

Occupational asthma due to poultry mites

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*The possible role of the northern fowl mite (NFM) in occupation-related respiratory disease of poultry workers was examined. The study population included 16 poultry workers with workplace-associated asthma and rhinitis, 27 atopic individuals with similar symptoms but no occupational exposure to poultry, and 12 asymptomatic nonatopic poultry-exposed controls. Ten of the 16 atopic poultry workers had immediate wheal-and-flare reactions to NFM, as compared with two of 27 non-poultry-exposed controls ($p < 0.001$). In cutaneous testing with five poultry-related antigens, the NFM was the most reactive. On skin tests, four atopic poultry workers were positive for NFM and negative for *Dermatophagoides farinae*; four workers were negative for NFM and positive for *D. farinae*. Radioallergosorbent test (RAST) showed specific IgE levels for NFM, with positive RAST scores in 60% of poultry workers having positive skin tests. A provocative bronchial test with NFM extract in a poultry worker having positive NFM skin test and RAST score resulted in an immediate 25% reduction in the FEV_1 and a 62% fall in forced expiratory flow volume at 25% of vital capacity. Collectively, the established presence of NFM in the poultry workplace, associated clinical histories, positive cutaneous tests, positive specific-IgE assays, and positive bronchial challenge combine to establish a role for NFM in occupational allergic respiratory disease of poultry farmers. (J ALLERGY CLIN IMMUNOL 73:56-60, 1984.)*

Ever since the association between *Dermatophagoides* spp. mites and house dust allergy was convincingly demonstrated,¹ numerous reports concerning house dust mites and their relationship to allergic asthma have been published.² In addition, with regard to allergic occupational respiratory illness among agricultural workers, grain storage mites were recently confirmed as the cause of work-related asthma and rhinitis in a group of farmers.³

In the poultry sector, avian species are parasitized by a great variety of mites, one of the most pathogenic being NFM, *Ornithonyssus sylviarum*.⁴ The widespread geographic distribution of NFM includes all

the temperate and north temperate regions (e.g., North America, Europe, and the British Isles) as well as a number of subtropical areas. This mite is regarded as the most prevalent and harmful external parasite of chickens in the United States.⁵ It is a vicious bloodsucker, causing extensive economic damage in the poultry industry from blood loss, skin scabbing, decreased weight gain, feather pulling, and reduced egg production.

Because of an increased interest in occupational asthma and its causes, we have studied the possible role of NFM in allergic respiratory disease of poultry workers.

METHODS

Subjects

The study population of 55 subjects included 43 males and females, all of whom had a clinical history of rhinitis and/or asthma and, except for one individual, had immediate wheal-and-flare reactions to a broad number of common inhalant allergens. Within this group of 43 atopics we studied 16 poultry workers, 14 with asthma and two with rhinitis temporally associated with their workplace environment. When outside the poultry house milieu, they experienced a marked reduction of symptoms. The 16 symptomatic poultry workers, 10 males and six females ranging in age from

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Abbreviations used

NFM:	Northern fowl mite
PAg:	Poultry-related allergens
RAST:	Radioallergosorbent test
BPT:	Bronchial provocation test
FEV ₁ :	Forced expiratory volume in 1 sec

11 to 47 years, were from seven agricultural communities; their average exposure time to the poultry workplace was 18½ yr. All worked in family owned and operated poultry farms involved in either egg or broiler production. Thirteen began their occupational exposure to chickens in the poultry workplace as children. All symptomatic poultry workers provided a complete history and underwent a thorough physical examination and skin tests. Serum samples were obtained for specific IgE radioimmunoassays.

Skin tests were also performed in a control group of 27 hypersensitive individuals with asthma and/or rhinitis who had never had occupational exposure to poultry. These 27 subjects were studied as outpatients in the Allergy Clinic of the Hadassah Medical Center, Jerusalem, Israel. All were atopic, evincing immediate wheal-and-flare skin reactions to common inhalant antigens; their ages ranged from 13 to 51 yr.

The two atopic groups, 16 poultry workers and 27 controls, were comparable with respect to age, sex, respiratory symptoms, and total serum IgE levels.

A second control group included 12 asymptomatic poultry veterinarians, whose practice brought them into almost daily contact with poultry. Their poultry workplace exposure ranged from 2 to 31 yr, average 12 yr. This group included 10 males and two females who had never experienced symptoms of asthma or allergic rhinitis and were totally asymptomatic after poultry house exposure; all 12 had normal pulmonary function studies and normal serum IgE levels.

Antigens

Northern fowl mite. Specimens of NFM were collected with a simple apparatus comprising a large (18 in. diameter) stainless steel funnel inverted over a garbage can cover on which freshly killed poultry previously identified as being infested with NFM were placed. A glass test tube was taped to the tapered end of the funnel and warmed by a 40 W light bulb. Mites leaving the cooling host body migrated upward on the inner surface of the funnel and localized in the warmed test tube. After 24 to 48 hr of collection, the tube containing the mites was capped and placed in a freezer at -20° C. Identification of mites was established morphologically by microscopic examination (Fig. 1). The frozen mites were weighed, defatted in ether, air-dried, and ground in a mortar and pestle. The mite powder was suspended in Coca's solution (1:10 w/v) and extracted on a rotary shaker for 72 hr at 20° C. After filtration through Whatman No. 1 filter paper (Whatman, Inc., Clifton, N.J.), the extract was

sterilized by successive passages through 0.45 and 0.22 µm Millipore filters (Millipore Corp., Bedford, Mass.). Bacterial sterility was determined by inoculation of thioglycollate broth and brain-heart infusion medium and examination after 48 hr of incubation at 37° C. Aliquots of the sterile extract were dispensed into small sterile vials and stored at -20° C.

Poultry-related allergens. Extracts for skin testing were made of solid poultry house materials including poultry feed, poultry litter, and chicken feathers, by using the extraction procedure described above.

Samples of chicken serum were diluted 1:10 in phosphate buffer and sterilized by Millipore membrane filtration. Skin test extract of mixed feathers (1:10 w/v dilution in 50% glycerine) was obtained from Hollister-Stier Laboratories, Spokane, Wash.

Other allergen extracts. Screening extracts (1:10 w/v in 50% glycerine), including mixed grasses, mixed trees, mixed molds, house dust, and house dust mite (*Dermatophagoides farinae*), were obtained from Hollister-Stier.

Skin tests

Skin tests were performed on the forearm of all subjects by the prick technique and graded according to the intensity of the immediate wheal-and-flare reaction.⁶ Control test solutions included 1:1000, w/v, histamine phosphate and diluent.

Radioimmunoassays

Specific IgE. Specific IgE antibody levels for NFM and other PAg were determined by the RAST. Allergen-bound discs of PAg were prepared with the CNBr coupling technique.⁷ Test results were expressed as RAST scores ranging from 0 to 4: class 0 and class 1 were considered negative; class 2 positive; class 3 strongly positive; class 4 highly positive.

Bronchial provocation tests

Provocative bronchial challenge tests with NFM extract were performed in a poultry farmer with a 3 yr history of work-related asthma who had an immediate wheal-and-flare skin reaction with NFM extract. Initial challenge strength was determined by end-point serial dilution skin testing, and BPT was performed according to standard methods.⁸ Two volunteers with no occupational poultry exposure, one having wheal-and-flare skin reactions with common inhalant antigens and a history of seasonal asthma and the other with no wheal-and-flare skin reactions or asthma symptoms, participated in the BPT as control subjects. Provocation tests were carried out with a nonglycerinated allergen extract from the same batch used in skin testing. The subjects were tested during an asymptomatic state and had not received any medications in the previous 24 hr. A control challenge was carried out with diluent.

Air sampling

Total poultry workplace dust samples were collected from poultry houses where NFM outbreaks had been re-

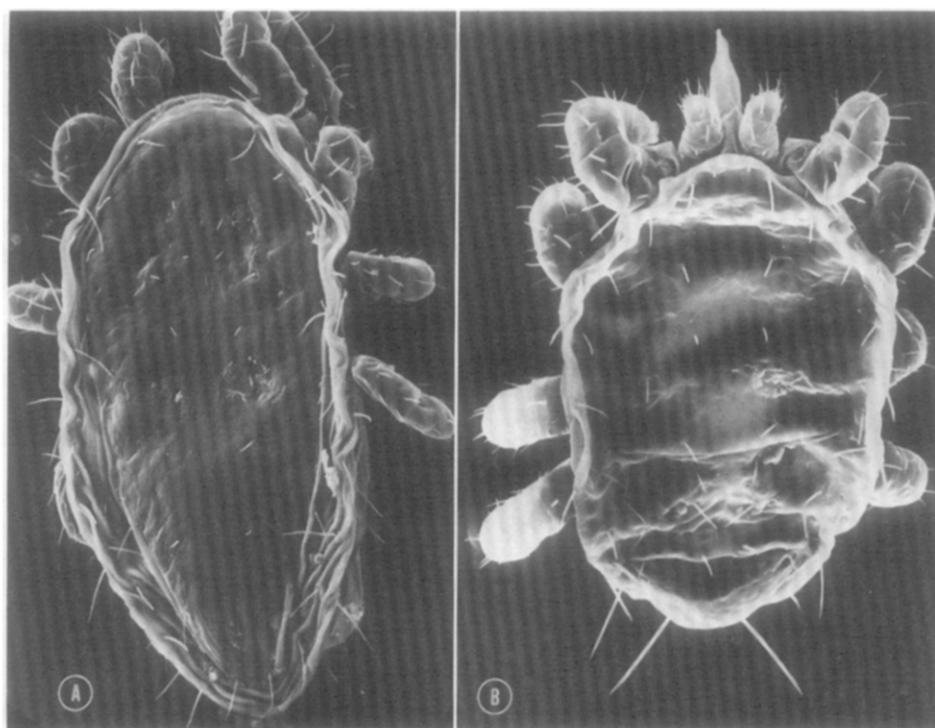


FIG. 1. Scanning electron micrographs of the NFM, dorsal views. **A**, Mature NFM. ($\times 130$.) **B**, Immature NFM. ($\times 200$.) *Ornithonyssus* mites have conspicuous mouth parts and paired chelicerae adapted for piercing the skin of the host. These features are absent in house dust mites (*Dermatophagoides* spp.), which also are generally smaller, i.e., $\frac{1}{3}$ to $\frac{1}{2}$ the body length of adult NFM.

TABLE I. Subjects with positive skin test reactions

Antigens	Atopic poultry farmers (16)	Atopic controls, no poultry exposure (27)	Nonatopic controls with poultry exposure (12)
NFM	10 ^c	2	0
Other poultry antigens ^A	11 ^c	1	0
House dust mite (<i>D. farinae</i>)	12 ^d	21 ^d	0
Common inhalants ^B	10 ^d	24 ^d	0

^AChicken feathers, litter, feed, and serum.

^BMixed grasses, mixed molds, mixed trees.

^c $p < 0.001$ vs. comparable value for atopic controls.

^d $p < 0.001$ vs. comparable value for nonatopic controls.

ported. With a stationary Casella personal sampler, samples were collected over 5 hr periods on Nuclepore membrane filters (Nuclepore Corp., Pleasanton, Calif.) in three-piece 37 mm cassettes by the open-face cassette technique. Selected samples were studied for the presence of mites or mite parts by light microscopy and scanning electron microscopy with a JEOL JSM-35 scanning electron microscope (JEOL USA, Electron Optics, Medford, Mass.).

Statistical analysis

Results were analyzed using the Fisher exact probability calculation. A probability level of 0.05 or less was considered statistically significant.

RESULTS

Skin tests

In skin tests employing five PAG, 14 of the 16 atopic poultry workers showed immediate wheal-and-flare skin reactions as compared with two of 27 atopic non-poultry-exposed controls ($p < 0.0001$).

Skin test reactions to the NFM and the common house dust mite (*D. farinae*) as well as two screening panels of common inhalants and four common PAG are shown in Table I. Among the 16 atopic workers with poultry workplace-related symptoms, 10 had immediate wheal-and-flare skin reactions to the NFM

TABLE II. Prick skin test results with NFM and *D. farinae* in 16 poultry workers

Allergen	Skin test results	No.
<i>D. farinae</i>	+	6
NFM	+	
<i>D. farinae</i>	—	4
NFM	+	
<i>D. farinae</i>	+	4
NFM	—	
<i>D. farinae</i>	—	2
NFM	—	

antigen extract. By contrast, among the 27 atopic controls not exposed to poultry, only two had reactions to NFM ($p < 0.001$). Immediate wheal-and-flare skin test reactions were elicited with one or more of the other 4 PAG in 11 of the 16 poultry workers. Two poultry workers were reactive only to NFM and not to other PAG. There were no significant differences between the two atopic groups when skin test reactivities with *D. farinae* antigen were compared.

In the 12 nonatopic poultry-exposed controls, skin reactivity was not demonstrable.

The skin test results shown in Fig. 2 depict relative reactivity of five PAG in 16 atopic poultry workers. The NFM was the most reactive antigen; feathers the least reactive. All subjects had no demonstrable immediate wheal-and-flare skin reactions to diluent, but all had such reactions to histamine.

A comparison of skin test reactions with NFM and *D. farinae* in 16 poultry workers is shown in Table II. Six workers had reactions to both mite species. Four workers skin reactive to *D. farinae* were negative to NFM; four workers reactive to NFM were negative to *D. farinae*. Two workers had no demonstrable skin reactions to either mite antigen.

The correlation of RAST findings with skin test results is shown in Table III. Nine subjects had both positive RAST and skin reactions; that is, more than 60% of the poultry workers with immediate wheal-and-flare skin reactivity to NFM had significant RAST scores. Thirteen of 14 sera from the poultry workers had demonstrable specific IgE to NFM as measured by RAST. In this same group of workers, eight of 12 sera tested had RAST reactions specific for *D. farinae*.

Environmental testing

The presence of NFM in the dust and atmosphere of buildings housing infected birds was established by examining collected workplace dust samples. Mites

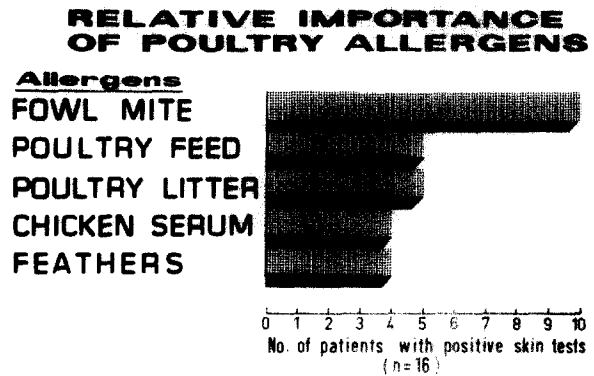


FIG. 2. Comparison of positive prick skin test results with five poultry-related allergens in 16 symptomatic poultry farmers.

TABLE III. Correlation of NFM skin test results with RAST results in 14 poultry workers

Radioimmunoassay vs. skin tests	
Skin test positive RAST positive	9
Skin test negative RAST positive	4
Skin test positive RAST negative	1

and mite parts in the dust were confirmed by light and scanning electron microscopy.

Bronchial provocation test

The test subject had an immediate wheal-and-flare skin reaction to NFM, with no reaction demonstrable by prick test to any screening antigen or PAG except for mixed feather extract. Specific IgE antibody to NFM could be detected by RAST. Bronchial challenge with a 1:100 extract of NFM resulted in an immediate 25% reduction in the FEV₁ and a 62% fall in forced expiratory flow volume at 25% of vital capacity. Control challenge with diluent was negative. The two control subjects had no changes in pulmonary function after similar challenges.

DISCUSSION

The inhalation of arthropod-laden dust can evoke rhinitis and bronchial asthma; clinically this is most commonly associated with house dust mites (*Dermatophagoides* spp.) and house dust sensitivity. The allergenic potency of arthropod dust has been demonstrated in occupational allergic respiratory disease of workers at locust breeding centers.^{9, 10} In farm workers, grain storage mites (*Tyroglyphidae*) have also been associated with allergic respiratory disease.³

NFM is widespread in its distribution and has been reported from almost every continent. Intensification in poultry husbandry practices has likely increased the concentration of NFM in the poultry workplace. NFM has not been reported as a constituent of house dust and thus has been ignored as a possible allergen. Nevertheless, the almost ubiquitous occurrence of NFM in domestic poultry flocks makes the sensitization of individuals occupationally involved in poultry husbandry a distinct possibility. Sensitization most likely occurs through inhalation of mite parts and fragments as well as the excretory products of these arthropods in the poultry house atmosphere.

In our study, antibody formation was successfully demonstrated by cutaneous testing and radioimmunoassay for specific IgE to NFM. The allergenic relevance of NFM was also demonstrated by BPT. Atopic poultry farmers and atopic subjects not exposed to poultry both exhibited positive wheal-and-flare results to the house dust mite; however, only the poultry farmers had significant demonstrable skin reactivity to NFM extract. Antigenic variation between house dust mite species has previously been demonstrated.¹¹ In our study an antigenic difference between NFM and *D. farinae* is also suggested by the skin test variability seen in the poultry workers.

The interrelationship of a history of respiratory disease associated with exposure to poultry house dust containing NFM, the demonstration of IgE antibody to the NFM by skin testing, and specific IgE assay together with a positive BPT establish this mite as a cause of allergic respiratory disease in poultry workers. It is likely that sustained exposure to the NFM may lead to workplace hypersensitivity not previously considered and that this exposure represents a *bona*

fide occupational health hazard in poultry farming communities.

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