

Mite allergy in Hong Kong

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Summary

The various species of mites in the bedding dust and in a number of quilts of twenty patients in Hong Kong with house-dust allergy have been identified and counted and skin tests performed with extracts of *Dermatophagoides* spp. and six storage-mites. These results are compared with a similar study in London. The particular environmental conditions which influence the numbers of mites and exposure to them have also been studied.

D. pteronyssinus is the most frequently occurring species in bedding dust in Hong Kong, as it is in London, and is found in higher numbers in the dust from quilts which appear to be the main source of allergy, as are pillows, blankets, eiderdowns and surface dust of mattresses in the U.K. All the patients of both groups gave positive skin-tests to this species.

Temperature, humidity and rainfall are all at their highest during the summer in Hong Kong, the time when quilts are discarded and stored, usually several together, in cupboards or drawers providing optimal conditions for breeding of mites and spread of infestation.

In a second group of eleven patients serial monthly *D. pteronyssinus* specific IgE-values, estimated by RAST, showed a peak in January approximately 2 months after increased exposure to the mites resulting from the quilts being put back onto the beds in October–November and an increase in the severity of patients' symptoms in November. There was a smaller peak in July possibly related to conditions caused by the high rainfall and cyclones in the preceding months.

Storage mites were found in higher numbers in Hong Kong than in London house-dust probably because sleeping rooms were often used for eating and cooking. The predominant species was *Blomia tropicalis* which produced the highest number of positive skin tests of the six storage-species. These species have little allergenic

relationship with *Dermatophagoides* so that hyposensitization with the latter may not be effective in patients with associated, predominantly storage-mite allergy.

Introduction

Allergy to house-dust mites is an important cause of asthma in many western european countries and reports from Africa (Gitoh & Rees, 1971; Buchanan & Jones, 1972), the Caribbean (Pearson & Cunningham, 1973) and Papua New Guinea (Anderson & Cunningham, 1974) suggest that this is also the case in tropical and subtropical areas. Pickering and Gabriel (1973) reported a high incidence of skin sensitivity to house-dust mites in patients with atopic asthma in Hong Kong, and the occurrence of relatively large numbers of these mites in several samples of house dust and in a small section of material cut from a Chinese quilt, and suggested that house-dust mite allergens were an important cause of extrinsic asthma in Hong Kong.

Many factors influence the growth and development of house-dust mite populations, including those of external origin, principally geography and climate (especially temperature and humidity) and those which affect the internal environment (such as the construction, age and conditions of dwellings, heating and ventilation, the quality and quantity of bedding and other furnishings) and the different social habits and life styles of the inhabitants.

The purpose of the present study was to investigate more fully the role of mites in house-dust allergy in Hong Kong; to show some qualitative and quantitative features of the mite fauna in the dust; to confirm the already established skin reactions to mite extracts; and to study the effects of environmental factors on the distribution of the mite fauna and clinical condition of the patients. In addition, serial monthly serum *D. pteryonyssinus* IgE-values were estimated in a small group of patients and fluctuations in these values related to the severity of symptoms and environmental influences. The opportunity was taken of comparing the results of this study with that of a similar investigation carried out in London, England.

Materials and methods

Collection of samples

Hong Kong. Samples of bedding dust were collected from the homes of twenty mite-sensitive asthma-patients attending the asthma clinic of the Ruttonjee Sanatorium, Hong Kong. Each sample consisted of dust brushed from the surface of a patient's mattress, if one were used, or shaken out from a sleeping mat or other bedding. Patients were advised to adopt certain simple hygiene measures to reduce the amount of dust present and a second series of samples was later collected from the homes of eight patients in order to assess the efficacy of these control measures. In addition, since Pickering and Gabriel (1973) had reported finding large numbers of mites in the filling of a Chinese quilt, several small pieces of material from the quilts of a number of patients were obtained for examination. After collection, the samples were placed in polythene bags, labelled and dispatched to one of us in England (A. M. Cunningham) where the mites were extracted, identified and counted using the method described by Stenius and Cunningham (1972). A questionnaire was completed for each patient listing the following details: age, sex, type and age of dwelling, heating arrangements, sleeping accommodation, type and age of bedding and use of sleeping quarters for heating and cooking.

London. Samples of mattress dust were collected from the homes of thirty-three patients with house-dust allergy and asthma in S.E. London. Each sample was obtained by brushing the surface of the mattress with a soft brush and collecting the dust in a sterile specimen-tube. A questionnaire, similar to that used in Hong Kong, was completed for each patient and the samples examined as above.

Skin tests

Skin-prick tests were carried out using the commercially available (Bencard) extracts of *D. pteronyssinus* and *D. farinae* and extracts of the following six storage species: *Acarus siro*, *Tyrophagus putrescentiae*, *Lepidoglyphus (Glycyphagus) destructor*, *Glycyphagus domesticus*, *Blomia tropicalis* and *Suidasia medanensis*, specially prepared by Mr. Brian Overell (Beecham Pharmaceuticals Bio-Science Research Centre, Epsom, Surrey) from cultures reared by A. M. Cunningham. All extract strengths were made up to give mite (whole culture) concentrations of 1.2%. Control tests were carried out with glycerol-saline solution and an extract of the culture medium on which the storage species were reared. The tests were read after 15 min when tracings of the weals were made and the mean diameter in mm. recorded. Reactions were regarded as positive if the mean diameter was 2 mm. or larger after deduction of any positive reactions to the solutions of glycerol-saline and culture media used as control. Antihistamines were discontinued prior to the tests.

Subjects

Hong Kong. Eighteen of the twenty patients whose dust samples were examined had skin tests. All were Chinese subjects with allergy to house dust and house-dust mite and with perennial symptoms which were usually worse in the winter. All lived in the same local area, i.e. at about the same altitude and distance from the waterfront. They comprised fourteen males and six females and covered the age span 6–37 years (mean 16 years). The average age at the onset of symptoms was 6 years and in all but two patients was below 20 years.

The asthma was controlled by bronchodilator drugs, except for three patients who needed sodium cromoglycate (Intal) and one who needed continuous steroids.

London. A similar number of London patients whose dust samples were examined were matched by age and sex with those in Hong Kong and similarly skin tested. These patients lived in a small area situated approximately 1–2 miles from the River Thames. All were British (Caucasian) subjects with allergy to house dust and house-dust mite and with perennial symptoms of asthma.

Monthly RAST values

Eleven Hong Kong patients, nine with asthma and two with rhinitis, with known raised RAST values for *D. pteronyssinus*, were selected for serial monthly serum RAST. These patients were additional to those selected for skin testing. RAST was performed in order to determine if fluctuations in IgE levels could be related to the severity of patients' symptoms and to seasonal or other environmental influences. Blood was taken at each monthly clinic attendance and a questionnaire completed which recorded severity of symptoms (time off work, school, etc.), treatment and environmental changes, including additional bedding. Records were obtained of the monthly mean-temperature, relative humidity and total monthly-rainfall. The serum was separated and kept frozen and each batch flown to London in refrigerated

containers. These were stored until the series was complete at which time RAST was carried out on all samples. Ages of the patients ranged from 10–34 years (mean age 20 years) and the duration of the symptoms from 2–22 years (mean period 10 years). All were receiving treatment with bronchodilator drugs and inhalations regularly or as necessary. None were on steroids.

Environmental and social factors

Hong Kong. The dwellings from which the dust samples were obtained consisted of twelve, relatively modern, resettlement flats built within the last 10 years, and five flats and three tenement dwellings, varying from 10–50 years old. Sixteen dwellings had no artificial heating and relied on atmospheric temperature for warmth, four used electric fires in their living rooms and three of these also used them in their bedrooms. In five cases a single room was used for all purposes, i.e. cooking, heating and sleeping, and in fifteen for eating and sleeping but not cooking. The maximum number of people occupying the sleeping quarters were nine with a mean of 5.3.

Much of the bedding was relatively new and, with one exception, none was more than 10 years old. Seven patients used mattresses of the normal box spring or plastic foam variety, ten used sleeping mats, one slept on a wooden plank, one on a square of fibre board and one on an old sofa. Dust from the latter contained 896 mites (predominantly *D. farinae*)/100 mg. dust, the highest mite density recorded during the investigations. Fourteen patients used blankets or similar coverings and six slept without exterior covering during the summer months, but all used quilts (nylon or cotton-wool) during the winter period. These were stored away in cupboards or drawers during the summer months from June to October. Pets (caged birds) were kept by four patients.

London. Of the thirty-three patients whose dust samples were examined, twenty-six lived in houses and seven in blocks of flats. Eighteen of the houses were more than 50, and four were more than a 100 years old. Most of the flats had been built within the last 5 years. Twelve dwellings had central-heating systems, the remainder were heated by gas or electric fires. From one to four persons slept in the bedroom, with an average of two per room.

Seven houses showed obvious signs of dampness with persistent damp-patches visible on walls or ceilings. Eight also contained very old settees or sofas.

All patients slept on mattresses either of the box spring, foam rubber or plastic foam variety, with the usual complement of other bedding, i.e. sheets, pillows, blankets and eiderdowns. In eighteen houses one or more of these articles of bedding were more than ten years old and in eight of them the age varied from 20–50 years. Pets (three cats, three dogs, five budgerigars) were kept in ten houses.

Results

The mite fauna—Hong Kong

Bedding dust. The mite fauna identified from the samples of bedding dust are summarized in Table 1 and 2. The density figures are based on units of 100 mg. dust and calculated from the number/weight ratio of each sample. Five species of Pyroglyphidae, *D. pteronyssinus*, *D. farinae*, *Euroglyphus maynei*, *Hirstia domicola* and *Malayoglyphus intermedius*, were recorded from the dusts. The most frequently occurring and most abundant species present was *D. pteronyssinus* which occurred in all samples and

Table 1. The mite fauna of Hong Kong house-dust in bedding (21 samples); species, occurrence and nos. of mites found.

Species	No. of times recorded	Total no. found	Estimated mean density/100 mg dust	Range
Pyroglyphidae				
<i>D. pteronyssinus</i>	20	1153	83.3	2-263.7
<i>D. farinae</i>	15	294	21.2	0.2-631.9
<i>E. maynei</i>	12	360	26.0	0.7-231.6
<i>H. domicola</i>	3	16	1.2	2.8-9.8
<i>M. intermedius</i>	1	3	0.2	—
Total Pyroglyphidae	—	1826	131.9	6-896
Acaridae				
<i>A. siro</i>	10	22	3.0	0.6-41.7
<i>Tyrophagus</i> sp.	5	13		
Others	3	6		
Glycyphagidae				
<i>B. Tropicalis</i>	15	235	17.0	4.7-105.0
<i>Glycyphagus</i> sp.	1	1		
Cheyletidae				
<i>Cheyletus</i> sp.	15	51	3.8	1.4-16.8
<i>Cheyletiella</i> sp.	2	2		
Tarsonemidae				
<i>Tarsonemus</i> sp.	6	55	4.0	0.6-43.2
Miscellaneous species	6	14	1.0	1.4-16.5
Total non-pyroglyphid species	—	399	28.8	1.3-130.3

accounted for 63% of the pyroglyphid and 52% of the total mite-population. *D. farinae* and *E. maynei* also occurred frequently, in small numbers in most samples but in relatively large numbers in two samples, a result which considerably weighted the mean values for these two species shown in Table 1 and 2. *H. domicola* and *M. intermedius* occurred infrequently and were relatively scarce. These two species are equatorial in distribution, *H. domicola* previously having been recorded from house dust in Japan, Bangkok, Surinam and the U.S.A. (Wharton, 1976) and *M. intermedius* from Singapore, Indonesia, Australia and South Africa (Fain & Lowry, 1974).

Together the five pyroglyphid species constituted 82% of the total mite fauna. The remaining 18% included various storage mites (Acaridae and Glycyphagidae), predator species (Cheyletidae) and small numbers of mycetophagous Tarsonemidae. Among this secondary group of mites, i.e. non-Pyroglyphidae, the Glycyphagid species *B. tropicalis* was the most numerous. This mite appears to be confined to tropical and subtropical areas and was described by van Bronswijk, de Cock and Oshima (1973) from house dust in Suranim, the East Indies, Japan Taiwan, India and Burma. These authors state that it is a regular, and sometimes abundant inhabitant of houses in these regions and suggest it may be a potentially important house-dust allergen. It has also been recorded in Barbados where (Pearson & Cunnington 1973) it occurred frequently, sometimes in large numbers, in the floor dust from patients' bedrooms. Charlet, Mulla and Sanchez-Medina (1977) reported that it was the most

Table 2. The mite fauna of Hong Kong house-dust in bedding; frequency of occurrence and relative abundance of species.

Species	Frequency of occurrence (%) $\left(\frac{n}{20} \times 100\right)$	Pyroglyphidae	
		Pyroglyphid population (%) $\left(\frac{n}{1826} \times 100\right)$	Total mite population (%) $\left(\frac{n}{2225} \times 100\right)$
<i>D. pteronyssinus</i>	100	63.1	51.8
<i>D. farinae</i>	75	16.1	13.2
<i>E. maynei</i>	60	19.7	16.2
<i>H. domicola</i>	15	0.9	0.7
<i>M. intermedius</i>	5	0.2	0.1
Non-pyroglyphid species			
		Non-pyroglyphid population (%) $\left(\frac{n}{399} \times 100\right)$	Total mite population (%) $\left(\frac{n}{2225} \times 100\right)$
Acaridae			
<i>A. siro</i>	50	5.5	1.8
<i>Tyrophagus</i> sp.	25	3.3	
Others	15	1.5	
Glycyphagidae			
<i>B. Tropicalis</i>	75	58.9	10.6
<i>Glycyphagus</i> sp.	5	0.3	
Cheyletidae			
<i>Cheyletus</i> sp.	75	12.8	2.4
<i>Cheyletiella</i> sp.	10	0.5	
Tarsonemidae			
<i>Tarsonemus</i> sp.	30	13.8	2.5
Miscellaneous mites	30	3.5	0.6

Table 3. The mite fauna of Hong Kong dust in quilts (19 samples).

No. samples	Total surface area (cm ²)	No. of Pyroglyphidae	No. of other mites	Samples with seams (mean no./cm ²)		
				Pyroglyphidae	Other mites	All species
5	91.25	3212*	32	35.20	0.35	35.55
Samples without seams						
14	518.25	658†	59	1.27	0.11	1.38

* *D. pteronyssinus*, 2659; *D. farinae*, 342; *E. maynei*, 211. † *D. pteronyssinus*, 513; *D. farinae*, 26; *E. maynei*, 118; *M. intermedius*, 1.

common and most numerous Glycyphagid species found in South American (Colombian) house-dust.

Quilt samples. The nineteen samples examined consisted of small pieces of coloured fabric cut from the outer cover of each quilt. Five samples had seams along one or more sides which, when cut open, were found to contain large numbers of mites enclosed in the folds between the stitched material. Fewer mites were found on the surface of the remaining samples, i.e. those without seams, although from 87–296 were found on four of them, indicating the occurrence of large mite-populations in the quilts from which these samples were taken. The results are summarized in Table 3. For these samples, mite densities were related to the surface area of the samples and expressed as the mean numbers present per cm² of material.

The data given in Table 3 indicates the existence of large mite-populations in the quilts of many Hong Kong patients. Such populations form extensive reservoirs of mite allergens to which patients may be exposed for considerable parts of the year.

Table 4. The effect of simple hygiene control measures on mite numbers in Hong Kong bedding-dust (8 patients).

	Total wt. dust collected (mg)	Total no. mites counted	Mean density (no. of mites/100 mg dust)
* Initial Examination	657	659	100.3
† Second Examination	512	198	38.7

* Prior to adoption of control measures; † After adoption of control measures

Table 5. The mite fauna of London bedding (mattress) dust (33 samples); species and numbers of mites found.

Species	No. of times recorded	Total no. found	Estimated mean density/100 mg dust	Range
Pyroglyphidae				
<i>D. pteronyssinus</i>	32	1814	79.4	4.2–826.7
<i>D. farinae</i>	3	89	3.9	0.8–767.9
<i>E. maynei</i>	23	499	21.8	0.8–645.2
Totals	—	2402	105.1	5.6–1193.5
Acaridae				
<i>A. siro</i>	6	9	2.4	0.8–17.9
<i>Tyrophagus</i> sp.	5	7		
Others	2	2		
Glycyphadidae				
<i>Glycyphagus</i> sp.	6	10	2.7	0.8–10.6
<i>Gohieria fusca</i>	1	2		
Cheyletidae				
<i>Cheyletus</i> sp.	9	35	4.6	0.4–17.7
Tarsonemidae				
<i>Tarsonemus</i> sp.	2	2	1.4	1.3–1.5

None of the samples examined included any of the cotton padding, with which these quilts are filled, and which Pickering and Gabriel (1973) showed also harboured large numbers of mites.

The mite fauna of both quilt and bedding samples was the same, except that the proportion of the total mite population formed by the pyroglyphid species in the quilt dust was much higher (97.7%) than in that from sleeping mats and surfaces of mattresses (63%). The relative proportions of the different species in the quilt dusts were as follows: *D. pteronyssinus* 80.1%, *D. farinae* 9.2%, *E. maynei* 8.3%, *H. domesticus* 0.1%, *M. intermedius* 0.03%, other mites chiefly *B. tropicalis* and *Cheyletus* sp. 2.3%.

Effect of hygiene control on mite numbers. Table 4 summarizes the results of the two examinations of bedding dust from the homes of the eight selected patients, the second examination having been carried out after an interval of about 6 weeks. It seems clear that the adoption of the simple hygiene control measures advocated by the health visitor during his first visit, i.e. frequent and regular shaking out of sleeping mats and quilts, extra cleaning to eliminate dust etc., successfully prevented the build up of mite populations to their initial level and probably helped in the considerable reduction of mite numbers which occurred.

Table 6. The mite fauna of London bedding (mattress) dust (33 samples); frequency of occurrence and abundance of species.

		Pyroglyphidae	
Species	Frequency of occurrence	Pyroglyphid population (%)	Total mite population (%)
		$\left(\frac{n}{2402} \times 100\right)$	$\left(\frac{n}{2469} \times 100\right)$
<i>D. pteronyssinus</i>	97.0	75.5	73.5
<i>D. farinae</i>	9.1	3.7	3.6
<i>E. maynei</i>	69.7	20.8	20.2
		Non-pyroglyphid species	
		Non-pyroglyphid population (%)	Total mite population (%)
		$\left(\frac{n}{67} \times 100\right)$	$\left(\frac{n}{2469} \times 100\right)$
Acaridae			
<i>A. siro</i>	18.2	13.4	26.8
<i>Tyrophagus</i> sp.	15.2	10.4	
Others	6.1	3.0	
Glycyphagidae			
<i>Glycyphagus</i> sp.	18.2	14.8	17.9
<i>G. fusca</i>	3.0	3.0	
Cheyletidae			
<i>Cheyletus</i> sp.	27.3	52.2	1.4
Tarsomenidae			
<i>Tarsonemus</i> sp.	6.1	3.0	0.1

The mite fauna—London

The mite fauna of the London dusts, summarized in Tables 5 and 6, are based on the examination of samples of surface mattress-dust from the homes of thirty-three patients with allergy to house dust and house-dust mite, eighteen of whom were selected for clinical study and comparison with patients in Hong Kong. The mite fauna was similar to that found in the Hong Kong dusts except for the absence of species with a tropical or subtropical distribution, i.e. *H. domicola*, *M. intermedius* and *B. tropicalis* and for a different balance in the proportions of the different species present.

As in the Hong Kong dusts *D. pteronyssinus* predominated, occurring in all thirty-three samples and forming nearly 74% of the total mite-population. *E. maynei* also occurred frequently and was second in order of abundance of species, accounting for a further 20% of the population. *D. farinae*, on the other hand, which occurred frequently and sometimes abundantly in the Hong Kong dusts was relatively scarce and was found in small numbers in only three samples. Together, the three pyroglyphid species accounted for 97.2% of the total mite-fauna, a considerably higher proportion than was recorded in the Hong Kong samples. The small number of other, i.e. non-pyroglyphid, species present consisted mainly of predator species belonging to the genus *Chenyletus* plus a few *Glycyphagus* sp. and other storage mites.

Skin tests

Hong Kong. All eighteen patients gave positive reactions to extracts of the two *Dermatophagoides* spp., whereas from eleven to seventeen failed to react to extracts of various storage mites (Table 7).

B. tropicalis provoked the greatest number of positive reactions of the storage species. Only four patients reacted positively to the two related Glycyphagid species, *L. destructor* and *G. domesticus*, which were scarce in the Hong Kong dust samples but more common in the London dusts from which *B. tropicalis* was absent. Six patients were allergic only to *D. pteronyssinus* and *D. farinae*. Multiple reactions were observed in the remaining patients, seven of whom reacted positively to three species and five to four or more species.

Taken by species, seven patients reacted positively to *B. tropicalis*, three to *L. destructor*, *T. putrescentiae* and *S. medianensis* and one to *A. Siro* and *G. domesticus*.

Only one patient gave a stronger reaction to a storage-mite extract than to the *Dermatophagoides* spp. extracts. Eleven (61%) reacted more strongly to the two *Dermatophagoides* spp. extracts than to any storage-mite extract, while six (33%) gave similar reactions to the extracts of both house dust and storage species.

London. All patients gave positive reactions to the two *Dermatophagoides* spp., whereas from two to eleven patients failed to react to extracts of the various storage

Table 7. Frequency of positive skin reactions in Hong Kong and London patients to extracts of eight mite species.

No. of positive patients	<i>D. pteronyssinus</i>	<i>D. farinae</i>	<i>A. siro</i>	<i>T. putrescentiae</i>	<i>S. medianensis</i>	<i>B. tropicalis</i>	<i>L. destructor</i>	<i>G. domesticus</i>
Hong Kong	18	18	3	3	3	7	3	1
London	18	18	8	9	15	16	9	11

mites. (Table 7). *S. medanensis* and *B. tropicalis* gave the greatest number of positive reactions of the storage species.

Neither *S. medianensis* nor *B. tropicalis* occurred in the mattress dust and the frequency of reactions to these species may have been caused by cross reactions between these and related species of the same family, e.g. *S. medianensis* with *Acarus* and *Tyrophagus* spp. (Acaridae), *B. tropicalis* with *Lepidoglyphus* and *Glycyphagus* spp. (Glycyphagidae). Two patients were allergic only to *D. pteronyssinus* and *D. farinae*. Multiple reactions were observed in the remaining sixteen patients, five of whom reacted positively to all eight species and eleven to four or more species.

Only two patients gave a stronger reaction to a storage-mite extract than to *D. pteronyssinus* or *D. farinae* extracts. Twelve reacted more strongly to the two *Dermatophagoides* spp. extracts than to any storage-mite extract, while four gave equal or similar reactions to both groups of species.

Monthly *D. pteronyssinus* specific IgE antibody levels

Fig. 1 shows the mean monthly serum *D. pteronyssinus* IgE values of the eleven patients (nine with asthma and two with rhinitis) and the mean monthly-temperatures and rainfall in Hong Kong from September 1976 to September 1977. The curve for patients' IgE values is bi-modal with a high peak occurring in January followed by a secondary smaller peak in July. Statistical analysis of the results using a two-way analysis of variance showed that both peaks were significantly greater ($P = < 0.01$) than any value preceding them and that there was a significant upward trend from

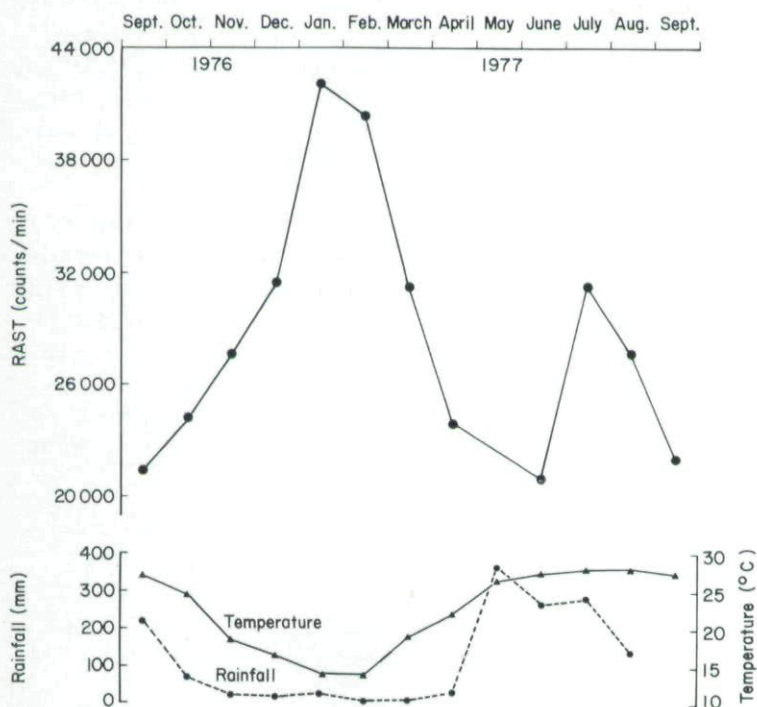


Fig. 1. Mean monthly serum *D. pteronyssinus* IgE levels, temperature and relative humidity, September 1976–September 1977.

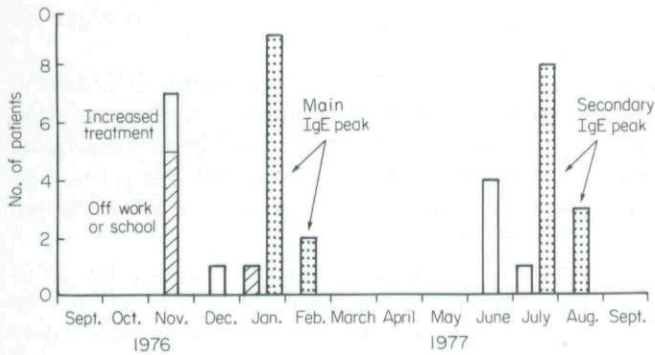


Fig. 2. Severity of symptoms (increased treatment or time off work or school) in relation to peak *D. pteronyssinus* IgE levels.

September to December 1976 and a significant downward trend from January to June 1977. Temperatures were highest during June to August and rainfall during May to July with typhoons occurring about mid-June and mid-July. The mean monthly relative humidity over the 12 month period varied from 62% in November to 83% in July, with a mean of about 82% during the summer months.

Patients began to use quilts and blankets on their beds at the beginning of October, after having discarded and stored these items of bedding during the summer months. The symptoms of a majority became worse in November (Fig. 2), five being prevented from attending work or school and a further two who needed increased treatment, though able to continue their normal employment. These seven patients and two others, whose symptoms remained unchanged, showed peak serum IgE-levels 2 months later (January). Peak values for the remaining two patients, one of whom needed further treatment during December and one who was absent from work in January, occurred in February.

During the summer period, four patients needed increased treatment in June and one in July. Three of the June patients and the July patient showed secondary-peak *D. pteronyssinus* IgE-levels during July and the fourth June-patient during August. Although the symptoms of the remaining six patients appeared unchanged, four of these also showed secondary-peak IgE-levels in July and two in August.

Discussion

Although various aspects of bronchial asthma have been studied (Lui, 1967; Lo, 1968; Yu, 1969), information on the allergic aspects of asthma in Hong Kong is lacking. Lo (1968), using scratch and intracutaneous skin tests, made a preliminary study of the allergens in a small group of children. More recently, Pickering and Gabriel (1973) investigated the pattern of atopic asthma in a larger group of patients including both adults and children. The authors noted the occurrence of *Dermatophagoides* spp. in Hong Kong house-dust and reported that all atopic patients gave positive skin-reactions to extracts of these species. They concluded that the marked skin-sensitivity of patients to house-dust mites implicated these species as important causes of allergic asthma in Hong Kong. Skin tests with fifteen commonly met extracts on 392 tuberculous patients in Hong Kong, as part of an investigation of their atopic status, gave 23% with one or more positive tests; the most frequent positive tests were given by

Dermatophagoides spp. (Hong Kong Tuberculosis Treatment Services Investigation, 1975).

The results of the present study confirm the conclusions of Pickering and Gabriel (1973). *D. pteronyssinus* and other pyroglyphid mites were found, sometimes in large numbers, in all twenty samples of bedding dust examined and all eighteen patients tested gave positive skin reactions to extracts of *D. pteronyssinus* and *D. farinae*. In addition some patients also gave positive reactions to extracts of a number of storage mites.

The mite fauna and numbers of mites found in the samples of bedding dust from Hong Kong and London were closely similar, a result of particular interest since the environmental influences, to which the two groups of patients were subject, are widely different. Many factors, however, influence the growth and development of house-dust mite populations. The combination and interaction of these factors produce conditions which are sometimes more, and sometimes less favourable for their development and increase. In the laboratory, optimum conditions for development of *D. pteronyssinus* are, according to Spieksma (1967), about 25°C and 80% rh. The relatively high moisture requirements of this species explains why large numbers frequently occur in damp, or moderately damp, situations and why few are found where dry conditions prevail. Spieksma (1967) and Maunsell (1971) both found that high humidity-levels in houses, whether related to climatic, geographical or geological features or to dampness caused by structural or other defects, were associated with high mite numbers in house dust.

Hong Kong has a tropical climate, although unusually variable for a tropical region, with a mean monthly temperature which ranges from about 15°C in February to about 28°C in July and a mean monthly relative humidity which ranges from 62% in November to 83% in July but which usually exceeds 80% from April to September. The highest rainfall occurs during the summer when there may also be spells of bad weather with strong gales and heavy rain due to tropical cyclones. It is also a densely populated region with a high human density/dwelling (mean 5 persons/room), which ensures ample supplies of desquamated human-scales on which the mites feed. While the physical conditions and food supply favour their growth and increase, other factors tend to hinder or limit mite development. All the Hong Kong dwellings, with the exception of three tenement buildings, were relatively newly built and showed no signs of dampness. Patients' bedding was relatively sparse and usually consisted of a sleeping mat, blanket and quilt, the latter being discarded during the summer months. Few dwellings had carpets or other floor coverings, dust from which has been found to contain higher numbers of mites than that from uncarpeted floors (Sharp & Haramoto, 1970).

In London, on the other hand, the climate is much cooler but only slightly less humid. Mean monthly temperatures range from 5°C in December to about 18°C in July and the mean monthly relative humidity from about 73% in June to about 86% in December, although during the winter months it seldom falls below 80% and is usually closer to 85%. The houses of the London patients were old and some were damp, but all were artificially heated and some had central heating. The human density/dwelling was much less than in Hong Kong (mean 2 persons/room), but the amounts of bedding used were greater; a mattress, sheets, pillows, blankets and an eiderdown, quilt or other covering being the norm for most patients. Most floors were carpeted or covered with rugs or linoleum and living rooms contained armchairs or other upholstered furniture.

It is impossible to assess the specific effect on mite numbers of each element in the balance of factors controlling the mite population, but clearly bedding plays a major role as one of the chief sources of infestation. In the U.K. the surfaces of mattresses have been shown to be one of the chief foci of infestation (Maunsell, Wraith & Cunningham, 1968) but blankets (Sesay & Dobson, 1972) and the interiors of pillows, eiderdowns and quilts (Wraith & Cunningham, 1975) have also been found to harbour large numbers of mites and to form reservoirs from which the allergen is disseminated. In Hong Kong, the suggestion by Pickering and Gabriel (1973) that the quilts used by Chinese patients were important sources of mite allergens was confirmed during the present study by the discovery of large numbers of mites in the quilts of several patients (Table 3). These quilts are discarded by their users and stored away in cupboards or drawers during the hot, humid, summer months, at a time when temperature, relative humidity and rainfall are at their highest, providing optimum conditions for mite development and enabling infestation to spread from one quilt to another. It is significant that the time of year when they are put back on the beds, i.e. at the beginning of winter, coincides with a period when symptoms become worse and the incidence of asthma is at its highest. Patients in the small group, subjected to monthly serial RAST, began to use quilts on their beds at the beginning of October. The symptoms in the majority became worse during November and the specific-IgE antibody levels to *D. pteronyssinus* increased to a peak level 2 months later. Other reports of serial RAST values have shown a similar delayed rise. Maximal increases of pollen IgE in pollen-sensitive patients, 1–2 months after exposure to the allergy, have been reported by Berg and Johansson (1971), Yunginger and Gleich (1973) and Henderson, Larsen and Gleich (1973). The secondary, smaller peak recorded in July can be attributed to increased exposure to the mites during May and June when the considerable increase in rainfall and occurrence of typhoons required the doors and windows to be kept closed and patients to spend longer periods in-doors. Although no increase in symptoms was recorded, as in November, it was noted that the amount of treatment was increased during this period.

Most Hong Kong patients use the same room for eating and sleeping and some also for cooking, a factor which probably accounts for the higher number of storage mites found in the Hong Kong dusts than in the London samples, small accumulations of food debris providing a suitable niche for the development of these species. The predominant storage-mite present was the Glycyphagid species *B. tropicalis* which van Bronswijk, de Cock and Oshima (1973) reported was common in house dust in tropical areas. This species provoked a higher number of positive skin reactions in Hong Kong patients than any other storage mite, the weals produced, in a few cases, being greater than or equal to those provoked by either *D. pteronyssinus* or *D. farinae*.

The frequency of occurrence of *B. tropicalis* and the relatively high proportion of Hong Kong patients giving positive skin reactions to this mite, indicate that it may be an important additional cause of allergy in Hong Kong and other tropical climates and should be taken into consideration when hyposensitization treatments with *Dermatophagoides* extracts are being planned since Wraith, Cunningham and Seymour (1979) have shown that there is little cross-reaction between *Dermatophagoides* and the storage mites common in U.K. house dust. It is possible, for instance, that greater improvement would have been obtained in the trial of patients with rhinitis and house-dust allergy treated with *D. pteronyssinus* extracts in Hong Kong (Gabriel *et al.*, 1977) if patients with associated or predominantly *B. tropicalis* sensitivity had been excluded.

Remarks and Conclusions

This study confirms the earlier observations of Pickering and Gabriel (1973) that pyroglyphid mites, chiefly the ubiquitous species *D. pteronyssinus*, are the most frequently occurring and abundant mites present in Hong Kong bedding-dust and that the marked sensitivity of patients to these species implicates these allergens as being the principal cause of allergic asthma in Hong Kong. The high number of mites found in the quilts of a number of patients indicate that these items of bedding are probably the main source of mite allergen, while in London and elsewhere, mattresses, blankets and the interiors of pillows and eiderdowns may be chief foci of infestation (Maunsell *et al.* 1968; Sesay & Dobson, 1972; Wraith & Cunnington, 1975). The simple hygiene measures of regularly shaking out the bedding and exposing it to the sunlight, adopted by some patients, reduced the number of mites present (Table 3). It is suggested that quilts stored away during the summer months should be taken out regularly and frequently subjected to this treatment in order to reduce the numbers of mites present and prevent the build up of large populations.

The occurrence of *B. tropicalis* and possibly other storage mites in Hong Kong dust may be an additional cause of symptoms. Recent work in the U.K. (Cuthbert *et al.*, 1979; Wraith *et al.*, 1979) has shown that storage mites are potent allergens and responsible for a proportion of allergic disorders. Since there appears to be little allergenic similarity between house-dust and storage mites (Wraith *et al.*, 1979), patients sensitive to both groups of species or predominantly allergic to one or more storage species may obtain less benefit from hyposensitization treatment with *Dermatophagoides* vaccine.

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