2000 Progress Report: Factors Controlling the Dust Mite Population in the Indoor Environment

EPA Grant Number: R825250
Title: Factors Controlling the Dust Mite Population in the Indoor Environment
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Project Period: December 1, 1996 through November 30, 1999 (Extended to November 30, 2000)
Project Period Covered by this Report: December 1, 1999 through November 30, 2000
Project Amount: $480,000
RFA: Air Quality (1996)
Research Category: Air Quality and Air Toxics

Description:

Objective:

The objectives of the research project are to:

1. Establish that the regulated use of dehumidifiers and air conditioning in homes with high mite levels reduces the relative humidity (RH) sufficiently to reduce mite and mite allergen levels.

2. Establish dust mite survival and population dynamics in fluctuating climatic conditions.

3. Define specific temperatures required to kill mites in water and evaluate various laundry detergents and carpet cleaning products for their efficacy in killing mites and removing allergens from various carpet types.

4. Elucidate the relationship between xerophilic fungi and house dust mites.

5. Elucidate how mites disperse and colonize dwellings.

Progress Summary:

The progress is reported below by objective.

Objective 1. Establish that the regulated use of dehumidifiers and air conditioning in homes with high mite levels reduces the relative humidity (RH) sufficiently to reduce mite and mite allergen levels.

During this funding year, sampling for mites/allergen occurred in March and then approximately every 4 weeks (June, July, August, and September) during the cooling season. In addition, the concentrations of the *Dermatophagoides*
mite allergens (Der f 1 and Der p 1) in all of the house dust samples previously collected were determined by the enzyme-linked immunosorbent assay (ELISA) method of Chapman et al. (1987) using well-characterized monoclonal antibodies specific for both Der f 1 and Der p 1 antigens.

In homes that maintained indoor RH <51 percent, the average live mite count was 401.2 mites/g of dust at

the beginning of the study then it declined to 8.2 mites/g by the end of the first heating season (March 99) and 6.7 mites/g at the end of the study in October 1999. In addition, reservoirs of dead mites gradually declined during the 17-month study. In contrast, the densities of live mites in homes in Groups A (average ambient RH >51 percent with air conditioning [with or without dehumidifier]) and C (average ambient RH >51 percent control homes [no air conditioning or dehumidifier]) increased in parallel with the summer increases in indoor ambient RH during both summers and then decreased in the late summer and fall as indoor ambient RH decreased. Dead mites in these high humidity homes paralleled live mite densities.

The mean concentrations of Der 1 (Der f 1 + Der p 1) for the 3 sampled sites continually decreased in the Low RH Group homes from 17.5 µg/g of dust at the beginning of the study to 4.0 µg/g of dust at the end of the study. In contrast, mean Der 1 concentrations in Group A and C homes showed similar trends to those seen for the mite counts and increased during the humid summer months then decreased during the winter months.

The ability to maintain RH <51 percent was independent of all of the physical house characteristics. Homes that maintained indoor RH <51 percent showed no correlation in live mite counts between those built with basements or slabs. In addition, there was no correlation between live mite counts and the presence or absence of pets. Similar results were seen with total Der 1 (Der f 1 + Der p 1) allergen.

Conclusion: Our study showed that it is possible, practical and effective in temperate climates to reduce indoor RH to levels that will control dust mites and their allergens. This coupled with regular vacuum cleaning by the participants of the study resulted in the reduction of allergen in surface dust to insignificant levels. In addition, there was no correlation between the physical home characteristics and the mite counts and allergen density in homes nor the physical home characteristics and the ability to maintain low RH. Presence or absence of pets was not a factor correlated with mite or mite allergen density in any group.

Objective 2. Establish dust mite survival and population dynamics in fluctuating climatic conditions.

Multiple Matings: Additional studies were conducted to test the viability of the eggs produced by *D. farinae* during the second reproductive period. Fifteen females produced 216 eggs and larvae emerged from 69 percent of those eggs produced during the second reproductive period.

A separate study was conducted to determine whether continuous mating occurs or if there are two distinct mating periods. *D. farinae*
tritonymphs were confined to cages and when females emerged, two males were added to the cage. Males were replaced every 10 days with two fresh males. Following the initial introduction of males, all 27 females produced eggs (range: 32?136). The mean number of days the females survived was 112.2 (range: 30?232) with an average reproductive period of 44.8 days (range: 13?73).

Conclusion: These studies revealed that after an initial mating and egg producing period, D. farinae females mated again and then produced a second small batch of fertile eggs. This was direct evidence that these mites are capable of successful multiple matings and determined that a second successful insemination was possible. Our findings indirectly indicated that in natural or cultured populations of D. farinae two or more successful inseminations must occur and that the females' reproductive potential is increased by multiple matings when they are continuously exposed to males.

Objective 3. Define specific temperatures required to kill mites in water and evaluate various laundry detergents and carpet cleaning products for their efficacy in killing mites and removing allergens from various carpet types.

Additional studies investigated the survival *Euroglyphus maynei* using water temperatures below 130?F (~55?C) that contained 13 different detergents and bleach at their recommended concentrations. Mite mortality ranged from 70-97 percent after 12-minute soaks in the various detergents at 50?C. Five of the detergents caused ~90 percent mortality while 12-minute water or bleach baths resulted in 28 and 99 percent mortalities, respectively. Further results showed that 5 minutes at 53?C was required for 100 percent mortality. Four hours in the various detergents at 35?C caused 14-46 percent mortality in *E. maynei*.

Conclusion: These experiments show that washing clothes and bedding in hot water at 50?C for >30 minutes is required to kill *D. pteronyssinus* and E. maynei whereas a 7.5-minute wash will kill *D. farinae*. One-hundred percent mortality can be reached for *D. pteronyssinus* and *E. maynei* after 12- and 5-minute soaks, respectively at 53 C. A 4-hour wash in warm water at 35 C kills less than half of the mites.

Objective 4. Elucidate the relationship between xerophilic fungi and house dust mites.

The previous years' experiments were conducted in order to determine if fungizone (amphotericin B) would kill mites if they ingested it. No mortality was detected at very low concentrations of fungizone (0.25, 2.5, 25 and 250 µg/ml). A long-term experiment was done by treating two different culture media with two concentrations of fungizone (250 µg/ml and 1 mg/ml) and then offering the treated media to caged D. farinae females. The populations were then determined at 4 and 8 weeks. Populations declined in all treated cultures and in the controls.

Conclusion: From this series of experiments, it appears that mites thrive on mold-free culture medium. Mold does not normally grow in thriving cultures as evidenced by the fact that when mite and culture medium from thriving cultures were used to inoculate plates used for culturing molds, no mold colonies grew. Therefore, there is no obligate mite-fungus association when mites are cultured on some lab diets. However, the role of fungi for mites feeding on human skin scales in the natural environment remains to be answered.

Objective 5. Elucidate how mites disperse and colonize dwellings.

1. Five homes that had live mites prior to replacing furnishings (carpet or furniture) were investigated. After replacing the carpeting or couch/chair, two of the homes had live mites on the new articles in <1 month. The three remaining homes (two with ultra-efficient dehumidifiers) had dead mites in 1-2 months. Only one of these homes eventually had live mites on a new leather couch after 6 months.

2. Two potential factors of mite dispersal were investigated. The numbers of mites were analyzed on clothing and on automobile driver seats along with specific locations in homes (sofas, carpets) of the drivers. One hundred fifty (67.3 percent) automobile seats contained at least one mite/50 mg dust sample analyzed. More than 29 percent of the automobiles contained at least one live mite/50 mg dust. Seventy-seven percent of the 144 homes that had mite densities >100 mites/g of dust (5 mites/50 mg) had mites on their automobile seats. In contrast, mites were recovered from only 12.2 percent of the clothing sampled.

Conclusion: It appears that automobile seats and clothing are contributing factors to mite dispersal. Automobile seats had mites at densities that could induce allergic symptoms in sensitive individuals. Clothing articles contained mites that could be carried from place to place within or between homes. Mites also were found to populate new furniture or carpet within one month.

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Type	Citation	Project	Document Sources
Abstract	Arlian LG, Neal JS, Bacon SW. Development of Dermatophagoides farinae under fluctuating relative humidity. *Journal of Allergy and Clinical Immunology* 1998;101:S157.	R825250 (2000) R825250 (Final)	*not available*
Abstract	Arlian LG, Alexander AK, Fowler BF, Morgan MS, Neal JS, Rapp CM, Vyszenski-Moher DL. Lowering humidity in homes reduces dust mites and their allergens. *Journal of Allergy and Clinical Immunology* 2000;105:S269.	R825250 (2000) R825250 (Final)	*not available*

Abstract	Arlian LG, Alexander AK, Fowler BF, Neal JS, Morgan MS, Rapp CM, Vyszenski-Moher DL. Reducing indoor humidity significantly reduces dust mites and allergen in homes. European *Journal of Allergy and Clinical Immunology* 2000;428:S63.	R825250 (2000) R825250 (Final)	*not available*
Abstract	Arlian LG, Neal JS, Alexander AK, Rapp CM, Vyszenski-Moher DL, Morgan MS. Relationship between house dust mites and their allergens on clothing and in automobiles with respect to densities in houses. *Journal of Allergy and Clinical Immunology* 2000.	R825250 (2000) R825250 (Final)	*not available*
Abstract	Juhas KM, Arlian LG, Neal JS. Effects of laundry detergents and bleach on dust mite mortality. *Journal of Allergy and Clinical Immunology* 1998;101:S28.	R825250 (2000) R825250 (Final)	*not available*
Abstract	Neal JS, Arlian LG, Vyszenski-Moher DL, Juhas KM. Population growth of dust mites exposed to fluctuating relative humidity. *Journal of Allergy and Clinical Immunology* 1998;101:S24.	R825250 (2000) R825250 (Final)	*not available*
Abstract	Neal JS, Arlian LG, Vyszenski-Moher DL. Effects of fluctuating hydrating and dehydrating relative humidity on the development of Dermatophagoides farinae. *Journal of Allergy and Clinical Immunology* 1999;103:S25.	R825250 (2000) R825250 (Final)	*not available*
Journal Article	Arlian LG, Neal JS, Bacon SW. Survival, fecundity, and development of Dermatophagoides farinae (Acari : Pyroglyphidae) at fluctuating relative humidity. *Journal of Medical Entomology* 1998;35(6):962-966.	R825250 (2000) R825250 (Final)	• Abstract from PubMed
Journal Article	Arlian LG, Neal JS, Vyszenski-Moher DL. Fluctuating hydrating and dehydrating relative humidities effects on the life cycle of Dermatophagoides farinae (Acari: Pyroglyphidae). *Journal of Medical Entomology* 1999;36(4):457-461.	R825250 (2000) R825250 (Final)	• Abstract from PubMed
Journal Article	Arlian LG, Neal JS, Vyszenski-Moher DL. Reducing relative humidity to control the house dust mite Dermatophagoides farinae. *Journal of Allergy and Clinical Immunology* 1999;104(4)852-856.	R825250 (2000) R825250 (Final)	• Abstract from PubMed • Full-text: Science Direct Full Text EXIT Disclaimer
Journal Article	Arlian LG, Neal JS, Morgan MS, Vyszenski-Moher DL, Rapp CM, Alexander AK. Reducing relative humidity is a practical way to control dust mites and their allergens in homes in temperate climates. *Journal of Allergy and Clinical Immunology* 2001;107(1):99-104.	R825250 (2000) R825250 (Final)	• Abstract from PubMed

Supplemental Keywords:

indoor air, life-cycle, relative humidity, development, fungi, mites, allergens, detergents. , Air, Scientific Discipline, Health, indoor air, Risk Assessments, Health Risk Assessment, Allergens/Asthma, climate factors, indoor air quality, inhalation, lungs, humidity, allergic rhinitis, dust mite, indoor environment, laundry, carpet cleaning, exposure, asthma, human exposure, fungi

Progress and Final Reports:

Original Abstract
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