

House dust acarofauna and *Der p* I equivalent in Australia: the relative importance of *Dermatophagoides pteronyssinus* and *Euroglyphus maynei*

M. J. COLLOFF, G. A. STEWART* and P. J. THOMPSON†

Department of Zoology, University of Glasgow, Scotland, *The Western Australian Research Institute for Child Health, Princess Margaret Hospital, Western Australia, and †University Department of Medicine, QEII Medical Centre, Western Australia

Summary

The acarofauna and *Der p* I allergen concentrations in dust samples from mattresses and lounge room carpets obtained from 20 homes from two coastal cities, Perth and Bunbury, were determined. All samples were shown to contain mites and the geometric mean numbers of total mites/g of mattress and carpet dust for Perth and Bunbury were 480 and 263, and 585 and 992, respectively. Carpets from both centres had a significantly ($P < 0.02$) greater mean number of mite species (Perth 9.1, Bunbury 9.0) than mattresses (Perth 5.2, Bunbury 5.7). The predominant mite species were *D. pteronyssinus*, *E. maynei* and *Tarsonemus* spp. *D. farinae* was found to be absent from all dust samples examined. *E. maynei* was present in the 10 Bunbury homes and in 50% of the Perth homes, ranging from 0 to 81% of mites identified. The arithmetic mean *Der p* I concentrations in the mattresses and carpets in Perth and Bunbury were 4.2 and 4.1, and 3.8 and 9.2 µg/per gram of fine dust, respectively, and *Der p* I concentration correlated with mite counts ($r = 0.75$; $P < 0.001$). The concentration of *Der p* I equivalent per 100 mites was 1.5 µg. The data are consistent with the view that asthmatic patients in Western Australia have significant exposure to a variety of house dust mites and that *E. maynei* may be clinically significant.

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Introduction

Asthma occurs commonly in Australia and New Zealand, and allergy to the house dust mite has been shown to be a significant risk factor [1,2]. Most ecological studies in temperate climates have demonstrated the pyroglyphid mites *D. pteronyssinus* and *D. farinae* to be the dominant mites of household dust accounting for 80–90% of the total mite population [3]. However, studies from 37 countries have shown the pyroglyphid mite, *E. maynei* is often detected in household dust [4]. In these studies [reviewed in Ref. 4], it has represented between 0.03 and 58% of the mites found but its contribution to the development of allergic disease remains unclear. As a

consequence, the WHO International Workshop on Mite Allergy and Asthma held in Bad Kreuznach recommended future studies of the pathogenesis of mite induced asthma should include *E. maynei* [5].

Australian studies of house dust mite ecology have been very few, and none appear to have documented the total diversity of mite fauna present, nor the specific occurrence of *E. maynei*. Initial studies demonstrated the general presence of mites in household dust and suggested mite growth may be seasonal [6,7]. Since then, most investigators have only assessed the distribution and abundance of mites within the home. Specific reference to species other than *D. pteronyssinus* and *D. farinae* are few, although *E. maynei* and unnamed species of mites belonging to the genus *Tyrophagus*, and families Acaridae and Tarsonemidae have been alluded to in scientific reports [8–10]. More recently, Green *et al.* [11] published a comparative study on house dust mite frequency and

Correspondence: Dr M. J. Colloff, Department of Zoology, University of Glasgow, Glasgow G12 8QQ, Scotland, U.K.

abundance in different geographical areas of Australia in relation to climate. Despite this work, the house dust acarofauna of Australia remains poorly characterized.

We report a detailed survey of mite species in house dust from Australia. The mite fauna of dust from mattresses and lounge room carpets from selected homes of asthmatic and control subjects from two Western Australian coastal towns, Perth and Bunbury (156 km south of Perth), were compared and contrasted. In addition, the concentration of the house dust mite allergen *Der p* I was determined in the same dust samples and its relationship to mite counts determined.

Materials and methods

Dust collection

Paired lounge room carpet and mattress dust samples from each of 10 homes in Perth and 10 homes in Bunbury were studied. These samples were drawn from a larger collection that had been obtained in September/October 1986 from the homes of mite allergic asthmatics and control subjects in both centres (total number of houses 70).

Dust samples from carpets were obtained by vacuuming 2 m² for 2 min; samples from mattresses were obtained by vacuuming the complete mattress surface for 2 min. The samples were sieved to remove large particles, weighed and stored at 4°C until shipment to Glasgow, Scotland, for mite species determination. The area of the bed and lounge room carpet sampled in each home was recorded. Measurements of temperature and relative humidity at the time of dust sampling were obtained using a thermohygrometer (Mik 3000; Novasina, Zurich, Switzerland). In addition, mean relative humidity and temperatures of the two localities were obtained from the Australian Government Bureau of Meteorology.

Mite counting

Mite extraction techniques were performed as described by Colloff [12]. Briefly, the dust samples were transferred to 9-cm diameter glass Petri dishes and to each dish were added 5–10 ml of 60% (v/v) aqueous lactic acid and a few drops of 1% (w/v) aqueous lignin pink. Samples were incubated at 50°C for up to 3 hr. The fluid was poured off into a clean Petri dish until only a thin film remained in the bottom of the first dish. This was scanned twice under a stereobinocular microscope at a magnification of $\times 25$ and the mites removed. This process of aliquoting to fresh dishes was repeated until all the fluid had been examined. The mites were washed in distilled water and transferred all together, using the frozen block technique [13], to glass microslides, mounted in gum chloral, counted and identi-

fied under a compound microscope. Mites were recorded as 'damaged' or 'intact' as an indicator of the number of live and dead mites in the samples at the time of sampling.

Immunochemical determination of *Der p* I

Dust samples (100 mg) were extracted in borate-buffered saline (2 ml) and the resulting supernatants were analysed for the presence of *Der p* I using a radioimmunoassay with a rabbit polyclonal antiserum [14]. The *Der p* I control used was a preparation of spent growth medium previously standardized against the International Standard NIBSC 82/518. *Der p* I was radiolabelled by the chloramine T technique.

Statistical analysis

The densities of mites in the samples were converted to and expressed as numbers per unit weight rather than per unit area to allow comparison with data from other studies. Following logarithmic transformation of the data, one-way analysis of variance (ANOVA) was used to compare densities of mites/g in different locations and habitats. Unpaired Student's *t*-tests were used for the location of significance within ANOVA. Untransformed data on species diversity and domestic microclimate were analysed using both paired and unpaired Student's *t*-tests. Data on occurrence of mite species were analysed using chi-square tests. The relationship between microscopically determined numbers of mites in dust and immunochemically determined concentrations of *Der p* I was determined by linear regression analysis after log. transformation of the data.

Results

Mite density

In total, 21 032 mites were recovered from all 40 samples, of which 4079 were intact. The total weight of the dust examined was 17.96 g, giving a mean intact mite count of 227/g of fine dust. Detailed analyses of mite density are listed in Table 1. Every sample contained mites, and only two samples were devoid of intact mites (carpet samples from a home in each locality). The highest number of total mites (intact and damaged) was 7242/g and the lowest was 13/g; both were obtained from carpets from Perth homes. The beds and carpets in Bunbury had higher geometric mean numbers of both total mites and *D. pteronyssinus* per gram of dust than Perth homes (Tables 1 and 2). However, none of these differences reached statistical significance. Further analysis indicated that *E. maynei* was present, occasionally at relatively high densities at both centres but was present in every sample in Bunbury,

Table 1. The geometric mean densities of all mites (mites/g of fine dust), *D. pteronyssinus* and *E. maynei* and the arithmetic mean ($\pm$ s.d.) species diversity in dust from mattresses and lounge room carpets in Perth and Bunbury

Mites	Perth		Bunbury	
	Mattress (n = 10)	Carpet (n = 10)	Mattress (n = 10)	Carpet (n = 10)
All mites				
Intact	72 (10)	33 (10)	79 (10)	146 (10)
Total	480 (10)	263 (10)	585 (10)	992 (10)
<i>D. pteronyssinus</i>				
Intact	56 (10)	37 (10)	60 (10)	172 (10)
Total	347 (10)	201 (10)	399 (10)	909 (10)
<i>E. maynei</i>				
Intact	37 (3)	18 (3)	19 (5)	8 (17)
Total	56 (5)	14 (5)	27 (10)	19 (10)
Number of species found*	5.2 $\pm$ 2.7	9.1 $\pm$ 4.9	5.7 $\pm$ 2.8	9 $\pm$ 2.8

* Arithmetic mean; all other readings geometric mean. Numbers in parentheses are number of homes in which mites were found.

while in Perth it was detected in only 50% of samples ($P < 0.001$, mattresses and carpets) (Table 1). The relatively low frequency of this mite in Perth dust samples precluded statistical comparisons of abundance. The relative densities of *E. maynei* and *D. pteronyssinus* are shown in Fig. 1.

Diversity of mite species

Thirteen named species of mites were identified and 14 further species were identified to genus only. In addition, there were several unidentified taxa (Table 2). The greatest species diversity was obtained from a carpet in Perth (15 spp.) and the lowest was from beds in two homes in Perth and a carpet in Bunbury (two spp.). The arithmetic mean number of mite species/g of dust was significantly higher in carpets than in mattresses for each location ($P < 0.02$) (Table 1). However, differences between localities for the same habitat were not statistically significant.

Dominance and frequency of mite species

D. pteronyssinus was found in all samples and was the numerically dominant species in the majority of dust samples (37 out of 40), ranging from 31% to 98% of the

total mite population in each sample. The next most frequent mite was *E. maynei*, followed by *Tarsonemus* spp. *E. maynei* was found in 75% of all dust samples and *Tarsonemus* spp. in 68%. *E. maynei* was dominant in two samples (71% and 81% of total mites) and *Tarsonemus* spp. in one sample (82% of total mites). In the 37 samples in which *D. pteronyssinus* dominated, *E. maynei* varied from 0% to 35% and *Tarsonemus* spp. from 0% to 14% of mites identified. Other frequent taxa were *Cheyletus* spp. and *Lepidoglyphus destructor*; *D. farinae* was not detected in any dust sample. In comparison with samples from carpets from each locality, *E. maynei* was detected with far greater frequency in mattress dust ($P < 0.001$).

Correlation between mites and Der p I

Der p I was found in every sample studied. The arithmetic mean concentrations of *Der p I* in mattress and lounge room carpet dust samples from Perth and Bunbury were 4.2 ± 2.2 and 4.1 ± 2.9 , and 3.8 ± 2.2 and 9.2 ± 8.1 , respectively. Although the means in each locality differed, statistically significant differences were not detected. The *Der p I* concentrations correlated with the total mite density (log-transformed data, $r = 0.75$, $P < 0.001$) and with *D. pteronyssinus* density ($r = 0.78$, $P < 0.001$). *Der p I* (or its equivalent) was detected in samples in which *E. maynei* was dominant (9.3 and 7.1 $\mu\text{g/g}$ fine dust) and in which *Tarsonemus* spp. were dominant (4.5 $\mu\text{g/g}$ fine dust) and was in accord with the mite densities observed.

Indoor and outdoor climate

There were no statistically significant differences in mean temperature and relative humidity values when comparing those taken above the carpet and those above the mattress in either locality (Perth: mattress, 17.5°C and 62.8%; carpet, 17.8°C and 61.9%. Bunbury: mattress, 18.6°C and 58.4%; carpet, 18.6°C and 58.2%) at the time of sampling. Data from the Australian Government Bureau of Meteorology showed marked seasonal divergence in the outdoor mean temperatures and humidity levels in Bunbury and Perth, particularly in the summer months. Thus, in the middle of summer (January), the mean relative humidity of Perth fell to 45.5% (absolute humidity 9.91 g/m³) and in Bunbury it was 58.5% (absolute humidity 11.7 g/m³); the mean temperatures in Perth and Bunbury were 24°C and 22.5°C, respectively.

Discussion

The mattresses and lounge room carpets from homes in Perth and Bunbury had relatively large mite populations. These were comparable to total mite densities previously

Table 2. Mite taxa found in mattress and lounge room carpet dust from homes in Perth (P) and Bunbury (B), Western Australia. The relative abundance (as a percentage of total mites) and the percentage frequency of species are provided

Species	% of total mites				% frequency			
	Beds		Carpets		Beds		Carpets	
	P (n = 10)	B	P (n = 10)	B	P (n = 10)	B	P (n = 10)	B
Astigmata								
Pyroglyphidae								
<i>Dermatophagoides pteronyssinus</i>	64.40	48.41	95.04	96.02	100	100	100	100
<i>Euroglyphus maynei</i>	31.61	46.70	1.24	1.38	50	100	50	100
Glycyphagidae								
<i>Lepidoglyphus destructor</i>	1.29	0.86	0.78	0.44	50	50	80	60
<i>Austroglyphus geniculatus</i>	0	0	0	0.1	0	0	0	10
Acaridae								
<i>Acarus gracilis</i>	0	0.5	0	0	0	10	0	0
<i>Acarus</i> sp.	0.07	0.05	0.27	0.16	10	10	50	80
<i>Thyreophagus</i> sp.	0	0	0	0.01	0	0	0	10
<i>Suidasia medianensis</i>	0	0.05	0	0	0	10	0	0
Indet. Acaridae	0.07	0.16	0.05	0	10	20	30	0
Histiostomidae								
<i>Histiostoma</i> sp.	0	0	0.02	0.03	0	0	10	10
<i>H. feroniarum</i>	0.13	0	0	0	1	0	0	10
<i>H. sapromyzae</i>	0	0	0	0.01	0	0	0	10
Prostigmata								
Scutacaridae								
<i>Scutacarus</i> sp.	0.03	0	0.16	0.03	10	0	50	20
Pygmephoridae								
<i>Pygmephorus</i> sp.	0.03	0.05	0.23	0.04	10	20	30	30
Tarsonemidae								
<i>Tarsonemus</i> 5 spp.	0.30	1.39	0.58	0.34	50	60	60	80
<i>Stenotarsonemus</i> sp.	0	0	0.04	0.03	0	0	10	10
Cheyletidae								
<i>Cheyletus eruditus</i>	0.21	0.41	0.20	0.78	20	40	50	50
<i>C. malaccensis</i>	0	0	0	0.03	0	0	0	10
<i>C. trouessarti</i>	0	0.02	0	0	0	10	0	10
Indet. <i>Cheyletus</i> spp.	1.35	0.91	0.48	0.39	60	30	60	50
Tydeidae								
<i>Tydeus</i> sp.	0.03	0	0	0	10	0	0	0
Demodicidae								
<i>Demodex brevis</i>	0.07	0	0	0	10	0	0	0
<i>D. folliculorum</i>	0.10	0.05	0	0	20	10	0	0
Tetranychidae								
<i>Tetranychus</i> sp.	0.03	0	0.02	0.03	10	0	10	10
Tenuipalpidae								
<i>Brevipalpus</i> sp.	0.03	0.05	0.05	0.01	10	10	10	10
Indet. Prostigmata	0.03	0.07	0	0.01	10	30	0	10
Mesostigmata								
Indet. Mesostigmata	0.03	0	0.12	0.04	10	0	40	30
Oribatida								
Indet. Oribatida	0.26	0.14	0.83	0.20	30	50	80	80
Total number of mites	3028	4398	5650	7956				
Total dust examined (g)	3.348	2.849	6.888	4.876				

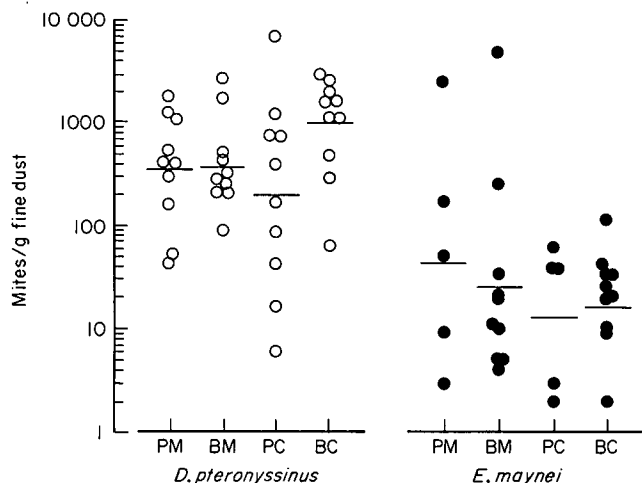


Fig. 1. Density and distribution of *D. pteronyssinus* and *E. maynei* (total, i.e. damaged plus intact specimens) per gram of sieved house dust taken from mattresses (M) and lounge room carpets (C) from Perth (P) and Bunbury (B), Western Australia. Solid lines represent geometric means.

reported for eastern Australian coastal towns with similar temperatures and humidities [11]. Thirty-two samples taken from 19 out of the 20 homes had more than $2 \mu\text{g}$ of *Der p* I per gram of fine dust; this value has been proposed as representing a risk factor for the production of specific IgE and the development of asthma [5]. These results are also consistent with clinical observations of the frequency of house dust mite allergy in asthmatic patients in Western Australia.

The most abundant mite species found in Perth and Bunbury were *D. pteronyssinus* and *E. maynei*; *D. farinae* was absent. The data regarding *D. pteronyssinus* and *D. farinae* are consistent with those reported by Green *et al.* [11] in a mite survey carried out in Busselton, a coastal town 206 km south of Perth. The absence of *D. farinae* contrasts with two separate studies in which it was detected together with *D. pteronyssinus* in townships on the eastern seaboard of Australia [11, 15].

Until now, there has only been occasional reference to *E. maynei* in Australia; Blythe stated it constituted 0.2% of mites in Melbourne [8], and Domrow reported the presence of an unnamed species of *Euroglyphus* (probably *E. maynei*) in Brisbane in 1970 [7]. The lack of detail of both reports make it difficult to assess the significance of these findings. In contrast to the southern and eastern seaboard studies, the data described here from Bunbury and Perth indicate *E. maynei* may occur frequently in Western Australian homes. It occurred with high frequency in both mattresses and carpets from Bunbury compared with Perth and was the dominant species in two mattresses. The pattern shown by *E. maynei* of generally

low densities, high frequency and sporadic dominance is similar to that reported in several studies [4].

The apparent high frequency of *E. maynei* in Bunbury may reflect the effects of higher humidity and milder temperatures. This concept is consistent with observations of Feldman-Muhsam *et al.* [16] who found the frequency of *E. maynei* was higher in the humid coastal locations of Israel than in arid inland sites; Burr *et al.* [17] have also suggested an association between dampness and abundance of *E. maynei*. In addition, recent studies have indicated *E. maynei* may be less able than *D. pteronyssinus* to withstand low humidity [18]. In contrast, however, Walshaw and Evans [19] were unable to show an association between humidity and abundance of *E. maynei* in a study of 50 homes where *E. maynei* was dominant in 48%.

The predilection of *E. maynei* for mattresses is consistent with the data reported by Walshaw and Evans [19]. They postulated the mattress was a preferred habitat and that the electrolyte concentration in the form of Na^+ ions may be more favourable to *E. maynei* growth compared with elsewhere in the home; this remains contentious.

Tarsonemus species do not appear to have been reported previously in Australian house dust. Our data would suggest they have a frequency of 68% in dust samples and represented 0–14% of the mite numbers detected in all samples. These results are similar to those reported from cities in Scotland and Denmark [12, 20].

There was a strong correlation between the *Der p* I concentrations and both the total mite and *D. pteronyssinus* counts, in accord with the findings of Platts Mills *et al.* [21]. Using the data obtained from the 40 dust samples, it would appear that 100 mites (intact and damaged)/g of fine dust are equivalent to $1.5 \mu\text{g}$ of *Der p* I, a figure similar to that proposed at the WHO workshop [5]. However, if only the total intact mite density is used, then the figure rises to $4.0 \mu\text{g}$ of *Der p* I. This disparity in the relationship between mites and *Der p* I concentrations highlights the importance of quantifying allergen load as opposed to mite load in scientific assessment of patient exposure.

The abundance and frequent occurrence of *E. maynei* and *Tarsonemus* spp. in Perth and Bunbury may have potentially important consequences for the diagnosis and treatment of patients allergic to house dust mites. There is little information about the allergenicity of these mites and the allergens of *E. maynei* are uncharacterised. Although the data from Perth and Bunbury and those of Platts-Mills *et al.* [21] indicate *E. maynei* may produce an allergen equivalent to *Der p* I, skin-prick test data have suggested *E. maynei* may produce species-specific allergens [6, 22]. Radioallergosorbent kits and extracts of *E. maynei* are now available commercially and studies to determine the serological and clinical importance of this

mite are presently underway in our laboratory. In regions where this species of mite is common, the use of *E. maynei* extracts for diagnosis and treatment seems justified.

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