

House dust mite fauna of tropical Singapore

F. T. CHEW, L. ZHANG, T. M. HO* and B. W. LEE

Department of Paediatrics, National University of Singapore, Singapore *Division of Acarology, Institute for Medical Research, Kuala Lumpur, Malaysia

Summary

Introduction and aims Sensitization to house dust mites is very common in the tropics. This study evaluated the dust mite fauna in Singaporean homes.

Methods A total of 134 dust samples from 50 homes were evaluated. Dust mites were isolated, identified and quantified by standard techniques.

Results Dust mites were isolated from 130/134 (97%) samples, with mites identified in all samples from sofas ($n = 21$) and carpets ($n = 13$), and 49/50 (98%) and 47/50 (94%) from mattresses and bedroom floors, respectively. All samples from sofas and carpets had more than 500 mites/g compared with 47/50 (94%) and 23/50 (46%) from mattresses and floors, respectively. *Blomia tropicalis* was the predominant mite (62% of total mites) followed by *D. pteronyssinus* (16% of total mites). Eight samples had a predominance of *Sturnophagoides brasiliensis* and *Tarsonemus granarius*. Other species that accounted $\approx 1\%$ of mites identified included *D. farinae*, *Austroglycyphagus malaysiensis*, *Cheyletus malaccensis*, *Malayoglyphus intermedius*, *Suidasia pontifica* and *Tyrophagus putrescentiae*.

Conclusion Dust mites were highly prevalent and present in high densities in Singaporean homes with *B. tropicalis* being the most prevalent species.

Keywords: bedroom floor, *Blomia tropicalis*, carpet, dust mites, homes, mattress, tropics, upholstered sofa

Clinical and Experimental Allergy, Vol. 29, pp. 201–206. Submitted 2 December 1997; revised 26 May 1998; accepted 22 July 1998.

Introduction

House dust mites, in particular *Dermatophagoides pteronyssinus* and *D. farinae*, have been shown to play an important role in the pathogenesis of asthma and atopic diseases [1–3]. These mites are found almost all over the world. Various studies have demonstrated that relatively high temperature [4,5] and humidity [6,7] are ideal conditions for mite growth. Singapore, with its equatorial climate characterized by evenly high temperatures (24–31°C) and relative humidity (64–96%) throughout the year, has thus a particularly conducive environment for mite growth and proliferation.

One in five schoolchildren in Singapore have doctor-diagnosed asthma [8]. A major risk factor for childhood asthma in Singapore is dust mite allergy [9], and about 90% of our atopic population are sensitized to dust mites of the *Dermatophagoides* spp. [10,11] and *Blomia tropicalis*

[12,13]. Reports from the surrounding Asia Pacific region, such as Taiwan [14], Thailand [15] and Indonesia [16] indicate that the *Dermatophagoides* spp. is the most prevalent and predominant mite. Studies conducted elsewhere in tropical and subtropical regions have also demonstrated high prevalence of the storage mite *B. tropicalis* [17,18]. In a previous study, we demonstrated high levels of *B. tropicalis* allergens in the dust of Singaporean homes by FAST inhibition assay [19]. To verify these findings, this study was carried out to evaluate the dust mite fauna in Singaporean homes by mite isolation and identification.

Materials and methods

Dust sample collection

A total of 134 dust samples were collected from mattresses, sofas, carpets and bedroom floors (usually under or beside the bed, and all were uncarpeted) of 50 homes across Singapore, between July and December 1996. Prior consent

Correspondence: B. W. Lee, Department of Paediatrics, National University of Singapore, Lower Kent Ridge Road, Singapore 119074.

was obtained from the occupants of all 50 homes. A modified Kirby Classic III (Kirby Co., Cleveland, Ohio, USA) vacuum cleaner, which was adapted with a chamber that collects dust onto a filter paper, was used for sampling. Each sample was obtained by vacuuming an area of 1 m² for 2 min. Cross contamination of samples was avoided by using different filter paper each time and dust particulates in the vacuum cleaner were blown out repetitively prior to the next sampling. Dust samples were stored at 4 °C in mini-grip lock bags during transportation back to the laboratory. The samples were then stored at – 20 °C until processed.

Mite count and identification

Samples were sieved through a mesh screen (500 µm pore size) to remove large particles and fibre, after which the fine dust was weighed. Each sample was then divided into two portions; one to be used for mite count and identification (20 mg), and the remaining for allergen quantification by immunoassay. The fine dust sample allocated for mite count was then suspended in 85% lactic acid in a ratio of 1 mg fine dust to 1 mL, heated to boiling and then left to cool at room temperature. All mites present in each sample were collected with a fine needle under a stereo-microscope and placed in one drop of Hoyer's medium on a microscope slide, identified using taxonomy tables [20,21], after which they were counted. Identification was made to the species level unless key appendages were not identifiable. The density of mites in each sample was expressed as number of mites per gram of fine dust [1].

Statistical analyses

Analysis was carried out using the statistical package SAS v6.08 for windows [22]. Comparisons of mite counts were analysed via nonparametric methods, i.e. Kruskal–Wallis test for comparing the medians between groups.

Results

Mite counts and species identified

Dust mites were isolated from 130/134 (97%) samples. They were present in all samples from sofas ($n = 21$) and carpets ($n = 13$), and 49/50 (98%) and 47/50 (94%) from mattresses and uncarpeted bedroom floors, respectively. All samples from sofa and carpets had more than 500 mites/g compared with 47/50 (94%) and 23/50 (46%) from mattresses and floors, respectively. There were significant differences in mite density of all four niches ($P < 0.001$) with the highest in the carpets, followed by the mattresses, sofas and bedroom floors. The median mite density per gram

of fine dust was 17 050 (range 5,550–73 900) in carpets. With the mattresses, sofas and bedroom floors, the medians (and range) were 10 250 (0–166 350), 8350 (1350–20 850) and 1550 (0–14200) mites/gram fine dust, respectively.

Table 1 shows the prevalence of individual mite species in the four niches surveyed. *B. tropicalis* was the most predominant mite isolated from all four niches surveyed; being the predominant species in 97/134 (70%) of the samples. It accounted for 62% of the total number of mites isolated and was found in all but three of the mattress samples and 13 floor samples. Nevertheless, there were samples where other mite species were predominant. In 25/134 (19%) of the samples, *D. pteronyssinus* was the predominant mite species (accounting for 16% of the total number of mites and found in 70% of the samples). Interestingly, there were eight samples where the predominant mite species was otherwise not frequently found. In five samples (three from bedroom floors, and one each in mattress and sofa), the predominant mite was *Sturnophagoides brasiliensis* (accounting for only 4% of total mites and found in 60% of samples). In another three samples (two from mattresses and another from a bedroom floor), the predominant species was *Tarsonemus granarius* (accounting for 4% of total mites and found in 40% of samples).

D. farinae was an uncommon mite, which accounted for only slightly more than 1% of total mites and found in 33% of the samples, mainly from sofas and carpets rather than the bedroom. Its numbers were comparable with another species of mites of the Glycyphagidae family, *Austroglycyphagus malaysiensis* (1% of total mites; present in 34% of the samples). This latter dust mite resembles *B. tropicalis* but is distinctly larger in size (>400 µm length) and has long slender legs. Other mite species sporadically isolated included *Cheyletus malaccensis*, *Malayoglyphus intermedius*, *Suidasia pontifica*, and *Tyrophagus putrescentiae* (all <1% of total mites).

Discussion

House dust mites have been shown to be strongly associated with allergic respiratory diseases the world over [1,2]. These associations were mostly made with reference to mites of the *Dermatophagoides* species. Recent data, however, has shown that another important source of dust mite allergens in tropical and subtropical regions is the storage mite, *B. tropicalis*. This mite has been found in house dust in Hong Kong, Brazil, Venezuela, Columbia, Taiwan, Spain, Egypt and Florida (USA) [23], but not in Thailand [15] or Indonesia [16]. Our earlier study [19] showed unexpectedly low levels of *Dermatophagoides* allergens compared with levels reported elsewhere in the region [15]. Further, *B. tropicalis* allergens, as measured by FAST inhibition assay, were found to be highly prevalent [19]. We therefore

Table 1. Mite species present in dust samples collected from 50 homes in Singapore

Niche/Species	+ (%)*	% sum†	Median‡	Range‡	Dominant(%)§
Bedroom mattress (n = 50)					
<i>B. tropicalis</i>	47 (94)	65.3	7250	250–158 200	40 (80)
<i>D. pteronyssinus</i>	40 (80)	5.8	1150	150–13700	6 (12)
<i>S. brasiliensis</i>	42 (84)	4.8	1050	150–7500	1 (2)
<i>T. granarius</i>	22 (44)	11.9	550	50–131350	2 (4)
<i>D. farinae</i>	13 (26)	0.5	350	150–2100	
<i>A. malaysiensis</i>	10 (20)	1.1	500	150–2100	
<i>C. malaccensis</i>	12 (24)	0.9	400	100–4650	
<i>M. intermedius</i>	6 (12)	0.6	400	100–4500	
<i>S. pontifica</i>	2 (4)	<0.1	175	150–200	
<i>T. putrescentiae</i>	1 (2)	<0.1	300	300	
Others	23 (46)	9.0	500	150–4100	
(Mainly Mesostigmata)					
Total	49 (98)	100.0	10250	400–174550	
Living room upholstered sofa (n = 21)					
<i>B. tropicalis</i>	21 (100)	41.1	3050	850–7450	15 (71)
<i>D. pteronyssinus</i>	18 (86)	32.5	2200	650–10700	5 (24)
<i>D. farinae</i>	14 (67)	6.6	700	200–2150	
<i>S. brasiliensis</i>	11 (52)	7.8	700	200–2800	1 (5)
<i>A. malaysiensis</i>	10 (48)	5.8	800	150–3150	
<i>T. granarius</i>	8 (38)	2.8	550	150–1350	
<i>M. intermedius</i>	5 (24)	1.5	500	200–900	
<i>C. malaccensis</i>	5 (24)	0.7	150	100–500	
<i>T. putrescentiae</i>	5 (24)	0.6	150	50–500	
<i>S. pontifica</i>	3 (4)	0.2	100	50–150	
Others	7 (33)	0.5	100	50–400	
(Mainly Mesostigmata)					
Total	21 (100)	100.0	8350	1350–20850	
Bedroom floor (n = 50)					
<i>B. tropicalis</i>	37 (74)	68.3	1100	50–12750	31 (62)
<i>D. pteronyssinus</i>	26 (52)	18.4	900	150–1650	12 (24)
<i>S. brasiliensis</i>	21 (42)	4.8	250	50–850	3 (6)
<i>T. granarius</i>	17 (34)	2.3	50	50–700	1 (2)
<i>A. malaysiensis</i>	17 (34)	2.1	100	50–400	
<i>D. farinae</i>	10 (20)	1.0	100	50–250	
<i>C. malaccensis</i>	10 (20)	0.7	50	50–200	
<i>T. putrescentiae</i>	7 (14)	0.6	50	50–200	
<i>M. intermedius</i>	5 (10)	0.3	50	50–100	
Others	22 (44)	1.5	100	50–200	
(Mainly Mesostigmata)					
Total	47 (94)	100.0	1550	50–14200	
Living room carpet (n = 13)					
<i>B. tropicalis</i>	13 (100)	68.6	8250	900–70250	11 (85)
<i>D. pteronyssinus</i>	13 (100)	15.3	2150	500–16500	2 (15)
<i>S. brasiliensis</i>	7 (54)	5.0	2250	750–5400	
<i>D. farinae</i>	7 (54)	4.0	1250	500–5350	
<i>A. malaysiensis</i>	7 (54)	3.8	1200	650–2700	
<i>T. granarius</i>	7 (54)	1.4	600	200–1000	
<i>M. intermedius</i>	4 (31)	0.9	550	400–1150	
<i>T. putrescentiae</i>	4 (31)	0.5	400	150–1000	
<i>C. malaccensis</i>	4 (31)	0.3	250	150–400	
Others	3 (23)	0.2	100	50–350	
(Mainly Mesostigmata)					
Total	13 (100)	100	17050	5550–73900	

+ (%)*denotes the number of dust samples in which the particular mite species was detected. % sum† denotes the % of total mites. ‡Median and range of the positive samples expressed as the number of mites per gram of fine dust. §Dominant refers to the number of samples in which the species is the predominant dust mite found.

speculated that the relatively low levels of *Dermatophagoides* allergens were due to the high prevalence of *B. tropicalis*. The results of this study have further verified the notion that *B. tropicalis* is the most prevalent dust mite in Singapore.

These results are consistent with earlier studies carried out locally and in neighbouring Malaysia in the early 1980s [24–26]. A report from Brazil suggested that *B. tropicalis* may be common in homes where rice is the main staple diet [27], which is supported by its characteristic as a ‘storage’ mite [28]. We have also noted that its allergens have been detected in relatively high levels in kitchens and storerooms [19]. In this study their densities were found to be highest in living room carpets and mattresses in the bedrooms. The lower mite counts in the bedroom floors is likely to result from the little use of carpeting in bedrooms of Singaporean homes. All the bedroom floors in this study were not carpeted.

Some tropical regions like Thailand [17], however, did not find *B. tropicalis*. As there are little differences in environmental factors between these regions, it is possible that differences in the methodology and sampling techniques for the evaluation of mite fauna [29,30] may be a reason. For example, the Thai study employed a modified flotation technique whilst our study used whole dust samples. Perhaps standardization of methods for regional comparison, like the study carried out in the USA [23], will provide useful comparative data for the Asia Pacific region.

Immunochemical quantification of specific mite allergens has facilitated the detection and evaluation of the prevalence and distribution of house dust mites [19]. In fact, the use of immunoassays to measure major indoor allergen levels is currently considered the best index for estimating indoor allergen exposure [31]. Nevertheless, identification of the dust mite fauna is also necessary as immunoassays are only widely available for the major *Dermatophagoides* spp. Further, there have been reports that Der p 1 levels quantified by enzyme immunoassay did not correlate well with mite counts [17]. This may be due to the fact that the Der p 1 allergen is found in fecal particles which may persist without the presence of the dust mites. Additionally, Der p 1 has been shown to be an extremely stable protein under natural conditions and may persist even after 1½ years at a high temperature and humidity [32].

Skin prick test results showed that the majority (>90%) of our local atopics are sensitized to both the *B. tropicalis* and *Dermatophagoides* species [11–13]. Our study [33] and another from South America [34] have shown that there are at least 28 allergenic components in *B. tropicalis*, with up to eight major allergens (i.e. >50% of the atopic population tested having IgE binding to the protein), indicating a substantial number of allergenic components. Further, our recent studies also indicated that there was little cross

reactivity between allergens of *B. tropicalis* and the *Dermatophagoides* spp. [13,33]. These findings have important practical implications as it would redefine the allergen panel used for diagnosis and immunotherapy of allergic diseases in Singapore specifically, and the tropics, in general.

From this study, three orders of acari (Astigmata, Prostigmata and Mesostigmata) were found in house dust in Singapore, with the Astigmata representing more than 95% of the total acari isolated. Other mite species were also found in relatively large numbers in some homes, in particular *Sturnophagoides brasiliensis* and *Tarsonemus granarius*. In addition, between 20 and 50% of the dust samples were also found to have *Austroglycyphagus malaysiensis*, *Malayoglyphus intermedius*, *Cheyletus malaccensis* and *Tyrophagus putrescentiae*. Although they were present in relatively lower densities compared with *B. tropicalis* and the *Dermatophagoides* spp. mites, these mites may play an important role in sensitizing predisposed individuals to their unique allergens and may also produce cross-reactive allergens which are similar to the major dust mites present. The allergenicity of these mites have not been well characterized or studied, and only few reports were observed in the literature. One study reported that systemic anaphylaxis occurred after food contaminated with the storage mite, *Tyrophagus putrescentiae*, was ingested [35]. Sensitization to *T. putrescentiae* and *Tarsonemus* spp. have also been reported [36,37] but not the rest of the species. Preliminary evaluation of the allergenicity of these dust mites via skin prick tests showed high degree of sensitization among atopic individuals in Singapore (unpublished data). More than 50–70% of atopic individuals were sensitized to *S. brasiliensis*, *A. malaysiensis*, *M. intermedius* and *T. putrescentiae*. It is likely that some degree of cross-allergenicity is expected between these mites and *B. tropicalis* and/or the *Dermatophagoides* spp. The situation may be the same as that seen for *D. farinae*, where a high degree of sensitization to its crude extracts in the Singapore population is probably related to cross-reactivity with *D. pteronyssinus*, although the dust mite is not extremely common. It is thus important that the allergenicity of these dust mites be evaluated and their allergenic components characterized.

Additionally, the homes with high counts of Prostigmata (e.g. *Cheyletus* spp. and *Tarsonemus* spp.) or Mesostigmata mites were found to have relatively lower densities of other Astigmata mites (which include *B. tropicalis* and *Dermatophagoides* spp.). These mites have been reported to be predacious on several other mite species although their numbers are always lower than the pyroglyphid or glycyphagid mites. High presence of predator mites may thus have an influence on the eco-bio-system balance within these niches. Additionally, it has been reported that *T. granarius* is a fungivorous mite, feeding on fungi usually associated with storage products. Thus, the dominance of *T.*

granarius in certain homes may be associated with the dampness which enables the presence of fungi such as *Aspergillus* spp., *Alternaria* spp., and *Penicillium* spp. to thrive, and thus support the growth of the tarsonemid mite population. Distinctly missing from this study however, were mites like *Lepidoglyphus destructor* and *Euroglyphus maynei*.

In conclusion, dust mites are highly prevalent in Singapore. A wide variety of mite species were identified. *Blomia tropicalis* was the most prevalent mite species identified.

References

- Platts-Mills TAE, de Weck A. Dust mite allergens and asthma – a worldwide problem. *J Allergy Clin Immunol* 1989; 83:416–27.
- Platts-Mills TAE, Thomas WR, Aalberse RC et al. Dust mite allergens and asthma: report of a 2nd International Workshop. *J Allergy Clin Immunol* 1992; 89:1046–60.
- Peat JK, Tovey E, Toelle BG et al. House dust mite allergens: a major risk factor for childhood asthma in Australia. *Am J Respir Crit Care Med* 1996; 153:141–6.
- Kuehr J, Frischer T, Karmaus W et al. Natural variation in mite antigen density in house dust and relationship to residential factors. *Clin Exp Allergy* 1994; 24:229–37.
- Harving H, Korsgaard J, Dahl R. House-dust mites and associated environmental conditions in Danish homes. *Allergy* 1993; 48:106–9.
- Sundell J, Wickman M, Pershagen G, Nordvall SL. Ventilation in homes infested by house-dust mites. *Allergy* 1995; 50:106–12.
- Custovic A, Taggart SC, Kenneough JH, Woodcock A. Portable dehumidifiers in the control of house dust mites and mite allergens. *Clin Exp Allergy* 1995; 25:312–6.
- Goh DYT, Chew FT, Quek SC, Lee BW. Prevalence of childhood asthma, rhinitis and eczema — a survey in Singapore. *Arch Dis Child* 1996; 74:131–5.
- Chew FT, Goh DYT, Teo J, Quak SH, Connett GJ, Lee BW. Risk factors for childhood asthma in Singapore. In: *Proceedings of the 5th Combined Scientific Meeting of the Community and Occupational Medicine*, 24 November 1996, Singapore. Singapore: Chapter of Community and Occupational Physicians, Academy of Medicine 1996:31.
- Lee BW, Teo J, Vellayapan K. Role of atopy in childhood asthma. *J Singapore Paediatr Society* 1989; 31:53–9.
- Lee BW, Chew FT, Goh DYT, Lim SH, Tan HTW, Tan TK. House dust mite allergy — its clinical relevance. *J Singapore Paediatr Society* 1994; 36:106–11.
- Lee BW, Chew FT, Goh DYT, Wong GW. Prevalence of *Blomia tropicalis* sensitisation in Singapore. *J Allergy Clin Immunol* 1996; 97:226.
- Lee BW, Chew FT, Zhang Z, Chapman MD, Arruda LK. Sensitisation to Blo t 5 and Der p 5 allergens in atopic subjects and the evaluation of their cross reactivity. *J Allergy Clin Immunol* 1997; 99:163.
- Chang YC, Hsieh KH. The study of house dust mites in Taiwan. *Ann Allergy* 1989; 62:101–6.
- Malaing N, Vichyanond P, Phan-Urai P. House dust mite fauna in Thailand. *Clin Exp Allergy* 1995; 25:554–60.
- Woolcock A, Konthen P, Sedgwick C. Allergic status of children in an Indonesian village. *Asian Pac J Allergy Immunol* 1984; 2:7–12.
- Hurtado I, Parini M. House dust mite in Caracas, Venezuela. *Ann Allergy* 1987; 59:128–30.
- Fernandez-Caldas E, Puerta L, Mercado D, Lockey RF, Caraballo LR. Mite fauna, Der p 1, Der f 1 and *Blomia tropicalis* allergen levels in a tropical environment. *Clin Exp Allergy* 1993; 23:292–7.
- Zhang L, Chew FT, Soh SY, Yi FC, Law SY, Goh DYT, Lee BW. Prevalence and distribution of indoor allergens in Singapore. *Clin Exp Allergy* 1997; 27:876–85.
- Colloff MJ, Spieksma FTM. Pictorial keys for the identification of domestic mites. *Clin Exp Allergy* 1992; 22:823–30.
- Krantz GW. A manual of acarology, 2nd edn. Oregon State University Book Store, Inc. 1978.
- SAS Institute Inc. SAS/STAT user's guide, Version 6, 4th edn. Vols. 1 & 2. SAS Circle, Box 8000, Cary MB, 27512–8000. 1991.
- Arlian LG, Bernstein D, Bernstein IL et al. Prevalence of dust mites in the homes of people with asthma living in eight different geographic areas of the United States. *J Allergy Clin Immunol* 1992; 90:292–300.
- Choy AWC. House dust mites of mattresses in Singapore: distribution and effect of bedkeeping hygiene. National University of Singapore, Thesis, 1983.
- Yeow MN. The mite fauna of house dust in Singapore with laboratory studies on the life history of *Austroglyciphagus malaysiensis* (Fain and Nadchatram). National University of Singapore, Thesis, 1984.
- Ho TM. Pyroglyphid mites found in house dust in Peninsular Malaysia. *Trop Biomed* 1986; 3:89–93.
- Rosa AE, Flechtman CHW. Mites in house dust from Brazil. *Int J Acarology* 1978; 5:195–8.
- Hughes AM. The mites of stored food and houses. London: HMSO, 1976.
- Feldman-Muhsam B, Mumcuoglu Y, Osterovich T. A survey of house dust mites (Acari: Pyroglyphidae and Cheyletidae) in Israel. *J Med Entomol* 1985; 22:663–9.
- Twiggs JT, Gray RL, DeJongh S, Marx JJ. *Dermatophagoides farinae* allergen levels from two different sources within the same home: evaluation of two different collection techniques. *Ann Allergy* 1991; 66:431–5.
- Pope AM, Patterson R, Burge H, eds. Indoor allergens: assessing and controlling adverse health effects. Washington DC: National Academy Press 1993.
- De Boer R, Van Der Hoeven WAD, Stapel SO. The decay of house dust mite allergens, Der p 1 and Der p 2, under natural conditions. *Clin Exp Allergy* 1995; 25:765–70.
- Chew FT, Chua KY, Fernandez-Caldas E, Arruda LK, Chapman MD, Lee BW. Allergenic differences between the dust mite *Blomia tropicalis* and *Dermatophagoides pteronyssinus*. *Clin Exp Allergy* 1999; 29: in press.
- Caraballo L, Puerta L, Martinez B, Moreno L. Identification of allergens from the mite *Blomia tropicalis*. *Clin Exp Allergy* 1994; 24:1056–60.
- Matsumoto T, Hisano T, Hamaguchi M, Miike T. Systemic

- anaphylaxis after eating storage-mite-contaminated food. *Int Arch Allergy Immunol* 1996; 109:197–200.
- 36 Wickman M, Nordvall SL, Pershagen G, Korsgaard J, Johansen N. Sensitization to domestic mites in a cold temperate region. *Am Rev Respir Dis* 1993; 148:58–62.
- 37 Ebner C, Feldner H, Ebner H, Kraft D. Sensitization to storage mites in house dust mite (*Dermatophagoides pteronyssinus*) allergic patients. Comparison of a rural and an urban population. *Clin Exp Allergy* 1994; 24:347–52.