

REVIEW

Allergy to storage mites

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Storage mites have been shown to cause symptoms of bronchial asthma, allergic rhinitis and conjunctivitis, particularly in rural occupational environments. Storage mites flourish in a warm humid environment, optimally at a relative humidity of 80% and a temperature between 25 and 30°C. They feed on a variety of substances including fungi and are found in stored food products like grain, flour and hay in greatest numbers where there are conditions of high moisture content.

Table 1 shows the relationship between the pyroglyphid mites *Dermatophagoides* (established as being chiefly responsible for house dust allergy [1,2]) and the non-pyroglyphid storage mites which both belong to the suborder Astigmata and the subclass Acari. Among the storage mites, the Glycyphagidae and the Acaridae families usually predominate. *Lepidoglyphus destructor* is the predominant species in Northern and Central Europe (with *G. domesticus* and the *Acarus* and *Tyrophagus* genus also important) whilst the *Blomia* genus is prevalent in the tropical and sub-tropical parts of the world [3,4].

Cuthbert in 1979 was the first to report allergy to storage mites in Scottish farm workers exposed to hay and grain used for feeding cattle wintered indoors [5]. Subsequent studies of farmers by Terho *et al.* [6] in Finland, Blainey *et al.* [7] in the United Kingdom, Iversen *et al.* [8] in Denmark and the extensive studies of van Hage-Hamsten *et al.* [9,10] in Sweden have confirmed the importance of storage mites in causing allergic respiratory symptoms in farm workers.

Ingram *et al.* [11] showed that UK farmers were exposed to large numbers of storage mites, particularly while feeding cattle. Leskinen and Kelin [12] studying cowsheds and hay stores on 19 Finnish farms found more storage mites in the cowsheds. Interestingly they found few or no mites in bales of dry, unmoulded hay and this fact was confirmed by Hallas and Gudmundsson [13] who found very few storage mites in fresh hay in Iceland. These authors found the greatest number in hay that had been stored for 1 year (50 000 live mites/kg).

Campbell *et al.* [14] were the first to demonstrate the abundance of *L. destructor* allergens in North American

dairy barns. In a case-control study of Wisconsin farmers to assess the role of antibody to a panel of antigens Marx *et al.* [15] found that IgE antibodies to house dust mites and storage mites, especially *L. destructor*, were the most prevalent.

Confirmation of the role of storage mites in the causation of allergy has been made by the use of nasal [16] and bronchial provocation tests [11,17–20].

Other occupations where storage mites have been shown to be a problem are in grain-store workers [18,21] and in bakery workers [22–24].

In a cross-sectional study of grain-store workers in the east of England Blainey *et al.* [18] found a significant association between work-related symptoms (WRS) and specific IgE to storage mites but not between WRS and IgE to *D. pteronyssinus* or grain. In another cross-sectional study of grain elevator workers in Denmark, Revsbech *et al.* [21] found storage mites to be the most important allergen. Warren *et al.* [20] reported that over 35% of 31 grain exposed asthmatic patients had a positive skin reaction to *L. destructor*, the most frequent response of the seven allergens tested.

In 1989 in a cross-sectional study of 279 UK bakery workers Musk *et al.* [22] found that 33% had a positive skin-prick test to one of five storage mites. However, after finding a similar high IgE response to storage mites in a comparison workforce (salt-packers) not occupationally exposed to storage mites Tee *et al.* [24] concluded that storage mites were probably widespread in the general environment and allergy to them among bakery workers was not only a consequence of exposure at work.

Revsbech and Dueholm [23] in a similar study took another view point when they compared 23 Danish bakery workers with 17 control non-exposed patients with respiratory symptoms. They found no difference between the two groups in the IgE response to any of three storage mite species and suggested that if a baker becomes sensitized to flour he will be more prone to producing specific IgE towards storage mites too.

Armentia *et al.* [17] also examined 43 patients with IgE mediated hypersensitivity to wheat flour for co-sensitization to *L. destructor* in Spain. Thirty per cent of these were positive to *L. destructor* of whom 23% were not occupationally exposed to wheat flour, implying that

Table 1. Relationships of mites

Family	Genus	Species
Pyroglyphidae	<i>Dermatophagoides</i>	<i>Dermatophagoides pteronyssinus</i> <i>Dermatophagoides farinae</i>
	<i>Euroglyphus</i>	<i>Euroglyphus maynei</i>
Glycyphagidae	<i>Glycyphagus</i>	<i>Glycyphagus domesticus</i>
	<i>Lepidoglyphus</i>	<i>Lepidoglyphus destructor</i>
	<i>Blomia</i>	<i>Blomia kulagini</i> <i>Blomia tropicalis</i>
Acaridae	<i>Acarus</i>	<i>Acarus siro</i> <i>Acarus farris</i>
	<i>Tyrophagus</i>	<i>Tyrophagus putrescentiae</i> <i>Tyrophagus longior</i>

L. destructor appears to be an allergen that also affects city dwellers.

Indeed, as long ago as 1967 Spieksma and Spieksma-Bozeman [25] suggested that storage mite allergy might be important in countries with a damp climate and several further urban studies have substantiated this suggestion. In 1979, Wraith *et al.* [26] showed an association between dampness in the dwelling and a positive skin-prick test to storage mites and Warren *et al.* [20] and Korsgaard *et al.* [27] reported significant skin-test responses to storage mites in patients at their urban clinics. Iversen *et al.* [28] suggested that allergy to storage mites in the farmers he studied might be partly attributable to damp housing conditions and indoor exposure to storage mites.

Recently, Ebner *et al.* [29] studied house dust mite allergic patients living in either a rural or urban environment in Austria and found that though there was a higher RAST response to storage mites in the farming population there was also a high response in the city dwellers. Eaton *et al.* [30] investigating patients with symptoms of house dust allergy found although all responded to storage mites, not all responded to *D. pteronyssinus*. All the patients' houses contained storage mites in the dust as well as *Dermatophagoides* which were found mainly in food stores or pet beds.

Luczynska *et al.* [31] add to the evidence that people from an urban environment also have a high hypersensitivity to storage mites. In their study of 196 factory workers not occupationally exposed to storage mites they found a 14% IgE response to one of three storage mites. Since all these workers also had IgE to *D. pteronyssinus* the authors thought this suggested cross-reactivity between the two types of mite. Griffin from the

same group also reported crossreactivity between these mites [32].

In contrast, other groups have found no significant crossreactivity between storage mites and *D. pteronyssinus*. These include Korsgaard *et al.* [27] looking at storage mites as a cause of bronchial asthma in Denmark, Georges *et al.* [33] studying asthmatic children with allergy to *D. pteronyssinus* in France, and Ford and Platts-Mills [34] who considered multiple sensitization more likely than crossreactivity. The detailed study of Swedish farmers by van Hage-Hamsten *et al.* [35] has provided the strongest evidence of lack of major cross-reactivity between *D. pteronyssinus* and the four storage mites. Using RAST inhibition techniques they found that *L. destructor*, *G. domesticus* and *T. putrescentiae* shared common or related allergens as we also found in our bakery worker studies. Similarly we found no significant correlation between the IgE response to these three storage mites and *D. pteronyssinus* in either our UK bakery workers or the Swedish farmers we compared them with [36].

Different conclusions may be made if RAST inhibition is used to examine allergenic crossreactivity since results depend on the primary sensitivity of the sera employed. Thus, using sera from different populations, where the main sensitizers are not the same, can lead to different interpretations. All studies may be further confused by poorly defined mite extracts. Further evidence of there being only low crossreactivity between storage mites and *D. pteronyssinus* comes from Arlian [37] who found that *D. farinae* and *T. putrescentiae* primarily possess their own specific antigenicity. Analysis of specific IgE surveys also gives supporting evidence. Agha and Gnanasakthy [38] used cluster analysis to examine the data provided by

Wraith *et al.* [26] on skin-prick test results of 210 patients with house dust allergy. This showed that storage mite species form a group of similar allergens distinct from the house dust mite. Similarly, Angrisano *et al.* [39] statistically analysed RAST levels in 467 unselected patients to two house dust mites and three storage mites and found no significant correlation between them.

Allergen characterization is required for understanding the mechanisms of allergic disease. Five allergens of *T. putrescentiae* have been identified by Arlian *et al.* [40] with the use of CRIE but the majority of allergen studies have been made on *L. destructor*.

Characterization studies have revealed that the major allergen of *L. destructor* detected by gel electrophoresis under non-reducing conditions is 14–15 kDa [41,42]. This 14 kDa allergen (*Lep d 1*), which has a molecular weight of 16 kDa under reducing conditions, has been purified by affinity chromatography using a monoclonal antibody (MoAb) [42]. Eighty-seven per cent of *L. destructor* allergic patients had specific IgE to *Lep d 1* which was able to inhibit the *L. destructor* RAST by up to 75%. *Lep d 1* does not crossreact with *D. pteronyssinus*. Van Hage-Hamsten *et al.* have purified their 15 kDa protein and analysed its N-terminal sequence [43]. The function is not known, as no homology was found with the N-terminal sequences of any known protein family, but it can of course now be synthetically produced to be used as a clinical reagent. These findings are in keeping with the Spanish group [44]. Van Hage-Hamsten thinks the allergens identified by the two groups may be one and the same [45].

However, *Lep d 1* is not the only major allergen as Johansson *et al.* showed that 50% of 20 sera detected an allergen of 53 kDa [41]. Using an immunoblot inhibition technique these authors demonstrated that the IgE antibodies to the 25 kDa allergen in *D. pteronyssinus* were inhibited to the same extent by extracts of *D. pteronyssinus* and of *L. destructor*. This allergen may be the one accounting for the low degree of crossreactivity found between these two mites.

Monoclonal antibodies have been raised to *Lep d 1* by the Spanish group [44] and to a 39 kDa allergen by the Swedish group [46]. Further characterization of the 39 kDa MoAb revealed that it binds to the wall of *L. destructor* gut and to faecal pellets suggesting that at least this 39 kDa allergen is associated with digestion [47]. The MoAb was shown to recognize the carbohydrate part of a glycoprotein in *L. destructor*. Using ELISA inhibition Harfast *et al.* [48] analysed the reaction pattern of this MoAb to 39 kDa with pyroglyphid and non-pyroglyphid mites. Storage mites exhibited more inhibition than house dust mites with *D. pteronyssinus* showing 1000 times less potency than *G. domesticus*. Using the MoAb

as a capture antibody in a modified radio-immunoassay the 39 kDa allergen of *L. destructor* was shown to be an important allergen in both urban and rural subjects [49].

Summary

There is now much evidence of sensitization to storage mites in urban populations as well as in the well-documented rural populations. Sensitization is therefore not restricted only to those with occupational exposure.

There appears to be a limited allergenic crossreactivity between storage mites and house dust mites, although both species also possess their own unique allergens.

More research on identification and characterization of storage mite allergens and their crossreactivity is needed to understand their complexity. Such studies are necessary to obtain high quality extracts for diagnosis and possible immunotherapy.

Development of immunoassays employing MoAbs will allow measurement of storage mite concentrations in workplaces and houses and the study of exposure-response relationships.

References

- 1 Voorhorst R, Spieksma-Boezeman MIA, Spieksma FThM. Is a mite (*Dermatophagoides* sp.) the producer of the house-dust allergen? *Allerg Asthma* 1964; 10:329–34.
- 2 Voorhorst R, Spieksma FThM, Varekamp H, Leupen MJ, Lyklema AW. The house-dust mite (*Dermatophagoides pteronyssinus*) and the allergens it produces. Identify with the house-dust allergen. *J Allergy* 1967; 39:325–39.
- 3 Gabriel M, Cunningham AM, Allan WGL, Pickering CAC, Wraith DG. Mite allergy in Hong Kong. *Clin Allergy* 1982; 12:157–71.
- 4 Hurtado I, Parini M. House dust mites in Caracas, Venezuela. *Ann Allergy* 1987; 59:128–30.
- 5 Cuthbert OD, Brostoff J, Wraith DG, Brighton WD. Barn allergy: asthma and rhinitis due to storage mites. *Clin Allergy* 1979; 9:229–36.
- 6 Terho EO, Leskinen L, Husman K, Karenlampi L. Occurrence of storage mites in Finnish farming environment. *Allergy* 1982; 37:15–9.
- 7 Blainey AD, Topping MD, Ollier S, Davies RJ. Respiratory symptoms in arable farmworkers: role of storage mites. *Thorax* 1988; 43:697–702.
- 8 Iversen M, Korsgaard J, Hallas T, Dahl R. Mite allergy and exposure to storage mites and house-dust mites in farmers. *Clin Exp Allergy* 1990; 20:211–9.
- 9 van Hage-Hamsten M, Johansson SGO, Hoglund S *et al.* Storage mite allergy is common in a farming population. *Clin Allergy* 1985; 15:555–64.
- 10 van Hage-Hamsten M, Johansson E, Wiren A, Johansson

- SGO. Storage mites dominate the fauna in Swedish barn dust. *Allergy* 1991; 46:142-6.
- 11 Ingram CG, Jeffrey IG, Symington IS, Cuthbert OD. Bronchial provocation studies in farmers allergic to storage mites. *Lancet* 1979; ii:1330-2.
 - 12 Leskinen L, Klen T. Storage mites in the work environment of farmers. *Eur J Resp Dis* 1987; 71, Supp 152:101-11.
 - 13 Hallas TE, Gudmundsson B. Storage mites in hay in Iceland. *Eur J Resp Dis* 1987; 71 Supp 154:60-4.
 - 14 Campbell AR, Swanson MC, Fernandez-Caldas E *et al.* Aeroallergens in dairy barns near Cooperstown, New York and Rochester, Minnesota. *Am Rev Respir Dis* 1989; 140:317-20.
 - 15 Marx JJ Jr, Twigg JT, Ault BJ, Merchant JA, Fernandez-Caldas E. Inhaled aeroallergen and storage mite reactivity in a Wisconsin farmer nested case-control study. *Am Rev Respir Dis* 1993; 147:354-8.
 - 16 Terho EO, Husman K, Vohlonen I, Rautalahti M, Tukiainen H. Allergy to storage mites or cow dander as a cause of rhinitis among Finnish dairy farmers. *Allergy* 1985; 40:23-6.
 - 17 Armentia A, Tapias J, Barber D *et al.* Sensitization to the storage mite *Lepidoglyphus destructor* in wheat flour respiratory allergy. *Ann Allergy* 1992; 68:398-403.
 - 18 Blainey AD, Topping MD, Ollier S, Davies RJ. Allergic respiratory disease in grain workers: The role of storage mites. *J Allergy Clin Immunol* 1989; 84:296-303.
 - 19 van Hage-Hamsten M, Ihre E, Zetterstrom O, Johansson SGO. Bronchial provocation studies in farmers with positive RAST to the storage mite *Lepidoglyphus destructor*. *Allergy* 1988; 43:545-51.
 - 20 Warren CPW, Holford-Strevens V, Sinha RN. Sensitisation in a grain handler to the storage mite *Lepidoglyphus destructor* (Schränk). *Ann Allergy* 1983; 50:30-3.
 - 21 Revsbech P, Anderson G. Storage mite allergy among grain elevator workers. *Allergy* 1987; 42:423-9.
 - 22 Musk AW, Venables KM, Crook B *et al.* Respiratory symptoms, lung function, and sensitization to flour in a British bakery. *Br J Ind Med* 1989; 46:636-42.
 - 23 Revsbech P, Dueholm M. Storage mite allergy among bakers. *Allergy* 1990; 45:204-8.
 - 24 Tee RD, Gordon DJ, Gordon S *et al.* Immune response to flour and dust mites in a UK bakery. *Br J Ind Med* 1992; 49:581-7.
 - 25 Spiekma FThM, Spiekma-Boezeman MIA. The mite fauna of house dust with particular reference to the house-dust mite *Dermatophagoides pteronyssinus*. *Acrologia* 1967; 9:226-41.
 - 26 Wraith DG, Cunningham AM, Seymour WM. The role and allergenic importance of storage mites in house dust and other environments. *Clin Allergy* 1979; 9:545-61.
 - 27 Korsgaard J, Dahl R, Iversen M, Hallas T. Storage mites as a cause of bronchial asthma in Denmark. *Allergol Immunopathol* 1985; 13:143-9.
 - 28 Iversen M, Dahl R. Allergy to storage mites in asthmatic patients and its relation to damp housing conditions. *Allergy* 1990; 45:81-5.
 - 29 Ebner C, Feldner H, Ebner H, Kraft D. Sensitization to storage mites in house dust mite (*D. pteronyssinus*) allergic patients. Comparison of a rural and an urban population. *Clin Exp Allergy* 1994; 24:347-52.
 - 30 Eaton KK, Downing FS, Griffiths DA *et al.* Storage mites culturing, sampling technique, identification and their role in house dust allergy in rural areas in United Kingdom. *Ann Allergy* 1985; 55:62-7.
 - 31 Luczynska CM, Griffin P, Davies RJ, Topping MD. Prevalence of specific IgE to storage mites (*A. siro*, *L. destructor* and *T. longior*) in an urban population and cross-reactivity with the house dust mite (*D. pteronyssinus*). *Clin Exp Allergy* 1990; 20:403-6.
 - 32 Griffin P, Ford AW, Alterman L *et al.* Allergenic and antigenic relationship between three species of storage mite and the house-dust mite *D. pteronyssinus*. *J Allergy Clin Immunol* 1989; 84:108-17.
 - 33 Georges P, Delvigne A, de Montis G. RAST et Acariens des denrees enterposees. *Allerg Immunol* 1987; 19:393-7.
 - 34 Ford AW, Platts-Mills TAE. Standardized extracts, dust mite, and other arthropods (inhalants). *Clin Rev Allergy* 1987; 55:49-73.
 - 35 van Hage-Hamsten M, Johansson SGO, Johansson E, Wiren A. Lack of allergenic cross-reactivity between storage mites and *Dermatophagoides pteronyssinus*. *Clin Allergy* 1987; 17:23-31.
 - 36 Tee RD, Gordon DJ, van Hage-Hamsten M *et al.* Comparison of allergenic responses to dust mites in UK bakery workers and Swedish farmers. *Clin Exp Allergy* 1992; 22:233-9.
 - 37 Arlian LG, Geis DP, Vyszynski-Moher DL, Bernstein IL, Gallagher JS. Cross-antigenic and allergenic properties of the house dust mite *Dermatophagoides farinae* and the storage mite *Tyrophagus putrescentiae*. *J Allergy Clin Immunol* 1984; 74:172-9.
 - 38 Agha M, Gnanasakthy A. A cluster analysis of the effects of storage mites as allergens in relation to certain occupations and living conditions. *Clin Allergy* 1981; 11:499-504.
 - 39 Angrisano A, Di Berardino L, Fregoso A *et al.* *Dermatophagoides* and storage mites: statistical analysis of RAST results. *Ann Allergy* 1990; 64:358-61.
 - 40 Arlian LG, Geis DP, Vyszynski-Moher DL, Bernstein IL, Gallagher JS. Antigenic allergic properties of the storage mite. *Tyrophagus putrescentiae*. *J Allergy Clin Immunol* 1984; 74:166-71.
 - 41 Johansson E, Borga A, Johansson SGO, van Hage-Hamsten M. Immunoblot multi-allergen inhibition studies of allergenic cross-reactivity of the dust mites *Lepidoglyphus destructor* and *Dermatophagoides pteronyssinus*. *Clin Exp Allergy* 1991; 21:511-8.
 - 42 Ventas P, Carreira J, Polo F. Purification and characterization of *Lep d 1*, a major allergen from the mite *Lepidoglyphus destructor*. *Clin Exp Allergy* 1992; 22:454-60.
 - 43 van Hage-Hamsten M, Bergman T, Johansson E *et al.* N-terminal amino acid sequence of principal allergen of storage mite *Lepidoglyphus destructor*. *Lancet* 1992; 340:614.
 - 44 Ventas P, Carreira J, Polo F. Identification of IgE-binding

- proteins from *Lepidoglyphus destructor* and the production of monoclonal antibodies to a major allergen. *Immunol Lett* 1991; 29:229-34.
- 45 van Hage-Hamsten M. Allergens of storage mites. *Clin Exp Allergy* 1992; 22:429-31.
- 46 Ansotegui IJ, Harfast B, Jeddi-Tehrani M *et al.* Identification of a new major allergen of 39 kilodaltons of the storage mite *Lepidoglyphus destructor*. *Immunol Lett* 1991; 27:127-30.
- 47 van Hage-Hamsten M, Scheynius A, Harfast B, Wiren A, Johansson SGO. Localization of allergens in the domestic mite *Lepidoglyphus destructor*. *Clin Exp Allergy* 1992; 22:251-6.
- 48 Harfast B, van Hage-Hamsten M, Ansotegui IJ *et al.* Monoclonal antibodies to *Lepidoglyphus destructor*: delineation of crossreactivity between storage mites and house-dust mites. *Clin Exp Allergy* 1992; 22:1032-7.
- 49 van Hage-Hamsten M, Lagging E, Harfast B, Johansson SGO. Occurrence of IgE antibodies to the 39 kilodalton component to the mite *Lepidoglyphus destructor* in urban and rural subjects. *Allergy* 1993; 48:209-11.

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