

A clinical and environmental study of the aeroallergens of the islands of Bermuda

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Summary

The major allergen responsible for allergic respiratory disease in the islands of Bermuda has been shown to be derived from *Dermatophagoides pteronyssinus*. 73% of the atopic group included in the survey gave weal and erythema reactions to extracts of this mite, whereas only 30% reacted to mixed pollen extracts and 10% to mould extracts. *D. pteronyssinus* was isolated from all house dust samples and it represented 63% of the total mite population. Allergic disease was predominantly of a perennial nature, with only a modest seasonal influence, and pollen counts were low throughout the year.

Introduction

No attempt has been made previously to correlate the incidence of allergic respiratory disease with skin reactions to common allergens in the environment in the islands of Bermuda. Gay, Curtis & Norris (1941) concluded that tree pollens were dominant in the atmosphere during March and early April. Pollen grains derived from the Bermuda cedar tree, *Juniperus bermudiana*, which reached peak concentrations of 7000 grains per cm², and from the Candleberry myrtle shrub (*Myrica cereifera*), were the only tree pollens identified in significant numbers. Grass pollens appeared from May onwards but only in very low numbers, with peak counts for all grasses in the range of 11 grains per cm².

Clinicians in the Hamilton area of Bermuda observed a peak incidence of allergic respiratory disease in October/November, supported by figures obtained from the King Edward VII Memorial Hospital, Paget, Bermuda, showing admissions for asthma over a 5 year period to be highest in October to December (Fig. 1, Table 1). The allergens responsible could not be identified from the pollen survey of Gay *et al.* (1941). Woolf considered that *Dermatophagoides pteronyssinus* might be responsible because of skin test responses to this mite (J. H. Woolf, personal communication).

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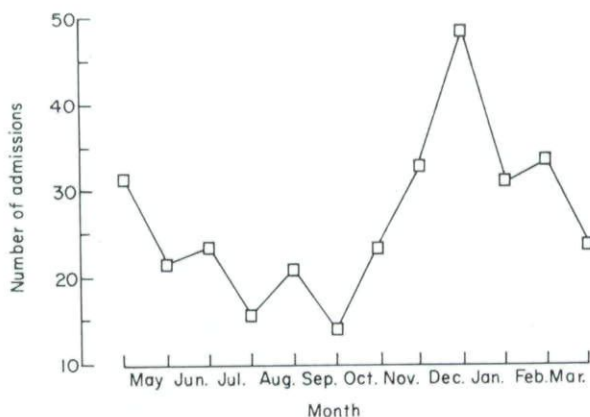


Fig. 1. Admissions to King Edward VII Memorial Hospital with primary diagnosis of asthma, by month, for the fiscal years 1972 to 1977.

Table 1. Admissions to the King Edward VII Memorial Hospital with primary diagnosis of asthma 1972-1977

Monthly	1972/3	1973/4	1974/5	1975/6	1976/7	Total
April	6	9	5	6	5	31
May	4	5	6	4	3	22
June	2	7	6	6	3	24
July	2	4	4	3	3	16
August	4	5	4	2	6	21
September	1	6	5	2	0	14
October	5	2	9	6	2	24
November	10	7	8	5	3	33
December	9	15	14	8	2	48
January	7	5	4	11	4	31
February	13	6	8	5	2	34
March	5	7	8	2	2	24
Total admissions	68	78	81	60	35	322
Total patients	51	61	60	45	30	247

Associated diagnoses were: forty-two with upper respiratory tract infections, twenty-five with bronchitis and fourteen with pneumonia.

The present survey was carried out to try to document the major aeroallergens of Bermuda as a preliminary to the design of clinical trials of immunotherapy for the treatment of allergic asthma and rhinitis on the islands.

The islands of Bermuda cover approximately 21 square miles and they lie in the Atlantic Ocean. Temperatures are relatively constant throughout the year, the mean being 15-20°C during November to May and 20-26°C during the summer months. Humidity is high and the percentage relative humidity throughout the year of this survey ranged from approximately 60 to 80%.

Materials and methods

Subjects

200 non-atopic subjects and 201 atopic subjects were admitted to the survey. The non-atopic control group was comprised of volunteers, a high proportion of whom were hospital staff. The median age of this group was 29 years, the age range 3–81 years, and only two were children under the age of 9 years. There were forty-four males and 156 females. The atopic group were patients attending the clinics for respiratory disorders judged by their physicians to be allergic in origin. The majority had responded to prick or intradermal skin tests with common allergens at varying times prior to this survey and most reported a family history of allergy. The median age of this group was 19.5 years, the age range 15 months to 68 years and there were forty-five children under the age of 9 years. Sixty-nine were males and 132 females. The atopic group comprised twice as many natives as immigrants. The majority of the immigrants were adults, whereas over 50% of the native population in the atopic group were children under the age of 14.

A questionnaire was completed for each subject based on the Bencard case history chart. Questions were directed towards climatic and environmental influences, the nature and severity of the allergic disorder, the type and frequency of therapy indicated and information was sought on family history of atopic disease. Diary cards were completed by the subjects at the beginning, middle and end of each month. These recorded symptoms (none, mild, average and severe) and therapy required. Periods of time spent away from Bermuda were noted. 127 (64%) of the atopic group reported a family history of allergic disorder in close relatives, either parents, grandparents or siblings. Only 15% of the control group had relatives with known allergic disease.

Skin tests

Allergen extracts (Table 2) supplied by Bencard U.K. were used for skin prick tests. Weal diameters were measured using the Bencard allergy skin test gauge. A selected number of subjects in the atopic group were also tested with a 2.5% glycerinated extract of *Myrica gale*.

Table 2. Skin test responses in atopic and control groups

Allergen	Atopics			Controls		
	Total with positive skin test	Size of weal reaction (mm)		Total with positive skin test	Size of weal reaction (mm)	
		Median	Range		Median	Range
<i>D. pteronyssinus</i>	146 (73%)	9	2–25	34 (17%)	4.5	2–16
Cat dander	74 (37%)	6	2–16	17 (9%)	3	2–8
Mixed grass pollen	60 (30%)	5	2–20	14 (7%)	5	3–20
Dog dander	33 (16%)	4	2–8	8 (4%)	4	2–6
Mixed moulds	21 (10%)	4	3–18	7 (4%)	3	3–8
<i>Aspergillus fumigatus</i>	16 (8%)	4	2–6	9 (5%)	4	3–7
Mixed tree pollen	14 (7%)	4	3–6	14 (7%)	4	3–6
Control solution	5 (2%)	3	2–4	4 (2%)	4.5	3–5

Pollen counts

The survey was carried out during December 1975–February 1977.

A Burkard 7-day recording volumetric spore trap was sited on the roof of the King Edward VII Memorial Hospital in Paget, Bermuda, so as to collect windborne pollens, the major potential aeroallergens, and not pollens which disperse only locally around the plants. Pollens were identified by reference to Faegri & Iverson (1950) and Hyde & Adams (1958).

Wind directions and relative humidity

Daily wind directions were obtained from the United States Naval Air Station. Relative humidity was recorded throughout the year at 09.00 hours and 17.00 hours.

Fungal spores

Petri dishes with Sabouraud's agar were placed in a number of the homes of the patients. In some instances dust raising operations were carried out during the exposure. The plates were returned to the U.K. laboratories and the moulds identified. No attempts were made to quantify them.

House dust analysis

Samples of house dust and mattress dust were obtained from the houses of eleven persons in the survey for analysis for mites at the Pest Infestation Control Laboratory, Slough, England, by Dr A. M. Cunningham.

Results*(a) Clinical studies*

Response to the survey. 183 subjects in the atopic group returned adequately completed diary cards for the months of December 1975 to February 1977. Complete sets were returned by 140 (70%).

Diagnostic skin tests. Prick test responses to *D. pteronyssinus* occurred in 146 subjects (73%) of the atopic group and in thirty-four (17%) of the control group ($P < 0.001$) (Table 2). Responses were obtained in the atopic group to mixed grass pollens (30%), cat and dog danders (37% and 16% respectively), and these responses occurred significantly more frequently than in the control group ($P < 0.001$). Only 10% of the atopic group responded to mixed moulds compared with 4% in the control group ($P < 0.01$). Responses to *Aspergillus fumigatus* and mixed tree pollens did not differ in the two groups. 167 (83%) subjects in the atopic group compared with forty-three (21%) controls responded to one or more allergens ($P < 0.001$) (Table 3). Thirty-four (17%) subjects in the atopic group failed to respond to any of the skin test reagents. Of the thirty subjects who were tested with extracts of *Myrica gale* pollen, only one gave a reaction greater than that of mixed grass extract.

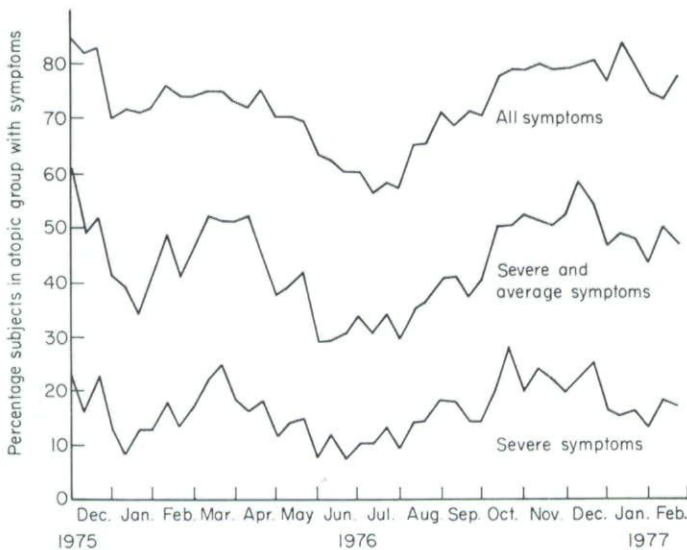
Symptoms. Table 4 shows the number of subjects reporting with perennial or seasonal symptoms; 193 (96%) suffered from perennial asthma or rhinitis or both. Of these subjects, eleven said that symptoms occurred mostly in humid weather and five related their symptoms to windy weather, particularly from the east. Of the 165 subjects in this group whose symptoms varied throughout the year, most recorded worsening of their condition between October and March. Only eight subjects had

Table 3. Incidence of positive skin test reactions

Total number of allergens (including control) to which subjects had positive reaction	Atopics	Controls
All negative	34 (17%)	157 (79%)
1	58	19
2	50	7
3	39	7
4	13	4
5	3	3
6	2	1
7	1	—
8	1	2
Total subjects tested	201	200

Table 4. Perennial and seasonal character of allergic disorders in the atopic group

allergic disorder	Severity of disorder			Total subjects
	Mild	Average	Severe	
Perennial asthma	24	34	54	112
Perennial rhinitis	37	56	60	153
Seasonal asthma	2	2	—	4
Seasonal rhinitis	4	6	3	13

**Fig. 2.** Graph showing the incidence of symptoms in the atopic group throughout the survey period.

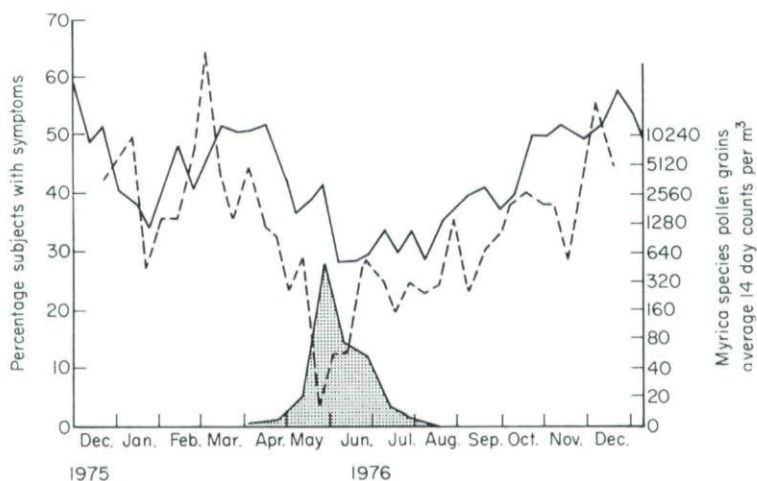


Fig. 3. Graph showing symptom trends in atopic subjects with positive and negative skin tests and lack of correlation of symptoms with *Myrica* pollen counts. Severe plus average symptoms (—) in all atopics, and (---) in skin test-negative atopics. Shaded area shows pollen counts.

seasonal complaints only, four of whom said that their symptoms occurred mostly in dry weather.

The analysis of diary cards showed (Fig. 2) that from December 1975 to February 1977 the peak level of symptoms was during October to December, with a significant fall in the proportion of patients with symptoms during May to August. It is clear from Fig. 2 that all subjects followed the same general pattern with respect to the incidence of symptoms, regardless of how severe their symptoms were. The same trend was observed in males and females, although the seasonal fall in incidence was more marked for males. Over the whole survey period, adults had a higher level of symptoms than children, and this was particularly marked for subjects with the less severe symptoms. Immigrant subjects had a marginally higher level of symptoms than the native subjects, but the majority of the immigrants were adults in whom, as noted, more symptoms were recorded.

The thirty-four subjects who failed to respond to skin tests were analysed further. Fig. 3 shows that the overall incidence and pattern of symptoms in this subgroup were similar to that of the atopic subject group as a whole and to the skin test-positive members of this group (not plotted). We have no evidence that their sensitivity is to an unidentified allergen. Certainly, their symptoms do not coincide in time with peak levels of *Myrica* pollen in the atmosphere (Fig. 3) and so on this data, and the skin test results with *Myrica*, the subgroup is not uniquely sensitive to this major environmental pollen.

Influence of housing and environment. The majority of both atopic and control groups lived out of town in houses over 10 years old and approximately 50% in each group said that the houses were damp. Both groups had equal contact with animals; 73% of the atopic group, 67% of controls. 64% of the atopic group reported that their symptoms depended upon their location; of these 47% were more severely affected indoors. Of the 67% who had a different level of symptoms at home and at work, 59% were worse when at home. 76% of the atopics experienced symptoms at night and on waking; 25% reported worse symptoms during the day.

(b) *Aeroenvironment studies*

Pollen counts. Total and differential pollen counts were performed over the period 26th February 1976 to 27th February 1977.

A technical problem was identified during the period 31st July to 15th August, during which pollen counts recorded rose sharply. This was shown to be due to contamination of the slides with pollen grains derived from local pollinating plants being handled adjacent to the counting laboratory. Counts made during this period were therefore disregarded.

Total pollen counts. Total pollen counts were low and, discounting the period noted above, rarely rose above 30 grains per m^3 , with the exception of the period during which *Myrica* was pollinating, noted below.

Differential pollen counts. It was possible to identify pollen grains derived from *Juniperus* in the period February to early April. The maximum recorded peak concentration of grains was greater than 25 grains per m^3 on only 8 days and on no day exceeded 40 grains per m^3 .

Myrica pollen was more abundant. As shown in Fig. 3, it reached mean peak concentrations mid-May to mid-June of over 500 grains per m^3 , with peak counts of 3000. Pollen from this shrub could be identified during most of the year, although at considerably lower concentrations than in May and June.

The Gramineae-derived pollens were at no time prominent in the atmosphere. A count of 25 grains per m^3 was recorded on only 6 days and even these figures might be in excess of the true readings due to the problems of contamination noted above.

Occasional pollen grains were identified from other species, including the Pinaceae, but numbers were exceedingly small. Plantain pollen counts were negligible, with only 10 grains identified during the year.

Fungal spores. The predominant moulds present on the agar plates were *Alternaria*, *Aspergillus*, *Cephalosporium*, *Cladosporium*, *Mucor* and *Penicillium*. No unusual moulds were found and in qualitative terms it was concluded that the moulds predominating in the air were similar to those in the U.K.

(c) *Analysis of dust samples*

All samples of house dust were shown to contain *D. pteronyssinus*, which represented over 96% of the total mite population (Table 5). The density of *Dermatophagoides* species per 100 mg of dust sample ranged from seventy-five to 700. In most cases,

Table 5. Mite fauna of Bermuda house dust

Species of Mite	Percentage frequency	Percentage of total mite population
<i>D. pteronyssinus</i>	100	63.1
<i>D. farinae</i>	54.5	32.7
<i>E. maynei</i>	9.1	0.02
Unidentified	9.1	0.40
<i>Blomia tropicalis</i>	63.6	1.9
<i>Cheyletus</i> spp.	63.6	1.8
<i>Tarsonemus</i> spp.	9.1	0.07

D. pteronyssinus was the dominant species. In one case, *D. farinae* was clearly dominant and this might have been related to a less humid, drier atmosphere in the air-conditioned house from which it was derived. The non-Dermatophagoides mite species represented less than 4% of the total mite population. *Blomia tropicalis* and *Cheyletus* spp. occurred in over 60% of samples, but in very low numbers only.

Discussion

A high proportion (73%) of the atopic subjects in Bermuda showed sensitivity to the house dust mite, *D. pteronyssinus*, corresponding to its presence in house dust samples. Although only limited sampling was done, all contained *D. pteronyssinus* and in some samples 400–700 mites per 100 mg dust were counted. Humidity is relatively high in Bermuda, creating conditions favourable for this mite. The majority of patients (96%) had perennial symptoms of asthma, rhinitis or both, probably due largely to mite allergy.

The slight increase in symptoms recorded in October was not related to any additional allergen which could be identified in the environment; it was most likely due to the onset of winter and longer periods spent indoors. Very low numbers of pollen grains were found throughout the year and the only plant to shed sufficient pollen grains to cause allergic symptoms was *Myrica*, a shrub found in marshy areas, especially in the Paget and Devonshire parishes in Bermuda. Sensitivity to this pollen was, however, low and in only one subject were responses to prick test greater than those to mixed grass. Moreover, the peak number of *Myrica* pollen grains in the atmosphere occurred during May–July, coinciding with few symptoms in the atopic subjects. Juniper pollen was the dominant pollen in the atmosphere early in the year, but concentrations were lower than recorded by Gay *et al.* (1941), whose survey took place before most of these trees were destroyed or had died. The major role of the Gramineae-derived pollens in Europe was not a feature of allergic respiratory disease in Bermuda. Counts were lower than 30 grains per m³, presumably due to the mainly southerly prevailing winds and the high relative humidity of the islands. Neither ragweed pollen nor plantain were present in significant numbers, if at all. Windborne pollens therefore do not seem to be important allergens in Bermuda, although different climatic conditions might influence their relative role in any given year.

These findings are similar to those of Pearson (1973) and Pearson & Cunningham (1973), who in a study in Barbados obtained positive skin test reactions to house dust in 64% of subjects and to mixed grass pollens in only 10%.

The number of responses to animal danders was higher than anticipated, and suggests a level of sensitivity in the atopic population which could contribute significantly to perennial respiratory disease.

In spite of the high humidity, allergy to moulds did not seem to be important, only 10% of patients responding to extracts containing those species identified in Bermudan houses by agar plate exposures. It is possible that actinomycetes, basidiomycetes and mildews, which would not be identified by our methods, could be sources of allergens, but we have no evidence of this.

Thirty-four patients (17%) failed to react to any of the allergens, suggesting either that their respiratory disease was not atopic in origin or that they were allergic to an allergen not present in the skin test reagents used. As a group, these patients followed the general pattern of incidence of symptoms throughout the year, and it is unlikely that

we have failed to identify a major allergen responsible for their symptoms. Further evaluation of their atopic status is therefore necessary.

The immigrant population experienced more symptoms than natives. We believe this was due not to any inherent differences in these groups, but to the disproportionately high number of adults in the immigrant group, for we found that adults experienced significantly more symptoms than children.

The overall conclusion from this survey is that the house dust mite *Dermatophagoides pteronyssinus* is the major cause of allergic respiratory disease in Bermuda.

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