

# Skin test and crossreactivity studies with *Euroglyphus maynei* and *Dermatophagoides pteronyssinus*

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## Summary

**Background** The prevalence of sensitization to *Euroglyphus maynei* (*E. maynei*) in the United States has not been reported previously.

**Objectives** To determine: (1) the prevalence of skin-test reactivity in allergic subjects to *E. maynei* compared to *D. pteronyssinus*, *D. farinae*, and *B. tropicalis* and (2) the allergenic crossreactivity between *D. pteronyssinus* and *E. maynei*.

**Methods** Skin testing with extracts of *B. tropicalis* and *E. maynei* (1:50 w/v) and standardized *D. pteronyssinus* and *D. farinae* extracts (1:50 w/v; 10 000 AU/mL) provided data on 250 subjects (87 males and 163 females) aged 9–77 years (mean age, 39.8 years) with possible allergic respiratory diseases. RAST inhibition assays were used to study crossreactivity between *D. pteronyssinus* and *E. maynei*.

**Results** One hundred (40%) of 250 subjects had insignificant or no allergic diseases. Of the 150 allergic subjects (53 males, 97 females), 101 (67.3%) had a positive test (a percutaneous test with a weal diameter  $\geq 3$  mm larger than the saline control) to at least one mite species; 60.7%, 60.0%, 28.7%, and 52.0% reacted to *D. farinae*, *D. pteronyssinus*, *B. tropicalis*, and *E. maynei*, respectively; 40 (26.7%) reacted to the four mite species. Positive tests to *D. farinae*, *D. pteronyssinus*, *B. tropicalis*, or *E. maynei* alone occurred in six (4.0%), four (2.7%), two (1.3%), and 0%, respectively. *D. pteronyssinus* and *E. maynei* showed moderately high crossreactivity in RAST inhibition assays.

**Conclusion** There is a high rate of skin-test reactivity to *E. maynei* in Florida. Moderately high crossreactivity exists between *E. maynei* and *D. pteronyssinus*.

**Keywords:** allergic rhinitis, asthma, *Blomia tropicalis*, *Dermatophagoides farinae*, *Dermatophagoides pteronyssinus*, *Euroglyphus maynei*, mite allergens

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## Introduction

*E. maynei* (Fig. 1) is a common house dust mite found throughout the world and it may be the predominant mite species in some homes [1–17]. It has been detected in Tampa, Florida house dust samples in concentrations as high as 1100 mites per gram of mattress dust and 60–200

mites per gram of carpet dust [18]. *E. maynei* was detected in homes of 25% of subjects with asthma that were surveyed in New Orleans, Louisiana, Galveston, Texas, Memphis, Tennessee, Delray Beach, Florida, and San Diego, California, and *E. maynei* was the most abundant species in five of these 154 homes. It was found in 43.8% of homes in Galveston, Texas [1]. Other studies have found *E. maynei* to be the dominant species in one of 20 homes sampled in Atlanta, Georgia, and one of 40 homes in Tampa, Florida [17,18]. Mite surveys worldwide have shown that most homes with *E. maynei* are co-inhabited by other pyroglyphid mites: *D. pteronyssinus*, *D. farinae*, or both [1,2,12,17]. Many of

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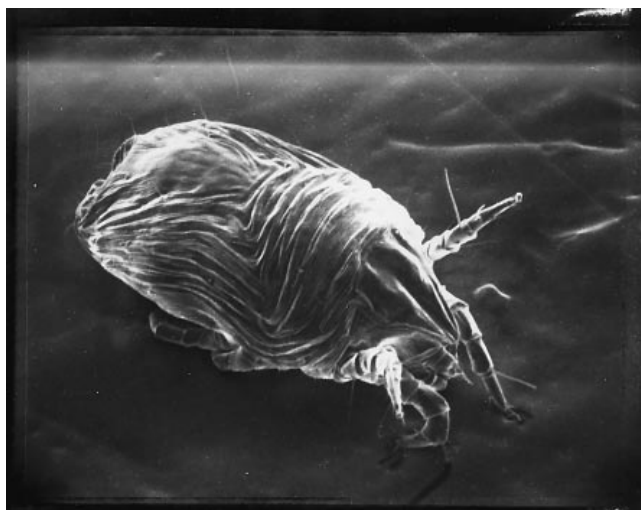


**Fig. 1.** A scanning electron micrograph of *E. maynei*.

these homes in subtropical climates are also inhabited by *B. tropicalis*, a glycyphagoid mite [19,20]. Numerous studies have shown that *E. maynei* possesses unique allergens [21–23].

The prevalence of sensitization to *E. maynei* in the United States has not been reported previously. The purpose of this study was to determine the prevalence of skin-test reactivity to *E. maynei* extract and to compare it to that obtained with *D. pteronyssinus*, *D. farinae*, and *B. tropicalis* extracts in allergic subjects and to establish the allergenic crossreactivity between *D. pteronyssinus* and *E. maynei* using RAST inhibition assays.

## Study design

### Study subjects

Two-hundred and fifty subjects underwent skin testing as part of an evaluation for rhinitis and/or asthma from March 1994 through to September 1994 at a university-affiliated allergy-immunology clinic in Tampa, Florida. All subjects had a history supportive of allergic respiratory disease. There were 87 males and 163 females, with a mean age of 39.8 years (range, 9–77 years). This study was approved by the Institutional Review Board of the University of South Florida College of Medicine, Tampa, Florida.

### Allergen sources

Standardized extracts (10 000 Allergy Units/mL) of *D. pteronyssinus* and *D. farinae* were obtained from Greer Laboratories (Lenoir, N.C.), and the extracts of *B. tropicalis* and *E. maynei* (1:50 w/v) were prepared by methods previously described [19,21]. Protein concentrations were

2.5 mg/mL for *D. pteronyssinus*, 3.5 mg/mL for *D. farinae*, 1.6 mg/mL for *B. tropicalis*, and 2.05 mg/mL for *E. maynei*.

### Skin tests

Nursing personnel not associated with the study conducted skin testing with a battery of 48 extracts (pollens, fungi, and animals, including dust mites and cockroach). Prepared extracts of *B. tropicalis* and *E. maynei* (1:50 w/v) and standardized *D. pteronyssinus* and *D. farinae* extracts (1:50 w/v; 10 000 AU/mL) were used for percutaneous testing. Study inclusion criteria defined a percutaneous test as 'positive' if it produced a weal diameter  $\geq 3$  mm ( $\geq 3+$ ) larger than the saline (negative) control. Precise dimensions of positive tests were not recorded and weal diameters for each of the four mite extracts were not compared with each other in a given study participant.

### RAST inhibition assays

RAST inhibition assays were used to study the crossreactivity between *D. pteronyssinus* and *E. maynei* following methods previously described [24]. Serum pools containing sera from six and seven mite-allergic individuals with high titres of specific IgE (Class 3 and 4) to *D. pteronyssinus* and *E. maynei*, respectively, were used.

### Statistical analysis

Statistical analysis was performed with a Macintosh SE 30 computer (Apple Computer, Inc., Cupertino, California) and the StatView II program (Brainpowers Inc., Calabasas, California, USA). Results were compared by contingency table analysis and  $\chi^2$  statistics. A *P*-value less than 0.05 was considered significant.

## Results

Two hundred and fifty subjects underwent skin testing as part of their evaluation for upper and lower respiratory symptoms. All tested subjects had histories suggestive of respiratory allergy, but 100 subjects were considered by study criteria to have insignificant to no allergic disease. Of the 150 allergic subjects, 101 (67.3%) subjects had a positive skin test to at least one of the four mite species. The prevalence of positive skin test reactions to *D. farinae*, *D. pteronyssinus*, *B. tropicalis*, and *E. maynei* was 60.7%, 60.0%, 28.7%, and 52.0%, respectively. Positive tests to both *D. farinae* and *D. pteronyssinus* occurred in 82 subjects (54.7%) of which 2 (1.3%) also reacted to *B. tropicalis* but not to *E. maynei*, 33 (22.0%) to *D. pteronyssinus*, *D. farinae*, and *E. maynei* but not to *B. tropicalis*, and 40 (26.7%) to all four mite species; the remaining seven (4.7%) had no additional reactivity. Positive tests to *D. farinae*, *D. pteronyssinus*, or *B. tropicalis* alone occurred in six (4.0%), 4 (2.7%),

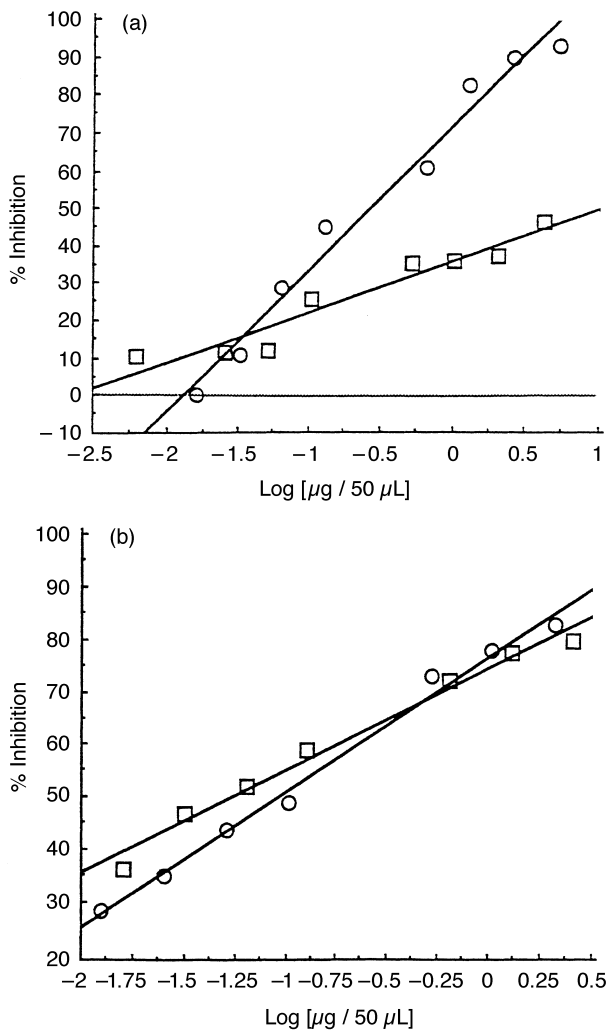


**Fig. 2.** (a) *D. pteronyssinus* solid phase ○, *D. pteronyssinus*; □, *E. maynei*. (b) ○, *E. maynei*; □, *D. pteronyssinus* *E. maynei* solid phase.

and two (1.3%), respectively. No subjects displayed skin-test reactivity to *E. maynei* alone. Other combinations accounted for the remaining seven subjects with positive tests.

The rates of sensitization in Tampa to *E. maynei*, *B. tropicalis*, *D. pteronyssinus*, and *D. farinae* were greater in asthmatic subjects with or without allergic rhinitis (58%, 31%, 69%, and 71%, respectively) than in subjects with allergic rhinitis alone (44%, 27%, 49%, and 49%, respectively). These results were statistically significant for *D. pteronyssinus* and *D. farinae* ( $P \leq 0.05$  and  $P < 0.05$ , respectively) but not statistically significant for *E. maynei* or *B. tropicalis* ( $P > 0.2$  and  $P > 0.5$ , respectively).

#### RAST inhibition

RAST inhibition assays demonstrated moderately high

crossreactivity between *D. pteronyssinus* and *E. maynei* (Figs 2a and b). In its homologous system, *D. pteronyssinus* achieved 50% inhibition at a 1:1000 dilution ( $0.128 \mu\text{g}/50 \mu\text{L}$ ), whereas *E. maynei* did not produce this inhibition even at the highest dose used (1:25 dilution,  $4.093 \mu\text{g}/50 \mu\text{L}$ ). *D. pteronyssinus* and *E. maynei* each achieved a high degree of inhibition when *E. maynei* was used in the solid phase. *D. pteronyssinus* achieved 50% inhibition at a 1:1000 dilution ( $0.128 \mu\text{g}/50 \mu\text{L}$ ), whereas *E. maynei* achieved 50% inhibition at the 1:500 dilution ( $0.513 \mu\text{g}/50 \mu\text{L}$ ). *E. maynei* and *D. pteronyssinus* exhibited similar increases in the slope of inhibition when *E. maynei* was used in the solid phase.

#### Discussion

The prevalence of skin-test reactivity in the United States to the pyroglyphid domestic mite, *E. maynei*, has not been reported previously. This study demonstrates a high prevalence (52%) of skin-test reactivity to *E. maynei* among allergic subjects in a university-affiliated allergy and immunology practice in Tampa, Florida. Seventy-eight (31%) of all 250 subjects evaluated by percutaneous skin testing had positive tests to *E. maynei*. Forty (51%) of these 78 *E. maynei*-sensitive subjects, or 27% of all allergic subjects, also demonstrated skin-test reactivity to the other three mite species tested. No subjects displayed skin-test reactivity to *E. maynei* alone. Evaluation of allergic subjects with *D. pteronyssinus* and *D. farinae* extracts identified 99 of the 101 (98%) mite-sensitive subjects. However, 78 (77%) of these mite-sensitive subjects were also sensitive to *E. maynei*. Forty of 78 (51%) *E. maynei*-sensitive subjects were also sensitive to *B. tropicalis*. No studies have compared *E. maynei* to *B. tropicalis* sensitivity. Morgan, Arlian and Fernández-Caldas have reported minimal to moderate immunological crossreactivity between these two mites [25].

Sensitization to *E. maynei* has been reported elsewhere [26–32]. Several studies have demonstrated that *E. maynei* extracts produce positive skin-test reactions in a high percentage of patients (51–85%) with allergic asthma and/or rhinitis and positive skin reactions to other mites (mainly *D. farinae* and *D. pteronyssinus*, which are also pyroglyphid mites) [26–29]. Similarly, Van Hage-Hamsten and Johansson reported that 37 of 64 (58%) farmers from the island of Gotland, Sweden, who had positive RAST results to one or more of the mites, *Acarus siro*, *Lepidoglyphus destructor* and *D. pteronyssinus*, also had a positive RAST to *E. maynei*. Five of the 64 (7.8%) had positive RAST results for *E. maynei* exclusively and 25 (39%) had a positive RAST for all three species [30]. Two studies have characterized the IgE-binding response to protein components of *E. maynei* extracts after they were fractionated

by non-reducing sodium dodecylsulfate-polyacrylamide gel electrophoresis (SDS-PAGE) [22,23]. The two studies identified a high number of allergens but disagreed on the extent of allergenic homology between *E. maynei* and *D. pteronyssinus*. Hill *et al.* reported that *E. maynei* had 28 IgE-binding bands that range from 185 kDa to less than 14 kDa in molecular weight. Twenty-four of the 28 IgE-binding bands of *E. maynei* had comparable IgE-binding bands in *D. pteronyssinus* extracts, suggesting homology between *E. maynei* and *D. pteronyssinus* [22]. Colloff *et al.* identified 25 and 28 IgE-binding components for *E. maynei* and *D. pteronyssinus*, respectively. However, the homology between IgE-binding components of *D. pteronyssinus* and *E. maynei* was relatively low. Thirty-two per cent of the components were shared by *D. pteronyssinus* and *E. maynei*, and 30% were unique to *E. maynei*. Both studies have identified *E. maynei* allergens that are similar in molecular weight to the group 1 and 2 allergens of *D. pteronyssinus* [23]. Platts-Mills *et al.* demonstrated by radioimmunoassay that *E. maynei* was the source of an allergen which cross-reacted with Der p 1 [31]. Arlian, Rapp, and Fernández-Caldas reported that *E. maynei* was the source of at least 33 antigens, at least 15 of which bind circulating IgE. Four of these allergens crossreacted with *D. farinae* and six crossreacted with *D. pteronyssinus*. Most of these sera recognized the same two to three crossreacting allergens [21].

RAST inhibition assays in this study demonstrated moderately high crossreactivity between *D. pteronyssinus* and *E. maynei*. The close similarity in slopes between the two species when *E. maynei* was used in the solid phase suggests that *D. pteronyssinus* contains many of the *E. maynei* allergens (Fig. 2b). Intercepting lines emphasize the presence of both species-specific and crossreactive allergens. Immunoelectrophoretic studies of these sera were not done. However, the RAST inhibition studies suggest that the six allergens shared by the two species may be the major allergens while the remaining nine or more *E. maynei* allergens may be less significant in this serum pool.

*E. maynei* appears to induce specific reactivity despite a high rate of simultaneous reactivity to *D. pteronyssinus*, *D. farinae*, and *B. tropicalis*. No subjects in this study were skin test positive to *E. maynei* alone. This finding contrasts with that reported by Van Hage-Hamsten and Johansson, who found that five of 64 individuals (7.8%) had a positive RAST to *E. maynei* alone [30]. RAST inhibition assays performed in the Tampa population confirm the presence of species-specific *E. maynei* allergens (Fig. 2a). It is possible that the population size for this study may have been too small to detect significant isolated *E. maynei* skin-test reactivity. Three of the 150 allergic subjects had 2+ percutaneous tests to *E. maynei* extract and negative percutaneous

tests to *D. farinae*, *D. pteronyssinus*, and *B. tropicalis* extracts. These reactions were insufficient for study inclusion. Moreover, geographical differences in dust mite sensitivity may reflect differences in mean dust mite allergen levels and in mite fauna. Genetic factors may also account for these differences.

A comparison of the data presented in this study with those obtained from an *E. maynei*-free region would be useful. There are no published reports concerning the prevalence of specific IgE to *E. maynei*, skin test or RAST, from an *E. maynei*-free community. Some positive skin tests would be anticipated in a region where *E. maynei* mites are absent because other pyroglyphid and non-pyroglyphid mite species share some epitopes with *E. maynei*. However, statistically significant skin test differences between matched endemic and non-endemic study populations would support the presence of true *E. maynei* hypersensitivity in the endemic region.

Mumcuoglu observed that the most frequent and severe skin-test reactions among Swiss subjects with allergic rhinitis, asthma, or both were caused by *E. maynei* extracts (85%) followed by *D. pteronyssinus* and *D. farinae* extracts, despite the fact that *E. maynei* was found less frequently in household mite surveys [28]. The clinical significance of multiple mite sensitivity remains to be established.

The rates of sensitization in Tampa to *E. maynei*, *B. tropicalis*, *D. pteronyssinus*, and *D. farinae* were greater in asthmatic subjects with or without allergic rhinitis (58%, 31%, 69%, and 71%, respectively) than in subjects with allergic rhinitis alone (44%, 27%, 49%, and 49%, respectively). However, these differences were statistically significant for the *Dermatophagoides* spp. alone. Overall results are comparable to other studies which have observed that sensitization to domestic mites and storage mites is more common among asthmatic individuals than those with allergic rhinitis alone [20,24,30]. Neither the immunological mechanism nor the genetic basis for this increased predisposition has been determined.

Several conclusions can be drawn from the present study:

- (1) The high rate of skin-test reactivity to *E. maynei* (52% of allergic subjects evaluated in Tampa) indicates that *E. maynei* sensitivity should be considered as a potential cause of allergic rhinitis and asthma in US regions where *E. maynei* is common.
- (2) Skin-test reactivity to multiple house dust mite species is common.
- (3) *E. maynei* possesses both species-specific and cross-reactive allergens.
- (4) Clinically significant hypersensitivity to *E. maynei* in North American subjects with positive skin tests to *E. maynei* extracts remains to be established, particularly in view of the known crossreactivity between *E. maynei* and other pyroglyphid mites.

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