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THE ANTIGENICITY OF HOUSE DUST AND MITES

By

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INTRODUCTION

Voorhorst & Spijksma (1967), *Maunsell* (1968), *Pepys et alii* (1968) and *Miyamoto et alii* (1968) have investigated the antigenicity in man of several species of mites such as *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, *Glyciphagus destructor*, *Tyrophagus putrescentiae* and *Acarus siro*. These authors found a number of positive skin-reactions to their mite extracts, but *Dermatophagoides pteronyssinus* caused the highest percentage of positive reactions in house dust positive patients. *Voorhorst & Spijksma* (1967) concluded that the antigens of house dust and of the mite *Dermatophagoides pteronyssinus* were identical.

It has already been pointed out (*Bernecker* 1968, 1969) that in the patients of the University Asthma-Clinic in Berlin there is no such identity of the antigens of *Dermatophagoides pter.* and house dust. We concluded that *Dermatophagoides pter.* is a major allergen in house dust, but that also other mites and/or other substances in the house dust might be antigenic. The fact that many authors found positive skin tests to several species of mites in house dust-sensitive patients may indicate that some cross antigenicity exists between the several species of mites occurring in house dust. Also, it appears possible that this cross antigenicity extends to mite species occurring in other environments than house dust. It was therefore of interest to investigate whether patients with a positive

skin tests to *Dermatophagoides pter.* or other mites occurring in house dust would also react positively to other mites not found in house dust, with which patients could hardly have had any contact. For this purpose the mites *Panonychus ulmi* (the fruit tree red spider mite), *Tetranychus urticae* (the glass house red spider mite or hop red spider mite) and *Dermanyssus gallinae* (the chicken mite) were selected.

MATERIALS AND METHODS

A series of patients were treated in the University-Asthma-Clinic in Berlin for chronic obstructive lung disease or rhinitis. All the patients were prick-tested with routine extracts of inhalant allergens such as several pollen mixtures, moulds, house dust and animal hairs. The house dust extracts used came from four different sources (two from Vitrum, Stockholm, Sweden; one from Dome Lab., Stoke Poges, Gt. Britain; one from Center Lab., Port Washington, U.S.A.) and these four extracts were meant to be used routinely for the detection of house dust sensitivity in outpatient clinics. Although the routine prick tests were done in all patients, the mite tests were carried out with different groups of these patients, as not all the extracts were available during the 3 years (1966-1970) when these investigations were done.

Group A: 65 consecutive patients were prick-tested with 4 different mite species occurring in house dust: 1) *Dermatophagoides farinae*. 2) *Tyrophagus putrescentiae*. 3) *Acarus siro*. 4) *Glyciphagus domesticus*, and the mediums of mite 1)-3).

Group B: 52 patients with positive skin-reactions to a 1 per cent extract of *Dermatophagoides pter.*, and a control group of 48 patients with positive skin-tests to various allergens but not to *Dermatophagoides pter.*, were skin-tested with an 0.1 per cent extract of *Panonychus ulmi* (the fruit tree red spider mite). As *Panonychus ulmi* possesses an extraordinary hard chitin skeleton, which is not easily crushed, the extract was made after crushing the mite bodies in liquid nitrogen.

Group C: 29 patients with positive skin-reactions to an 1 per cent extract of *Dermatophagoides pter.* and 53 patients positive to various allergens but not to *Dermatophagoides pter.* were prick-tested with an 1 per cent extract of *Tetranychus urticae* (the glasshouse red spider mite).

Group D: 24 patients positive to the 1 per cent extract of *Dermatophagoides pter.* and 32 control patients (as above) were prick-tested with an 1 per cent extract of *Dermanyssus gallinae* (the chicken mite).

Group E: 450 consecutive patients were prick-tested with two different chitin extracts: one suspension in alcohol and the other in aqua bidestillata. For this purpose 250 mg pure chitin obtained from the Zoological University Institute was crushed in a mortar until a fine powder was produced. This powder proved

to be practically insoluble in alcohol and in water. To this powder 4 ccm alcohol (96) per cent) or aqua bidest. was added so that each suspension had a chitin concentration of about 6 per cent. This suspension was used for prick-testing.

The patients of group A-D were partly identical. In all patients the skin-reaction was graded with 1-4 crosses, according to the size of the wheal and flare after 15 minutes.

RESULTS

Group A

1) Out of 65 consecutive patients 14 were completely negative. Of the remaining 51 patients (Table 1) 28 (55 per cent of the 51 patients) had positive reactions to mites and of these 25 were positive to house dust (89 per cent of the 28 patients). 23 patients (45 per cent of the 51 patients) had negative skin-tests to mites; but 18 of these were positive to house dust. 32 of the 51 allergic patients (63 per cent) reacted positively to mites and/or their medium.

2) 28 patients positive either to mites or to mites and their medium (but not to mites' medium alone) were positive to one or to several mite species (Table 2).

3) Mites and their medium: of 3 species of house dust mites also the mediums were prick-tested. The distribution of positive skin-reactions either to mites or to mites' mediums or to both is shown in Table 3 (32 patients).

Group B

Panonychus ulmi. Out of the 52 patients positive to *Dermatophagoides pter.* 24 (46 per cent) were positive to *Panony-*

TABLE 1
Skin-Sensitivity to House Dust and Mites (51 Patients).

	Positive to mites	Negative to mites
Positive to house dust	25	18
Negative to house dust	3	5

TABLE 2

Skin-Reactions of 28 Patients to Four Different Mites Occurring in House Dust.

Positive to (number of mite species)	Glycy- phagus dome- sticus	Tyro- phagus putres- centiae	Dermato- phagoides farinae	Acarus siro	Number of patients
1	+	o	o	o	5
	o	+	o	o	3
	o	o	+	o	3
	o	o	o	+	1
2	+	o	+	o	2
	+	o	o	+	3
	o	+	+	o	1
	o	+	o	+	1
	o	o	+	+	1
3	+	+	o	+	1
	+	o	+	+	1
	o	+	+	+	3
All 4	+	+	+	+	3

chus ulmi, whilst in the control group of 48 patients only three (6 per cent) showed a positive reaction to *Panonychus ulmi*. Of the 100 patients of group B prick-tested with *Panonychus ulmi*, 79 showed positive skin-tests to house dust. Of these 79 house dust positive patients 23 (29 per cent) were positive to *Panonychus ulmi*. Of the 21 house dust negative

TABLE 3

Skin-Reactions of 32 Patients to Three Different Mites Occurring in House Dust and to their Medium.

Mite species	Positive to mites	Positive to medium	Positive to mites and medium
<i>Acarus siro</i>	3	5	11
<i>Dermatophagoides farinae</i>	7	4	7
<i>Tyrophagus putrescentiae</i>	6	8	6

TABLE 4

Correlation of Skin-Reactions to three Species of Mites not Occurring in House Dust with the Skin-Sensitivity to House Dust and Dermatophagoides pteronyssinus.

	Positive to Dermat. pter. %	Negative to Dermat. pter. %	Positive to house dust %	Negative to house dust %
Positive to <i>Panonychus ulmi</i>	46	6	29	14
Positive to <i>Tetranychus urticae</i>	62	43	52	36
Positive to <i>Dermanyssus gallinae</i>	21	9	11	25

patients of group B only 3 (14 per cent) had positive reactions to *Panonychus ulmi*.

Group C

Tetranychus urticae. Out of the 29 patients positive to *Dermatophagoides pter.* 18 (62 per cent) were positive to *Tetranychus urticae*, whilst in the control group of 53 patients 23 (43 per cent) had positive reactions to *Tetranychus urticae*. Of the 71 house dust positive patients of group C 37 (52 per cent) had positive skin-reactions to *Tetranychus urticae*; out of the 11 house dust negative patients of group C 4 (36 per cent) showed positive prick-tests to *Tetranychus urticae*.

Group D

Dermanyssus gallinae. 5 (21 per cent) of the 24 patients positive to *Dermatophagoides pter.* had positive prick-tests to *Dermanyssus gallinae*; in the control group of 32 patients 3 (9 per cent) reacted positively to the chicken mite. 44 patients of group D were house dust positive; 5 of these (11 per cent of the 44 patients) reacted positively to *Dermanyssus gallinae*. Out of 12 house dust negative patients 3 (25

TABLE 5

Comparison of Skin-Reactions to Chitin with the Skin-Sensitivity to House Dust, Dermatophagoides pteronyssinus and Pollen.

	Positive to house dust	Negative to house dust	Positive to Dermat. pter.	Negative to Dermat. pter.	Positive to pollen*
Number of patients	204	88	100	192	80
Positive to chitin in alcohol	8% (17)†	6% (5)	7% (7)	8% (15)	6% (5)
Positive to chitin in aqua dest.	8% (17)	5% (4)	11% (11)	5% (10)	5% (4)

Dermat. pter. = *Dermatophagoides pteronyssinus*.

* These patients were positive to pollen, moulds or animal hairs, but negative to both house dust and mites.

† The numbers in brackets are the absolute numbers of positive chitin reactions.

per cent of the 12 patients) had positive skin-tests to *Dermatophagoides pteronyssinus*.

The results of group B, C and D are shown in Table 4.

Group E

Of the 450 consecutive patients prick-tested with chitin, 158 were completely negative to inhalant allergens and also to chitin. Of the remaining 292 patients with positive skin-tests 22 showed positive reactions to chitin suspended in alcohol (respectively 21 patients to chitin in aqua bidest). That there is no correlation between positive skin-reactions to chitin and positive prick-tests to house dust or *Dermatophagoides pteronyssinus*, is shown in Table 5.

DISCUSSION

1) In group A 55 per cent* of the patients with positive skin-tests to house dust show positive reactions to one or more species of mites occurring in house dust. This percentage, which has been obtained with a relatively small number of patients lies very close to our previous results. Only about half of our house dust positive patients react positively to mites occurring in house dust.

It could perhaps be argued that the house dust extracts used in our series have been too strong and this could have given a number of false positive reactions. Against this argument points the fact that we have tested simultaneously with four different house dust extracts which are used in many laboratories for routine prick-testing. House dust sensitivity was therefore only assumed in a patient if he showed a strongly positive reaction to one house dust extract or a somewhat weaker but all the same distinctly positive reactions to two or more house dust extracts used. False positive reactions to house dust must therefore have been rare.

The present investigations confirm our previous results that mites are a major allergen for the patients of the University-Asthma-Clinic in Berlin but not the only source of house dust antigenicity. The reason that this percentage is much lower than with patients in the Netherlands or Gt. Britain could be a lower average number of mites in the Berlin house dust. It is known that the content of allergens in the air is influenced by the climate. In Davos, for instance, less allergens are found in the air than elsewhere, possibly because of less humidity and/or electrostatic differences. It has been suggested that there is a correlation between humidity and the number of mites (*Spicksma* 1969, *Maunsell* 1970).

A similar situation as in Berlin exists probably in Scandinavia, where *Stenius & Wide* (1969) found no significant correlation between the commercial house dust and *Dermato-*

* If the patients with positive reactions to mites' medium are included this percentage increases to 63 per cent.

phagoides culinae extracts in the IgE and skin-test reactions. The extracts of house dust and *Dermatophagoides culinae* had some common as well as unrelated antigens. They concluded that the house dust extracts investigated in Scandinavia may contain allergens from other mites to which its population may have been sensitized. Stenius & Wide stated that different house dust extracts would probably vary as to their content of *Dermatophagoides* species allergen. As in some countries mites account only partly for house dust sensitivity, other components than mites in house dust must have antigenic potency. In Japan, for instance, *Miyamoto et al.* (1969) found that the antigens in house dust are not always mite antigens. They have found that in a number of patients the house dust sensitivity was not caused by mite antigens but by silk or moulds.

2) Out of 28 patients of group A who reacted positively to one or more species of mites occurring in house dust, 57 per cent showed positive skin-tests to more than one of these mites. Also other authors (*Voorhorst & Spijksma* 1967, *Maunsell* 1968, *Pepys et al.* 1968, *Miyamoto et al.* 1968) have found a number of positive skin-tests to every mite occurring in house dust to which they have tested. *Spijksma* (1969) has suggested that positive skin-reactions to several mites occurring in house dust in the same patient could be explained by statistical probability. However, cross-antigenicity to an antigen component, which is common to all mites occurring in house dust, should also be considered. (*Bernecker* 1969). The second possibility has also been suggested by *Miyamoto et al.* (1969); they investigated the cross-antigenicity of six different house dust mites using the Prausnitz-Küstner-test. The correlations between the various mite species were relatively high. Close antigen correlation was found between house dust and the mites tested. As *Dermatophagoides farinae* represents only about 4 per cent of the mites found in house dust, but *Dermatophagoides pteronyssinus* 32 per cent and *Glyciphagus* 27 per cent, the close relationship of *Dermatophagoides farinae* with house dust is

regarded as evidence that this mite contains an antigen which is common to most other house dust mite species.

3) Cross antigenicity between mites occurring in house indicates the possibility that a common antigen might also be found in mites *not* occurring in house dust. A comparison between groups of patients with positive reactions to *Dermatophagoides pteronyssinus* and control groups of patients who were negative to this mite but allergic to other substances showed that the former were positive to mites *not* occurring in house dust in a much higher percentage. In particular, the results with *Panonychus ulmi* (46 per cent and 6 per cent) suggest the possibility of cross antigenicity between these two mite species.

A certain cross antigenicity exists also between *Dermatophagoides pteronyssinus* and house dust respectively on the one hand and the two other mites investigated, but to a minor degree. With *Tetranychus* it is still considerable, but with *Dermanyssus* it is only just noticeable. In any case, it must be of great interest, that so many patients have shown positive reactions to these three mite species which do not occur in house dust. Cross antigenicity between these species can be assumed of course only if our patients have not had any contact with the mites *Panonychus ulmi*, *Tetranychus urticae* or *Dermanyssus gallinae* and thus have not acquired the sensitivity by direct contact.

Because all our patients are townspeople the possibility of contact with mites living on fruit trees, in hop fields, glass houses or in chicken pens is very improbable but cannot be absolutely excluded.

4) The possibility must be considered that cross—antigenicity exists not only between mites in general but even between arthropods. Such a possibility was already suggested by *Bachofen et al.* (1967) and by *Mitchell et al.* (1969), who found that out of 100 mite positive patients 61 per cent had positive reactions to one or more insects or spiders. The observed cross—antigenicity between mites and spiders was not more frequently seen than between mites and insects.

It must be kept in mind that many children in early life have close contact with insects: they are stung by mosquitos, fleas and other insects. That children are often hypersensitive to these insects, can be seen from the sometimes enormous reaction they show to these stings. Those children who have an allergic disposition will probably retain this hypersensitivity for life. It could be that their sensitivity to mites is derived from their early sensitization to other arthropods. If this were the case, it would clarify why many house dust sensitive people are sensitive not only to *Dermatophagoides pteronyssinus* but also to many other species of mites; it would appear that in these cases the house dust sensitivity is a consequence of a general arthropod sensitivity acquired early in life.

An antigen common to all arthropods has not yet been isolated. As chitin is a component of almost all arthropods the skin sensitivity to this substance was investigated. Our results do not indicate cross antigenicity between chitin and mite extracts. This negative result may be caused by the very weak concentration of our chitin extracts and our inability to produce stronger extracts. Further investigations on this subject will be necessary.

SUMMARY

Four groups of patients were prick-tested with extracts of house dust, several house dust mites and/or some mites not occurring in house dust.

1) 89 per cent of 28 patients with positive skin-reactions to house dust mites were also positive to house dust, whilst the skin sensitivity to this substance was investigated. Our positive mite reactions.

2) 57 per cent of the 28 patients with positive prick-tests to any of the four species of mites occurring in house dust were positive to more than one of these mites.

3) Patients with positive reactions to the house dust mite *Dermatophagoides pteronyssinus* were positive to mites *not*

occurring in house dust in a higher percentage (46 per cent to *Panonychus ulmi*, 62 per cent to *Tetranychus urticae* and 21 per cent to *Dermanyssus gallinae*) than were control groups of patients with negative reactions to *Dermatophagoides pter.* (6 per cent, 43 per cent and 9 per cent).

4) It is therefore suggested that a certain cross antigenicity exists not only between mites occurring in house dust but also between mites in general.

5) These results confirm that house dust mites and, in particular, *Dermatophagoides pteronyssinus* play a major part in the antigenicity of house dust, but that also other substances, particularly in some regions, for instance in Berlin, must be of antigenic importance.

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