
Mites are ubiquitous: are mite allergens, too?

Our knowledge of the biology of the Acari and the impact of mites on humans has grown tremendously during the last few decades. Thirty years ago research in this discipline was primarily limited to taxonomy (identification and description of new species) and systematics (developing phylogenetic relationships). These extremely valuable and necessary areas of research generally precede studies of other aspects of the biology, ecology, and importance of a species. The importance of some mite species in biologic control, soil and forest ecology, agriculture, as pests and as vectors or causative agents of diseases in human and veterinary medicine are now well documented. I will focus this editorial on the role of mites in human disease although this is connected to other areas. This was the case where apple farmers¹ and children living around the orchards as reported in this issue² became sensitized to spider mites that were pests in apple orchards. These spider mites have become abundant in citrus and apple orchards in the US because the use of insecticides has killed predaceous mites that controlled them. Predaceous phytoseiid mites are now used as biologic control species to control spider mites in orchards. One wonders if these biologic control mites also sensitize orchard workers, individuals living around the orchards and researchers who routinely handle them.

Mites are known to be vectors or causative agents of diseases that impact millions of people worldwide. Most notable are the house dust mites, *Dermatophagoides farinae*, *D. pteronyssinus*, and *Euroglyphus maynei*, and the storage mite, *Blomia tropicalis*,

that are major sources in dwellings of multiple important allergens that elicit IgE-mediated allergic reactions in predisposed individuals. Based on studies primarily in Europe, storage mites are also important sources of allergens in farming populations.³ The importance of allergies to storage mites in the US population has not been investigated. I believe that the prevalence of allergies caused by storage mites is significant among farmers and workers in grain storage, feeding and transfer facilities or that process grains to make cereals, flour and baking products (eg, pancakes and donuts). Since storage mites are common in food grains, products from these grains may contain significant mite allergens and/or mites. For example, an anaphylactic reaction from eating beignets made from beignet mix that contained the house dust mite *D. farinae* has been reported.⁴ I have also observed a significant number of *D. farinae* in a freshly opened box of buttermilk pancake mix.

Scabies mites (*Sarcoptes scabiei*) affect 300 million people in the world. This mite burrows in the stratum corneum of the skin and induces an IgE-mediated skin reaction that is associated with the inflammatory/immune reaction in many individuals.⁵ Proteins from these mites are highly cross-reactive with proteins in extracts of *D. farinae*, *D. pteronyssinus*, and *E. maynei*. This complicates the diagnosis of scabies since it is difficult to recover scabies mites with skin scrapes. Other mites that parasitize humans probably induce IgE responses but this has never been investigated. For example, while feeding from the skin surface, chiggers and ticks that puncture the skin with their piercing or cutting mouthparts, respectively, introduce into the host enzymes and other substances with

their saliva that likely induce an IgE response.

The species mentioned above are better known because of the important diseases they cause and the large number of humans they affect; however, many mite species that may cause allergies in particular situations are unknown. Mites are ubiquitous organisms and are present everywhere. Because they are small (except ticks) we don't usually see them without using a microscope. Occasionally we can see one run across the page we are reading (mesostigmatid species, in particular) or we see many on a sunny windowsill (eg, spider mites). In particular situations, humans may come into contact with these microscopic arthropods that may cause disease. For example, species of spider mites, the topic of a paper in this issue, are common parasites of many house plants, agricultural crops including citrus, strawberries and beans, and many yard and garden flowers, trees, and shrubs. Human exposure to them and their products can be significant. Given that most mites to which we have significant exposure (eg, house dust, scabies, storage) are the sources of allergens, it is not surprising that spider mites are the source of allergens that sensitize and trigger allergic reactions in adults and children that live near or work in the vicinity of apple orchards where this mite is abundant.^{1,2} Nor is it surprising that another prostigmatid mite (*Hemisarcoptes cooremani*) that feeds on scale insects in orchards and yards is also another source of allergens.⁶

Many people come into contact with other mite species in their daily lives and thus there is the potential for sensitization and allergic reaction. These situations and potential for allergies have yet to be documented. I will mention of few of these here. Many species

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of storage mites thrive in stored grain and hay, processed foods (flour, cereals, cake and pancake mixes), dried fruit, stored cheeses, fruits, and vegetables. Several predaceous species of mesostigmatids and prostigmatids live in homes and grain/hay storage facilities and feed on house dust mites and storage mites, respectively. Still other mites are common in soil and plant litter on the surface of the soil, on grass, on leaves and bark of shrubs and trees, and in the galleries of wood-boring beetles that infest trees used to make lumber and other building materials. These mites may therefore be sources of allergen in wood dust and sawdust. Many species in the family Pyemotidae (Prostigmata) are parasites of insect larvae that are found in the seeds of plants. These and species in the family Eriophyidae also suck juices of grasses including cereal grains (eg, rust mites) and can be abundant. *Pyemotes* species can be brought into homes in the fall in dried cattails and flowers in floral arrangements and can be dispersed in hoards onto unsuspecting humans. Several species of parasitic mites are common in the feathers and on the skin of wild and domestic fowl and in their droppings. These mites (eg, *Ornithonyssinus* sp. and *Dermanyssus* sp.) when abundant can

be major pests in chickens and turkeys in farm operations. Finally, other species of parasitic mites burrow in the epidermis (mange mites), live in fur of mice, prairie dogs, squirrels, guinea pigs, laboratory and feral mice and other rodents, or live in the hair follicles and sebaceous glands of humans and other mammals. There are species that also inhabit the nasal cavities of birds and dogs and the lungs of some primates. It would not be surprising to eventually learn that many of these species in particular situations elicit IgE responses in exposed individuals. The challenge to researchers and allergists is to recognize that mites may be sources of allergens that induce allergic reactions in humans in certain situations beyond those already known. This requires a thorough review of all potential exposures to mites and their products and requires some knowledge of the diversity and habitats of mites. Exposure may result from eating contaminated foods, working with poultry, cleaning barns, feeding livestock, picking apples, citrus or strawberries, pruning bushes and fruits or ornamental trees, or handling laboratory or pet rodents, straw, hay, or grain. The allergens from these mites that remain in the environment can come from enzymes/proteins in their

salivary secretions left on feeding substrates or introduced into hosts, enzymes in their fecal material, soluble proteins in blood that are released when they die and the body disintegrates, molting enzymes produced during ecdysis, and fragments of their bodies. The route of exposure may be through contact or inhalation. The article in this issue² and two other recent articles^{1,6} serve to alert allergists and researchers that the Acari are more important sources of allergens than we may realize. Although the classification and phylogeny of the higher taxa of the Acari are not agreed upon, the more common orders of mites⁷ that humans encounter and some representative examples are as follows: *Ixodida*—These are all hard and soft ticks. *Mesostigmata*—These include predaceous mites often found in orchards, gardens, dwellings, and grain storage facilities. They also include parasitic mites of wild birds and rodents, some of which nest in human dwellings and may bite humans, and pests of chickens and turkeys (eg, *Ornithonyssinus sylvarium*, *Dermanyssus gallinae*). *Prostigmata*—Representatives include chiggers, follicle mites, spider mites, and predaceous mites common in gardens, dwellings and grain storage, and feeding facilities. *Astigmata*—This group includes house dust, storage, cheese, feather, mange, fur, and scabies mites. *Oribatida*—These mites are common in litter/humus layer of soil and are called soil mites. These groups are distantly phylogenetically related and are given to illustrate that the mites that can induce IgE responses are widely distributed in various orders of Acari. Generally, most immunobiochemical studies indicate that closely related mites are the sources of many allergens that cross-react while more distantly related mites show little or no cross-reactivity. This is particularly evident within the Astigmata where species that have induced allergic reactions have been more extensively studied (Fig 1).⁸ For

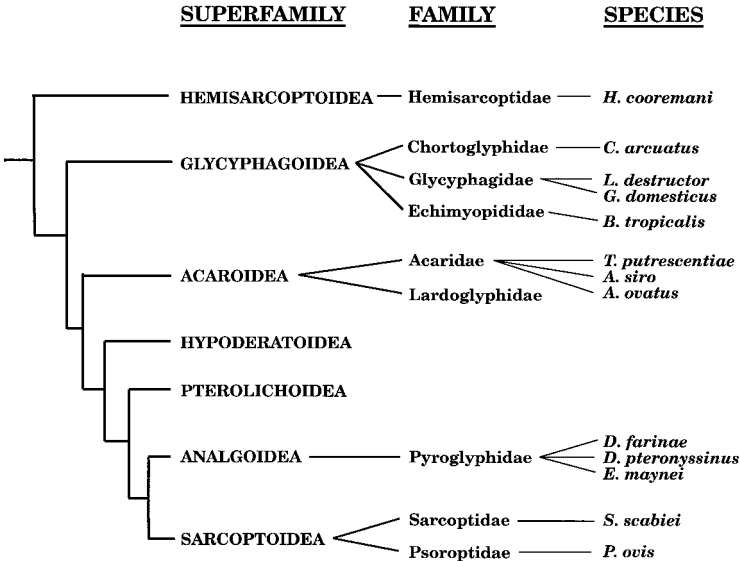


Figure 1. Phylogenetic relationship of the Astigmatid mites that are known sources of allergen.

example, *D. farinae* and *D. pteronyssinus* are members of the same family (Pyroglyphidae) and genus and they are the sources of allergens with extensive interspecific cross-reacting epitopes. Allergens of *D. farinae* and *D. pteronyssinus* also show some cross-reactivity with allergens and antigens of *E. maynei*, a member of the same family but a different genus. Antigens of *D. farinae*, *D. pteronyssinus*, and *E. maynei* also cross-react with many antigens of *S. scabiei*,⁹ *S. scabiei* are in the superfamily Sarcoptoidea which phylogenetically is the closest relative of dust mites. In contrast, most studies show that allergens of the three pyroglyphid species share little or no cross-reactivity (number of antigens) with storage mites which are in the distantly related superfamilies Glycyphagoides (eg, *B. tropicalis*) and Acaroidea (*T. putrescentiae*). Although this is now not so clear since a recent study reports that two monoclonal antibodies (1D8 and 7A1) to group two allergens of *Dermatophagoides* sp. bind to epitopes on a 16kD allergen of *T. putrescentiae*.¹⁰ Likewise, allergens of *B. tropicalis* share little cross-reactivity with allergens of *T. putrescentiae* which is in a different superfamily. In spite of the little cross-reactivity many studies report positive skin test results in individuals to multiple species of the astigmatid dust mites, storage mite, and the prostigmatid spider mites. In an investigation of spider mite sensitivity, Kim et al¹ found that out of 725 apple farmers, 23.2% were skin test positive to the European red mite (*Panonychus ulmi*), 21.2% to the two-spotted spider mite (*Tetranychus urticae*), 16.6% to *D. farinae*, 16.3% to *D. pteronyssinus*, and 8.6% had positive skin reactions to only the spider mites. This group also reported of 1,055 children

living around citrus orchards 26.6, 22.7 and 14.2% were found to have positive skin-test responses to *D. pteronyssinus*, *D. farinae* and *P. ulmi*, respectively. Others report similar skin test result profiles for various species of storage and house dust mites.¹¹ Coupled with the results of immunobiochemical studies, the skin test results indicate that the distantly related species of mites are the sources of some species-specific allergenic epitopes and the skin test positive patients had multiple mite sensitivities. It is therefore important to consider all potential mite exposures when making a diagnosis. The extent to which allergens of distantly related mite species share cross-reactive epitopes and the significance of these still require study.

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REFERENCES

1. Kim YK, Lee MH, Jee YK, et al. Spider mite allergy in apple-cultivating farmers: European red mite (*Panonychus ulmi*) and two-spotted spider mite (*Tetranychus urticae*) may be important allergens in the development of work-related asthma and rhinitis symptoms. *J Allergy Clin Immunol* 1999;104:1285–1292.
2. Lee MH, Cho SH, Park HS, et al. 2000. Citrus red mite (*Panonychus citrilis*) is a common sensitizing allergen among children living around citrus orchards. *Ann Allergy Asthma Immunology* 2000;85:200–204.
3. 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.
4. Erben AM, Rodriguez JL, McCullough J, Ownby DR. Anaphylaxis of ten ingestion of beignets contaminated with *Dermatophagoides farinae*. *J Allergy Clin Immunol* 1993;92:846–849.
5. Arlian LG. Immunology of Scabies. In: SK Wikel, ed: The immunology of host-ectoparasitic arthropod relationships. UK: C-A-B International, 1996: 232–258.
6. Arlian LG, Morgan MS, Houck MA. Allergenicity of the mite *Hemisarcoptes cooremani*. *Ann Allergy Asthma Immunol* 1999;83:529–532.
7. Evans GO. Principals of Ecology. UK: C-A-B International, 1992.
8. Norton RA, Kethley JB, Johnston DE, O'Connor BM. Phylogenetic perspective on genetic systems and reproductive modes of mites. In: DL Wrench and MA Ebbert, eds. Evolution and diversity of sex ratio in insects and mites. New York: Chapman and Hall, 1992:8–99.
9. Arlian LG, Vyszynski-Moher DL, Ahmed SG, Estes SA. Cross-antigenicity between the scabies mite, *Sarcoptes scabiei*, and house dust mite. *Dermatophagoides pteronyssinus*. *J Invest Dermatol* 1991;96:350–354.
10. Park JW, Ko SH, Yong TS, et al. Cross-reactivity of *Tyrophagus putrescentiae* with *Dermatophagoides farinae* and *Dermatophagoides pteronyssinus* in urban areas. *Ann Allergy Asthma Immunol* 1999;83:533–539.
11. Fernandez-Caldas E, Baena-Cagnani CE, Lopez M, et al. Cutaneous sensitivity to six mite species in asthmatic patients from five Latin American countries. *J Invest Allergy Clin Immunol* 1993;3:245–249.

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