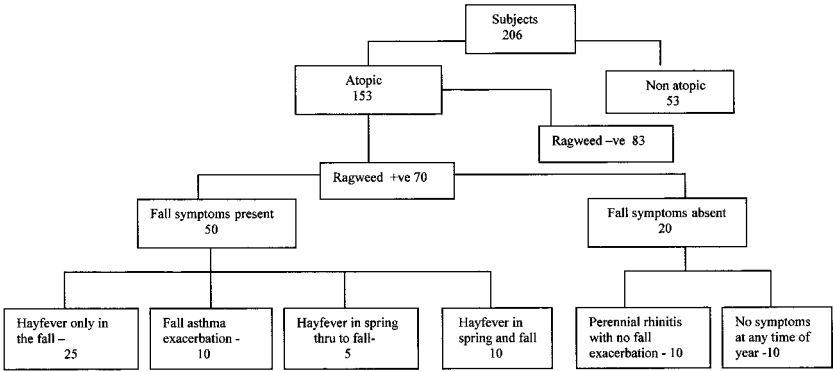


Figure 3. Flow chart showing the symptom subgroups of the ragweed positive subjects.

there is no interval between the grass pollen season and the ragweed pollen season (Fig 2 and Table 1). Of the 70 ragweed-sensitive subjects in the Northern Rivers area of New South Wales, 50 had marked exacerbation of symptoms during the ragweed flowering season or only during the ragweed flowering season. Only eight (11.4%) subjects were sensitive to ragweed as the sole allergen, and of these, seven were symptomatic only in the ragweed flowering season. This is comparable to the eastern seaboard states of United States where it is unusual to have subjects with ragweed pollen as the sole allergen.²¹ A similar rate of sole pollen sensitivity has been recorded to birch²² and *Parietaria judaica*²³ in Australia, with the majority of birch and parietaria pollen allergic subjects also sensitive to grass pollen. Fall hayfever and asthma, associated with ragweed sensitivity is also recorded in other Northern Hemisphere countries including France,²⁴ Northern Italy,²⁴ Hungary,²⁴ Taiwan,²⁵ China,²⁶ and Japan.²⁷ There have been no reports of ragweed pollinosis from any Southern Hemisphere

country except Australia,² although ragweed skin test positivity has been recorded in Colombia.²⁸ The peak grass pollen count in Casino in March coincides with the start of the ragweed season and the grass pollen count declines as the ragweed count increases (Table 1 and Fig 2). Grasses flowering in the Casino district at this time are Rhodes grass (*Chloris gayana*), Bermuda grass or Couch grass (*Cynodon dactylon*), Paspalum spp., Carpet grass (*Axonopus affinis*) and South African Pigeon grass (*Setaria sphacelata* var. *sericea*). Although little is known about the allergenicity of Rhodes and Carpet grasses it is likely that there will be cross reactivity between Carpet grass and Paspalum spp., both members of the tribe Paniceae, and between Rhodes grass and Bermuda grass, members of the Aristideae tribe. Sensitization to these grasses would account for early summer (December to February) symptoms, and ragweed sensitization for fall respiratory tract symptoms. Bermuda grass is a well-documented aeroallergen causing allergic disease

and is usually part of a standard skin test panel. Bahia grass pollen extract has not been used in previous epidemiologic studies in Australian children although Bahia grass is a documented allergen in subtropical areas.²⁹ In this study there is a statistical association between asthma and Bahia pollen sensitization in children. Rye grass is not considered a risk factor for asthma either in this study or in a previous one.³⁰ In this small study the rate of childhood atopy (72.4%) is double (34.9%) that of a large school population study in Peat et al³¹ in 1995, only 20 km distant from the present study area. Interestingly, however, ryegrass SPT positivity in children in this study is only slightly more than half (4.14%) that in the previous study (7.0%).³¹ Apart from small isolated stands in other parts of New South Wales, widespread ragweed growth in Australia occurs only in Southern Queensland close to the New South Wales border and the Northern Rivers area of New South Wales. In this study ragweed skin test positivity was 27.6% in children. In comparison, ragweed skin prick test positivity in Wagga Wagga, Belmont, and Villawood (cities between 500 to 1000 km south of the Northern Rivers area) ranged between 2.2% and 4.1%.³² Airborne ragweed pollen has not been documented in any of the state capital cities of Brisbane (Queensland),³³ Sydney (New South Wales),¹⁰ Canberra (ACT),³⁴ Melbourne (Victoria),³⁵ Adelaide (South Australia),³⁶ or Perth (Western Australia).³⁷ Our study also suggests that skin testing with regional allergens as well as ryegrass may give a more accurate picture of pollen sensitization than skin testing with ryegrass, which is not a dominant grass in subtropical climates. Although numbers are too small for statistical significance, 11 subjects in Alstonville demonstrated sensitivity to Tibouchina pollen by skin prick testing and two subjects had circulating antibodies demonstrated by specific RAST. One of the subjects had seasonal symptoms provoked by Tibouchina pollen exposure. Tibouchina trees in Alstonville outnumber those in

Casino, and with trees planted within 4 m of homes, *Tibouchina* pollen concentration would be sufficient to sensitize. *Tibouchina*, which is native to South American countries, is also planted widely as an ornamental shrub in the southern states of United States and South Africa and is reported as an alien weed in Hawaii and the Philippines. *Tibouchina* has been a previously unrecognized aeroallergen. Our study suggests it has the potential to cause seasonal allergic rhinoconjunctivitis, if it is planted close to domestic dwellings.

This study was not able to address the correlation of symptom scores with ragweed pollen counts. Symptom scores of ragweed sensitive subjects, with hay fever symptoms but no asthma, correlate well with ragweed pollen counts in clinical trials.^{38,39} There is, however, no consistent correlation in asthmatic subjects between actual ragweed pollen counts and the severity of asthma.⁴⁰ Ragweed sensitive asthmatics have failed to respond to inhalation of whole ragweed pollen with asthma symptoms but did have an asthmatic response following the inhalation of ragweed extract.⁴¹ It has been demonstrated by immunoblotting methods that antigen morphologically unrecognizable particles may occur in the atmosphere in numbers that are several fold greater than the numbers of recognizable pollen^{42,43} and it may be that pollen fragments are more likely to be inhaled than whole pollen grains, which in turn will provoke a late phase inflammatory response. As an indicator of the degree of pollen exposure, medication scores, using a mathematical model,⁴⁴ are unreliable, but in this study, all 10 asthmatics who were skin prick test positive to ragweed reported the need for either increased bronchodilator use or increased inhaled or ingested corticosteroid medication during March and April.

CONCLUSION

In this small study, statistical correlation has been shown between exposure and sensitization to ragweed and respi-

ratory tract symptoms during the ragweed flowering period. This study also demonstrates a different pollinosis pattern in the Northern Rivers area of New South Wales to that of the southern Australian states. *Tibouchina* pollen appears to be a weak allergen with positive skin prick tests and low circulating *Tibouchina* IgE RAST scores in only a few subjects, however symptoms of some subjects were sufficiently severe to warrant removing the tree from the vicinity of the home, leading to improvement of symptoms. Many subjects who thought that *Tibouchina* was a cause of their seasonal symptoms were allergic to ragweed and not to *Tibouchina*.

Our study documents for the first time the presence of airborne ragweed pollen in the Southern Hemisphere. Pollen was recorded in sufficient concentration and for sufficient length of time to sensitize and cause allergic respiratory tract disease and was significantly associated with symptoms of hayfever. Our study also identified a previously unreported association between Bahia grass (*Paspalum notatum*) pollen and asthma in children. Bermuda grass was also associated with hayfever in the volunteer population.

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