Effects of Relative Humidity on the Population Growth of House-Dust Mites

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Introduction

The genus *Dermatophagoides*, the dominant species of house-dust mite, has been recognized as a major source of house-dust allergens since 1964 (Voorhorst et al., 1964). Since *Dermatophagoides* spp., which prefer higher relative humidity and often multiply under moist conditions in airtight rooms, have recently become common in Japan (Moriya, 1989), the control of these mites is seen to be in the public interest.

Relative humidity is the most important climatic factor affecting the growth, breeding and distribution of *Dermatophagoides* spp. owing to the fact that they primarily absorb moisture from the air (Bronswijk, 1981). The populations of *Dermatophagoides* spp. in wooden houses are generally smaller than those in concrete ones. This difference is due to the greater vapor condensation which occurs in concrete houses.

The objective of this study was to clarify the effects of various relative humidity levels on the population growth of *Dermatophagoides* spp., specifically, the population density of *Dermatophagoides pteronyssinus* Trouessart reared under 33-85% RH conditions.

Methods

Dermatophagoides pteronyssinus Trouessart reared on a culture medium composed of equal parts of powdered rat food and dried yeast in a growth chamber at 23°C and 85% relative humidity (RH) were used.

Three parts of hiba (*Thujopsis dolabrata* S. and Z. var *hondai* M) sawdust, from which the wood oil had been extracted with methanol, were mixed with 1 part of the culture medium to prevent the culture medium from getting sticky or hardening. Four thousand mites and a 1-gram mixture consisting of hiba sawdust and the culture medium were put into a 20 ml glass jar. Five saturated aqueous solutions of salts, namely, MgCl₂·6aq for 33%, Ca(NO₃)₂·4aq for 51%, NH₄NO₃ for 61%, NaCl for 75% and KCl for 85% RH, were used for maintaining the relative

humidity in the desiccators. Four glasses containing mites and the mixture were placed in each desiccator at 23°C. Two hundred to 3500 micrograms of the mixture were extracted for bioassay in a modified Matsumoto and others' rearing container (Matsumoto et al. 1986), and moving mites were counted each week after the onset of exposure to relative humidity conditions. Differences in the average number of moving mites between groups were analyzed by Student's *t*-test.

Results and Discussion

D. pteronyssinus multiplied exponentially under conditions of 75% RH and 85% RH (Fig. 1), with mite populations increasing eightfold at 75% RH and tenfold at 85% RH. Population levels reached a plateau in the 6th week after the onset (Fig. 1). Miyamoto et al. (1975) reported that *D. pteronyssinus* population growth depended on the kind of protein source in the culture media. As was the case in the control experiments of our previous studies (Miyazaki et al., 1989; Miyazaki, 1996; Oribe and Miyazaki, 1997), we observed normal population growth of *D. pteronyssinus* at 75% RH and 85% RH in the medium, including powdered rat food and dried yeast (Fig. 1).

Miyamoto et al. (1975) monitored breeding of *D. pteronyssinus*, which was reared at 52-94% RH in 2-week intervals and reported that the mites could not multiply at 52% RH. In the present study, we reduced the minimum humidity to 33% RH and counted moving mites each week in order to clarify the effects of relative humidity on the population growth of *D. pteronyssinus* in detail.

D. pteronyssinus population growth was suppressed under relative humidity conditions lower than 61%. The average number of moving mites in each group decreased after a certain time period under all conditions (Fig. 2). From the 2nd week after the onset of exposure, the 33% RH, 51% RH and 61% RH groups differed significantly from the 85% RH group, which showed great population growth (Figs. 1 and 2). Moving mites decreased by 65% at 33% RH, 44% at 51% RH and 32% at 61% RH after 1-week

Fig. 1 Changes in the number of moving *D. pteronyssinus* exposed to different relative humidities. : 75%, : 85%.

Fig. 2 Changes in the number of moving *D. pteronyssinus* exposed to different relative humidities. : 33%, : 51%, : 61%. : $P < 0.01$ from 85% RH values (Student's *t*-test).

exposure periods, and could not be found after 4 weeks in any group (Fig. 2).

The critical equilibrium humidity (CEH), at which the sorption and desorption of vapor are in equilibrium in a mite's body, is 73% RH at 25°C for *D. pteronyssinus* (Arlian, 1992). Adult *D. pteronyssinus* kept at humidity conditions below the CEH cannot survive desiccation long (Bronswijk, 1981; Moriya, 1989; Arlian, 1992). The mite's population growth and their movement in the present study were limited to relative humidity conditions lower than 61% below the CEH (Fig. 2).

According to article 129-2-3 of the Building Standard Law Enforcement Order of Japan (1990), indoor air conditions should be kept at 40%-70% RH. Takaoka (1989) recorded the humidity and the number of mites in houses of patients with infantile asthma. In the houses of children who reacted to house-dust allergens, the relative humidity conditions were higher than 70% and there were about 1000 mites in 0.5 g of house-dust. In contrast, in the houses of patients who were negative to house-dust allergens, the humidity was lower than 65% RH and few mites were observed. On the basis of his results and the results obtained in the present study, a relative humidity level of 40%-60% could help control the population growth of *D. pteronyssinus* and reduce house-dust allergens.

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