

## Distribution of pyroglyphid mites in Birmingham with particular reference to *Euroglyphus maynei*

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### Summary

The *Dermatophagoides* mites are well recognized as allergens in bronchial asthma. A survey of mattress dust in Birmingham showed large numbers of *Euroglyphus maynei* to be present in addition. A variation was found in mite populations in dust collected by vacuum cleaner when compared to brushed samples, which may explain previous findings of only small numbers of *E. maynei*. A mean density of 296 pyroglyphid mites/100  $\mu$ g dust was found in mattress dust. *Glycyphagus* species formed only 1% of all mites seen.

### Introduction

Since the demonstration of pyroglyphid mites in house dust much evidence has shown that house dust allergy is predominantly due to the presence of these mites. Most attention has been focused on the species of *Dermatophagoides* which have been found to be most abundant—*D. pteronyssinus* in the Old World and *D. farinae* in North America. Reactions to these mites have been shown to be very common in this country, both in adults (Pepys, Chan & Hargreave, 1968; McAllen, Assem & Maunsell, 1970) and in children (Morrison Smith *et al.*, 1969). During investigation of mattress dust in Birmingham, we found a high frequency and high population density of a further pyroglyphid *Euroglyphus maynei*. This paper describes our findings on mite distribution in Birmingham, describes various procedures for collecting dust specimens and discusses why this mite has previously been underestimated.

### Methods

Thirty-eight patients attending the asthma clinic were asked to take samples of the dust from their beds. They were instructed to remove the bedclothes and to brush the dust from the surface of the mattress into a paper bag provided. Special attention was to be given to the deposits of fluff under the buttons and along the seams. The paper bag was sealed, enclosed in a larger polythene bag and sent to the laboratory. Between 5 and 30 mg of dust was usually collected.

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The dust sample was weighed and examined in a glass petri dish in 70% alcohol with a  $\times 8.75$  stereomicroscope and the mites removed with fine forceps or a needle and mounted on a slide in polyvinyl lactophenol. The mites were individually examined, unstained and identified.

Ten houses were examined in greater detail. The mattress dust was collected by means of a portable vacuum cleaner, the normal bag of which had been replaced by a

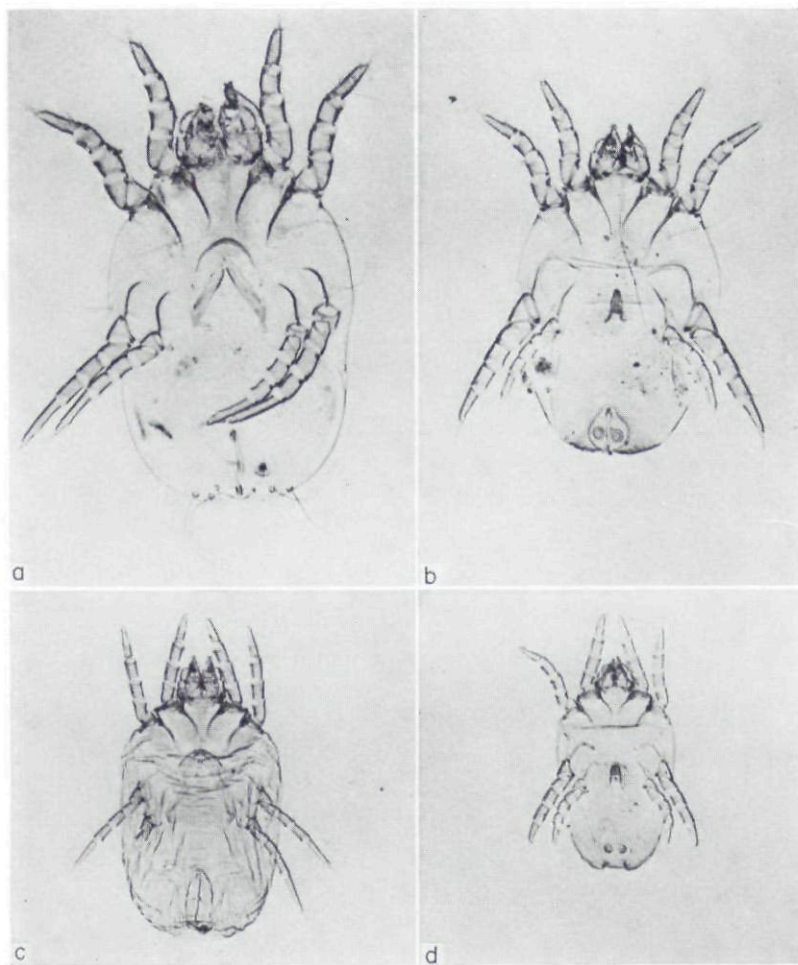


Fig. 1. Photomicrographs of the adults of the two pyroglyphid species reproduced to the same scale. (a) *D. pteronyssinus*, female; (b) *D. pteronyssinus*, male; (c) *E. maynei*, female; (d) *E. maynei*, male.

detachable paper bag. After sampling, the paper bag was removed, sealed and labelled, and the vacuum cleaner flushed by running it for a few minutes without a bag. Several mattresses from the same house were examined when these were available for study.

The vacuum cleaner produces masses of fine dust and fluff, and this is difficult to examine in 70% alcohol. These samples were suspended in warm 90% lactic acid which clears and swells the mites, especially the shrivelled mites and the mite fragments, making them easier to see against the background of the dust, but has the disadvantage of making it impossible to distinguish those mites which were alive at the time of

sampling from the more numerous dead ones. In 70% alcohol, the living mites were clearly distinguishable by their plump, whitish bodies from the dried brown bodies of the dead mites. The mites were examined on a slide in a mountant of lactic acid and glycerol.

Between August and September 1972, samples of dust were collected by vacuum cleaner from the carpets of five Birmingham houses. 25–30 mg quantities, two from each carpet whenever possible, were sorted in 90% lactic acid. The mite populations from the carpets were compared with those found in the mattress of the same house.

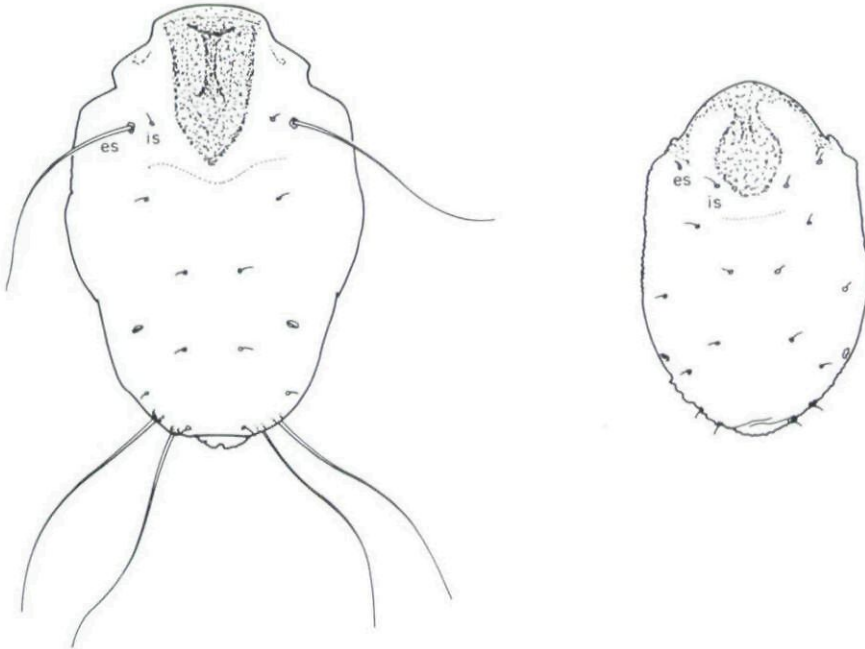


Fig. 2. The dorsal view of the idiosoma of the nymphs of *Dermatophagoides pteronyssinus* (left) and *Euroglyphus maynei* (right). The external scapular setae (es) are greatly enlarged in the genus *Dermatophagoides* compared with the internal scapulars (is). The shaded area at the anterior end of the idiosoma is the propodosomal shield.

### Identification

The adults of the two pyroglyphid species, reproduced to the same scale, are shown in the photomicrographs in Fig. 1. The males may be readily separated from the females by the sclerotised mid-ventral penis and by the pair of suckers situated on either side of the anus.

The Pyroglyphidae may be separated from the other mites likely to be found in mattress dust by the absence of a pair of setae near the anterior margin of the body, the internal vertical setae, just above the chelicerae. The two common pyroglyphid species may readily be separated in all their instars by an examination of their scapular setae. There are two pairs of these setae, situated dorsally on either side of propodosomal shield (the medium wedge-shaped sclerotisation extending back from the anterior margin of the dorsum). They are shown in Fig. 2. In the Pyroglyphinae, the subfamily to which *Euroglyphus* belongs, the scapular setae are small and equally

spaced across the body of the mite. In the Dermatophagoidinae, the two scapular setae on each side are generally close together, and the external scapulars (es) greatly enlarged compared with the internal scapulars (is). The great disparity in size of the basal sockets affords a ready means of identification, even in dead mites, when the setae themselves are often broken off. Further details are provided in the taxonomic papers by Fain (1965, 1966 for *Euroglyphus* and *D. pteronyssinus* respectively).

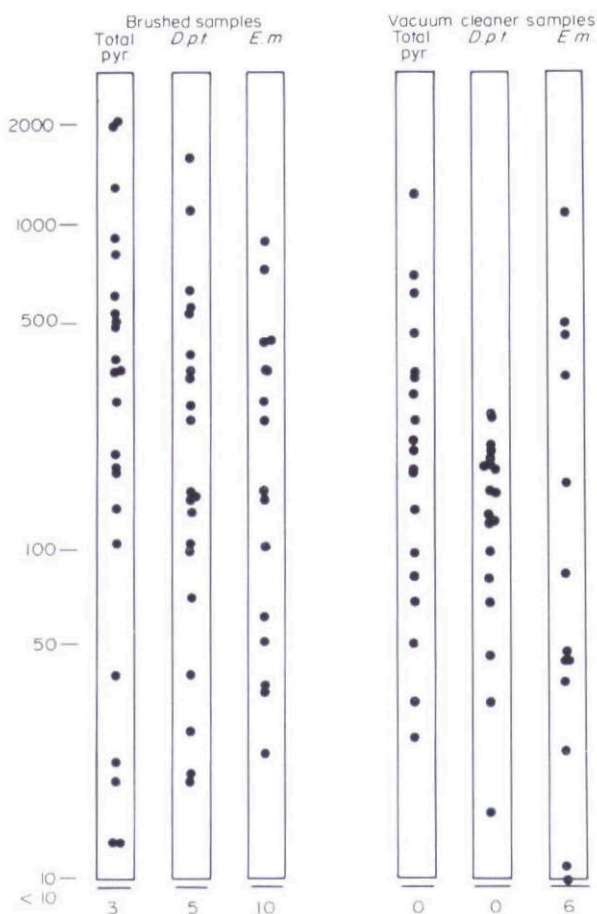


Fig. 3. The densities of the two pyroglyphid species expressed as mites/100 mg of mattress dust. The figures include dead mites, mite fragments exuviae. The vacuum cleaner samples show a markedly better grouping than the samples collected by the patients. Total pyr., total number of pyroglyphid mites; *D.pt.*, *D. pteronyssinus*; *E.m.*, *E. maynei*.

## Results

90% of all the mites found in the survey belonged to the family Pyroglyphidae. The two pyroglyphid species found were *Dermatophagoides pteronyssinus* (Trouessart, 1897) and *Euroglyphus maynei* (Cooreman, 1950). No other pyroglyphid species were found. *D. pteronyssinus* was found in every dust sample examined. *E. maynei* was found in 76% of the dust samples and made up 33% of the pyroglyphid mites seen. *E. maynei* was more numerous than *D. pteronyssinus* in the dust samples from ten out of the thirty-eight houses, but in two of these the difference was marginal. In the nine

houses where more than one mattress was sampled, a similar mite population was found in each of the mattresses in the house. A new mattress in one house had, as expected, a much smaller mite population than an older mattress.

The densities of the pyroglyphid species in the mattress dust are shown in Fig. 3, expressed as numbers of mites/100 mg mattress dust. Live mites, dead mites, mite fragments and exuviae have all been counted, so the figures represent the allergenic contribution of each species in the dust rather than the living mite population. The mean density overall was 296 pyroglyphid mites/100 mg. The means for *D. pteronyssinus* and *E. maynei* were 167 and 129 mites/100 mg respectively. The series of vacuum cleaner samples showed a better grouping for the population densities of *D. pteronyssinus*, with a mean of 144 mites/100 mg ( $s = 72$ ,  $n = 19$ ). The densities of *E. maynei* showed a wider, less regular scatter.

An interesting situation was found in one house, where an antelope skin hanging on the wall yielded a heavy population of *Glycyphagus domesticus* (about 500 mites/100

**Table 1.** The distribution of pyroglyphids in five houses in Birmingham

| Place in house | House 1                 |     |    | House 2                 |     |    | House 3                 |     |     | House 4                 |     |     | House 5                 |     |     |
|----------------|-------------------------|-----|----|-------------------------|-----|----|-------------------------|-----|-----|-------------------------|-----|-----|-------------------------|-----|-----|
|                | Total <i>D.pt./E.m.</i> |     |    | Total <i>D.pt./E.m.</i> |     |    | Total <i>D.pt./E.m.</i> |     |     | Total <i>D.pt./E.m.</i> |     |     | Total <i>D.pt./E.m.</i> |     |     |
| Living rooms   | 0                       | 0   | 0  | 5                       | 5   | 0  | 17                      | 17  | 0   | 37                      | 30  | 7   | 20                      | 20  | 0   |
|                | 0                       | 0   | 0  |                         |     |    | 39                      | 35  | 4   |                         |     |     | 101                     | 79  | 22  |
| Kitchen        | 8                       | 8   | 0  | 8                       | 4   | 4  |                         |     |     |                         |     |     |                         |     |     |
| Hall/stairs    | 7                       | 4   | 3  | 3                       | 3   | 0  | 10                      | 10  | 0   | 85                      | 67  | 18  | 35                      | 23  | 12  |
| Landing        | 49                      | 45  | 4  |                         |     |    | 10                      | 7   | 2   | 63                      | 35  | 28  | 36                      | 25  | 11  |
| Bedrooms       | 91                      | 73  | 19 | 15                      | 10  | 6  | 34                      | 25  | 8   | 132                     | 47  | 84  | 98                      | 69  | 29  |
|                | 363                     | 286 | 73 |                         |     |    | 29                      | 22  | 7   |                         |     |     |                         |     |     |
| Mattress(es)   | 179                     | 132 | 47 | 199                     | 176 | 23 | 724                     | 212 | 512 | 630                     | 229 | 401 | 350                     | 185 | 165 |
|                |                         |     |    |                         |     |    |                         |     |     | 631                     | 156 | 475 | 256                     | 206 | 50  |

*D.pt.* = *Dermatophagoides pteronyssinus*; *E.m.* = *Euroglyphus maynei*. Figures in mites/100 mg vacuum cleaner dust.

mg of vacuum cleaner dust). However, the bed underneath, and the other mattress in the same room, yielded a normal mixed fauna of *D. pteronyssinus* and *E. maynei* with no *Glycyphagus* at all.

In another house, both pyroglyphid species were found in each mattress despite the regular use of an electric blanket on both of the beds. The population of the two beds was estimated at 250 and 350 pyroglyphid mites/100 mg vacuum cleaner dust. In all but one case, the concentration of pyroglyphids on the mattress was considerably higher than elsewhere in the house (Table 1). There were usually more mites in the bedroom carpets than in the carpets downstairs (presumably these mites come from the mattress while the bed is being made) and more mites in old carpets than in new ones. The very high concentration in the bedroom carpet in house 3 came from a very old carpet with a deposit of fluff under the bed.

The non-pyroglyphid mites recorded in the survey were representatives of a wide variety of families. Of these only the predaceous species of the genus *Cheyletus* (3%) were sufficiently regular in their occurrence to be considered as a normal part of the

mattress dust ecosystem. *Cheyletus* is presumably acting as a predator on the pyroglyphids and other Astigmata present in the bed.

Species of *Glycyphagus*, several Acaridae (mostly *Tyrophagus*), various acarid hypopi, *Gohieria fusca*, and members of the ubiquitous genus *Tarsonemus* were all irregular in their occurrence, but occasionally numerous. Specimens of the skin parasite *Demodex* were found in two of the vacuum cleaner samples.

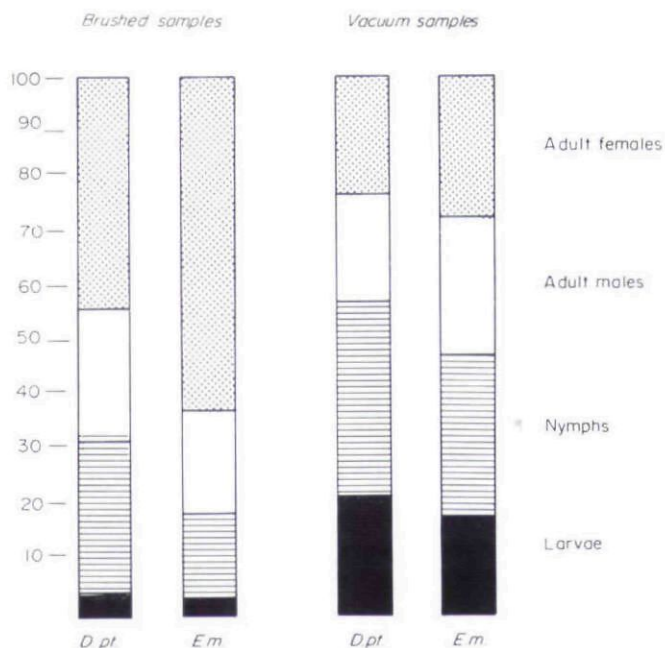


Fig. 4. An analysis of the mite populations revealed in the two surveys. The brushed samples collected by the patients show a marked bias in favour of large size compared to the vacuum cleaner samples produced by a more standardized method and sorted in lactic acid. *D.pt.*, *D. pteronyssinus*; *E.m.*, *E. maynei*.

#### Structure of the mite populations related to sampling technique

Although the dust samples supplied by the patients were sometimes too small to provide a representative section of the fauna of the mattress, mites were found in every sample, even those of a few milligrams. The brushing technique produced a sample consisting largely of coarser particles and fluff, quite unlike the dense masses of fine particles produced by the vacuum cleaner. An examination of the structure of the mite populations revealed by the two methods brings to light serious discrepancies. Fig. 4. displays the population structures produced by the two methods. The section headed 'nymphs' includes two stages of the life cycle, the protonymph and the tritonymph. It will be seen that, particularly in *E. maynei*, there is a large excess of adult mites, and particularly adult females, in the brushed samples. The relative sizes of the adult mites are shown in Fig. 1. The largest is the female of *D. pteronyssinus*, while the male of *E. maynei* is the smallest. Compared with the vacuum cleaner samples, the brushed samples showed a pronounced sampling bias in favour of the larger instars.

One bed was sampled by both methods, and both samples were sorted in lactic acid. In the brushed sample, 59 pyroglyphid mites/100 mg (36% *E. maynei*) were

found and in the vacuum cleaner sample 498 pyroglyphid mites/100 mg (74% *E. maynei*). Subsequent vacuum cleaner samples from the same bed, and from other beds in the same house, have confirmed the species distribution in the vacuum cleaner sample quoted above rather than the brushed sample.

### Discussion

Allergy to house dust is a clinical diagnosis arrived at in patients with asthma which is present all the year round, is exacerbated by exposure to house dust, and is usually worse by night than by day. Many constituents of house dust have been suggested as the responsible allergen, but until Voorhorst, Spieksma & Vorekamp (1969) incriminated a pyroglyphid mite, *Dermatophagoides pteronyssinus*, none had received wide acceptance. The subsequent confirmation and extension of these findings in many countries has led to this mite being regarded as the main producer of 'house-dust allergen'. Skin testing, inhalation tests (Pepys *et al.*, 1968) and *in vitro* immunological tests (McAllen *et al.*, 1970) have shown how potent and specific this allergen is. In children with asthma, 80% were found to be sensitive to mite allergen (Morrison Smith *et al.*, 1969).

The mites of house dust were first examined by Spieksma (1967). Dust was collected by vacuum cleaner from the rooms of 150 houses in the Netherlands, and the mites extracted by a flotation technique in lactic acid. 70% of the mites seen were members of the family Pyroglyphidae. Of these, 88% were *D. pteronyssinus*, 1% *D. farinae* and 11% *E. maynei*.

There have been two previous house-dust surveys published for the British Isles. In 1967 Cunningham reported on 186 samples of general house dust collected from houses in London, the Home Counties and South Wales. 82% of the mites found were Pyroglyphidae, and of these 82% were *D. pteronyssinus*. *E. maynei* made up the remaining 18%. In twenty-two paired samples of mattress and living room dust, *D. pteronyssinus* was found to be 100 times more numerous in the mattress dust (mean density 257/100 mg) than in the dust from the living rooms (mean 2/100 mg).

Sesay & Dobson (1972) of Glasgow University published the results of an examination of 486 dust samples from sixty beds in private houses in Glasgow and Edinburgh. Here also the same two pyroglyphid species made up 86% of the mites seen. *D. pteronyssinus* was once more the dominant species, making up about 85% of the Pyroglyphidae present, with *E. maynei* as the remaining 15%. *D. pteronyssinus* was present in fifty-nine out of the sixty beds, and was the dominant species in fifty-five. *E. maynei* occurred in twenty-seven beds and was dominant in four. In one bed it was the only pyroglyphid present. Mite densities were lower than those reported by Cunningham, the maximum recorded for *D. pteronyssinus* in a whole bed being 193/100 mg. No difference in mite densities was noted between the beds of patients with asthma or papular urticaria and control beds, but higher densities were shown to be associated with lower standards of housekeeping.

Our figures differ from those quoted above in showing a markedly higher proportion of *E. maynei*, which was present in 76% of the dust specimens and made up 33% of all the pyroglyphid mites seen.

The results of the house surveys (Table 1) show a tendency to a higher proportion of *E. maynei* in the mattress and on the floor of the bedroom than elsewhere in the house. The number of houses examined is too small to confirm this trend, but it is interesting to note that Sesay & Dobson observed the same phenomenon in their

preliminary survey. It may be, therefore, that *E. maynei* is more restricted to the mattress environment than the versatile *D. pteronyssinus*. In this connection it is important to remember that the figures quoted by Spieksma and Cunnington relate to general house dust and not just mattress dust. The large numbers of mites on the bedroom floor have presumably come from the mattress (Cunnington & Gregory, 1968).

During the examination of the mattress dust samples submitted by the patients, it was noticed that a large proportion of the specimens of *E. maynei* were adult females. Closer analysis showed that 61% of the specimens were adult females, 18% adult males, 17% nymphs and only 4% larvae. A similar but less marked discrepancy was shown by *D. pteronyssinus*. Similar abnormal sex ratios in *E. maynei* were commented on by Spieksma and by Sesay & Dobson. However, in the later vacuum cleaner samples, the sex ratio made no significant deviation from equality. Adult females made up 27%, adult males 24%, nymphs 30% and larvae 19% of the *Euroglyphus* population. These results are displayed in Fig. 4.

*E. maynei*, the species which showed the greatest discrepancy in its sex ratio, also shows the greatest disparity in size between the males and females. The male of *E. maynei* is, in fact, smaller than the *Dermatophagoides* tritonymph (mean idiosomal length of fifty-eight specimens  $158 \pm 3 \mu\text{m}$ ). It is difficult to avoid the conclusion that its systematic under-estimation was connected with its small size. This under-estimation may have occurred in two ways.

(a) The vacuum cleaner collects finer particles than the brush and might, therefore, be expected to collect more of the smaller mites and mite fragments.

(b) Whether or not a concentration technique has been used to aid the extraction of the mites from the dust, the mites have ultimately to be sorted by hand from the fine particles of dust. The process is laborious, and it is impossible to be sure that all the mites have been extracted. Those missed are likely to be the smallest and hence least conspicuous. The lactic acid used for sorting the vacuum cleaner samples swells the mites and makes them easier to see. The 70% alcohol used for the brushed samples is much less satisfactory, and this must have contributed to the poor sex ratio previously observed.

In conclusion, it is unlikely that *E. maynei* shows a sex ratio which departs from equality, and the reports of excesses of adult females are probably due to sampling errors operating in favour of large size. *E. maynei* is smaller than *D. pteronyssinus* in all its instars and hence more liable to this form of selective sampling. Its numbers, and thence its allergenic contribution to the mattress dust, may still have been underestimated in this survey.

We have been unable as yet to show any seasonal variation in mite numbers in mattress dust. This is probably due to the failure to differentiate between live and dead mites in our samples. Spieksma (1967) showed some seasonal variation of mite populations in Leiden with an increase in the early autumn months. Hughes & Maunsell (1973) found a sudden increase in numbers of live mites in a bed in late May 1971. This coincided with the turning off of the central heating system, and was probably due to a hatch of eggs. Regular monthly cleaning of the mattress prevented these mites from building up a large autumn population. The clinical evidence of seasonal variation in asthma in Birmingham is conflicting. Morrison Smith (1970) found that 72% of mite sensitive children showed no seasonal difference in severity, 14% worse in winter and 10% worse in summer. There is, however, a marked

increase in asthma admissions to paediatric wards in September (Disney, Matthews & Williams, 1971).

Much of the clinical work with mites which has been undertaken in the past relates to *D. farinae*, which is the predominant mite in the United States and is much easier to culture in the laboratory than *D. pteronyssinus*. *D. farinae* is an uncommon mite in English house dust, and its effectiveness as an extract for clinical testing is presumably due to common allergens with *D. pteronyssinus*. *E. maynei* has been cultured by Spiksma, and an extract used for skin testing showed a high correlation with *D. pteronyssinus* extract.

The role of different mites in the aetiology of asthma is not clear. It appears that *D. pteronyssinus* and *E. maynei* are both important because of their almost constant presence in mattress dust. However, the mattress is not the only source of mites in the household and these sources may also be important for example the large population of *G. domesticus* found in an antelope skin. Furthermore, skin reactions to *Glycyphagus* are more common in asthmatic patients than its presence in mattress dust would lead one to expect (Morrison Smith *et al.*, 1969).

We are at present engaged in establishing laboratory populations of *E. maynei* with a view to analysing its contribution to house dust sensitivity in Birmingham children.

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