



Contamination of passenger trains with *Dermatophagoides* (Acari: Pyroglyphidae) mite antigen in Japan

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Abstract. Passenger trains were surveyed for contamination with *Dermatophagoides farinae* Hughes and *Dermatophagoides pteronyssinus* (Trouesart) mites in Japan. A total of 492 dust samples were collected from upholstered seats in six commuter trains, one long-distance express train and three night trains in October, 1996 and January, April, and July, 1997. Mite antigen levels contained in fine dust fractions of these samples were measured by an enzyme-linked immunosorbent assay. Most samples obtained from commuter trains showed relatively high mite antigen levels of $> 10 \mu\text{g m}^{-2}$ (corresponding to > 100 mites). Express and night trains showed lower antigen levels per square meter, but higher mite antigen levels per gram of fine dust than commuter trains, indicating relatively high mite antigen densities. Seasonal comparisons indicated that commuter trains showed the highest mean antigen level per square meter in winter (January), whereas the highest antigen level per gram of fine dust was observed in summer (July) in express and night trains.

Key words: Allergen survey, *Dermatophagoides farinae*, *Dermatophagoides pteronyssinus*, mite antigen, dust mites

Introduction

The assessment of contamination with house dust mites, *Dermatophagoides farinae* and *Dermatophagoides pteronyssinus*, in the indoor environment is important for mite allergic patients to escape from allergen exposures and to recover from acute symptoms. Mite contamination in some patient homes has been successfully controlled on the basis of doctor's advice and the education of patients. However, there is almost no information on mite allergens outside homes. We have surveyed mite contamination among public facilities

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(hospitals, hotels, ryokans, movie theaters, and offices) in Japan, and revealed significant levels of contamination in some facilities. In this paper, we report the status of mite contamination in passenger trains.

Trains are the best-developed and most useful means of transportation in Japan. It appears that cars of passenger trains acquire daily supplement of scurf and humidity from a relatively large number of human bodies (Park and Tamura, 1992), providing an environment suitable for mite breeding. Although air-conditioning train cars may have lower interior humidity, the humidity does not seem to be low enough to suppress mite growth in a humid country like Japan, since the cars are efficiently ventilated with outside air whenever the door opens. Upholstered seats are the most probable mite habitat in train cars. Dust particles containing mite allergens may be released from upholstered seats, and passengers may be frequently exposed to floating mite allergens in the train cars.

The reports concerning mite contamination in passenger trains have been limited (Colloff, 1987; Custovic *et al.*, 1994). It is usually difficult to obtain permission from railroad companies to collect dust samples for surveying mite contamination in cars. We here surveyed three types of trains (commuter train, express train and night train) in Japan.

Materials and Methods

Train cars

The dust samples in passenger cars were collected in Kobe and Osaka, the middle west part of Japan; six commuter trains (designated Com-A to Com-F), one long-distance express train (designated Exp-A) and three long-distance night trains (designated Night-A to Night-C). Com-E was a subway running underground in most of the line. A total of 492 dust samples consisted of 125 samples collected in October 1996, 133 samples in January 1997, 122 samples in April 1997 and 112 samples in July 1997 (Table 1). Each commuter train was made up of 4–10 cars and each of express and night trains was made up of 10–26 cars. In most cases, three cars were randomly selected and 2–32 samples were collected from each train in each season.

Dust collection

All dust samples were collected from a 25 cm × 25 cm surface area of upholstered seats of commuter and express trains or bed clothes of night trains for 15 s using a handy-type vacuum cleaner (Matsushita Electric Industrial Co., Ltd.: National HC-V15, 38W) with a paper bag. Paper bags containing dust samples were stored at 4°C until examined.

Table 1. Number of dust samples used in this survey

Train category	Train type	Number of dust samples				Total
		1996*	1997	1997	1997	
		Oct	Jan	Apr	Jul	
Commuter	Com-A	2	9	10	10	31
	Com-B	18	12	9	10	49
	Com-C	25	14	13	6	58
	Com-D	17	12	16	16	61
	Com-E	16	19	16	16	67
	Com-F	19	33	32	30	114
Express	Exp-A	10	10	6	6	32
Night	Night-A	4	5	6	5	20
	Night-B	8	10	6	7	31
	Night-C	6	9	8	6	29
Total		125	133	122	112	492

*Survey period.

Measurement of mite antigens

Dust samples were weighed and antigen levels of these samples were measured by an enzyme-linked immunosorbent assay using a monoclonal antibody against *D. farinae* as previously described (Konishi and Uehara, 1990). Antigen levels were expressed as antigen equivalents in microgram per square meter of surface area ($\mu\text{g m}^{-2}$) and microgram per gram of fine dust ($\mu\text{g g}^{-1}$). The *D. farinae* antigen detected by this assay is cross-reactive to the equivalent antigen contained in *D. pteronyssinus* and the antigen level of $10 \mu\text{g}$ obtained with our reference antigen corresponds to approximately 100 mites of either *D. farinae* or *D. pteronyssinus*. Both live and dead mites can be equally detected in this assay. Microscopic detection of mite bodies was attempted by isolating mites from dust samples using saturated saline.

Weather record

All climatic data were obtained from meteorological stations in Kobe.

Statistical analysis

The significance of differences was evaluated by the Friedman test or the Kruskal-Wallis test for overall samples and the Mann-Whitney *U*-test for

individual pairs (Ichihara, 1990). Probability levels (p values) less than 0.05 were considered as significant.

Results

A total of 492 data in passenger trains were divided into two groups according to the structure of cars; 380 data from commuter trains and 112 data from both express and night trains.

Comparison of antigen level per square meter

Overall, higher mite contamination levels were observed in commuter trains than express and night trains (Figure 1). Individual comparison of mean mite antigen levels in each season indicated that commuter trains showed significantly higher antigen levels than express and night trains in October 1996 ($p < 0.05$ by the U-test), January 1997 ($p < 0.001$) and April 1997 ($p < 0.001$). Significant variations in mean antigen levels were observed among commuter trains ($p < 0.001$ by the Kruskal-Wallis test), but not among express and night trains ($p > 0.05$).

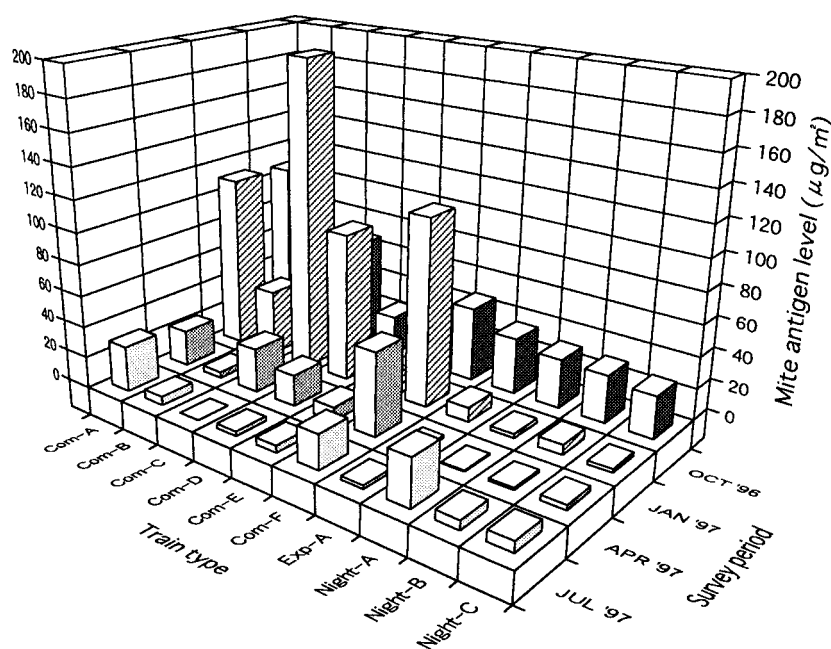


Figure 1. Area-based mite antigen levels ($\mu\text{g m}^{-2}$) in 10 passenger trains in four seasons. (Com: commuter train, Exp: express train, Night: night train).

Seasonal variation of mean antigen levels in commuter trains was significant ($p < 0.01$ by the Friedman test). Comparisons in commuter trains among seasons indicated significant differences in mean antigen level: January 1997 > October 1996 ($p < 0.001$ by the U-test); October 1996 > April 1997 ($p < 0.001$); April 1997 > July 1997 ($p < 0.01$). Individual commuter trains had their own seasonal variations, but the highest antigen level in January 1997 was consistently observed in Com-C, Com-D and Com-F. In seasonal variation among express and night trains ($p < 0.05$ by the Friedman test), the mean antigen level observed in October 1996 was higher than that observed in July 1997 ($p < 0.001$ by the U-test), which was higher than those observed in January 1997 ($p < 0.01$) and April 1997 ($p < 0.001$).

Comparison of antigen level per gram of fine dust

To estimate mite growth, antigen levels were recalculated based on the weight of dust samples (Figure 2). Express and night trains showed significantly higher mean antigen levels than commuter trains in October 1996 ($p < 0.001$ by the U-test) and July 1997 ($p < 0.001$), but significantly lower mean antigen levels than commuter trains in January 1997 ($p < 0.001$) and April 1997 ($p < 0.05$). Seasonal variations in mean antigen levels per gram were

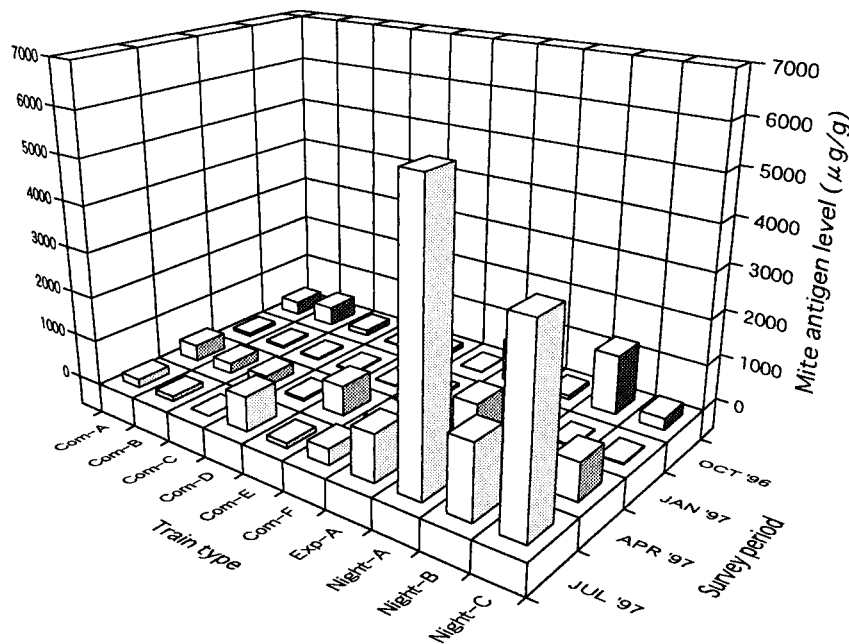


Figure 2. Weight-based mite antigen levels ($\mu\text{g g}^{-1}$) in 10 passenger trains in four seasons. (Com: commuter train, Exp: express train, Night: night train).

observed for commuter trains ($p < 0.05$ by the Friedman test) and for express and night trains ($p < 0.01$). Samples obtained from express and night trains in July 1997 showed a higher mean antigen level than all other samples obtained in different times or trains ($p < 0.001$ by the U-test).

Relation of dust weight and weather

Figure 3 showed climatic conditions in Kobe during the survey period and weights of fine dust samples (g m^{-2}) collected in commuter trains. The mean

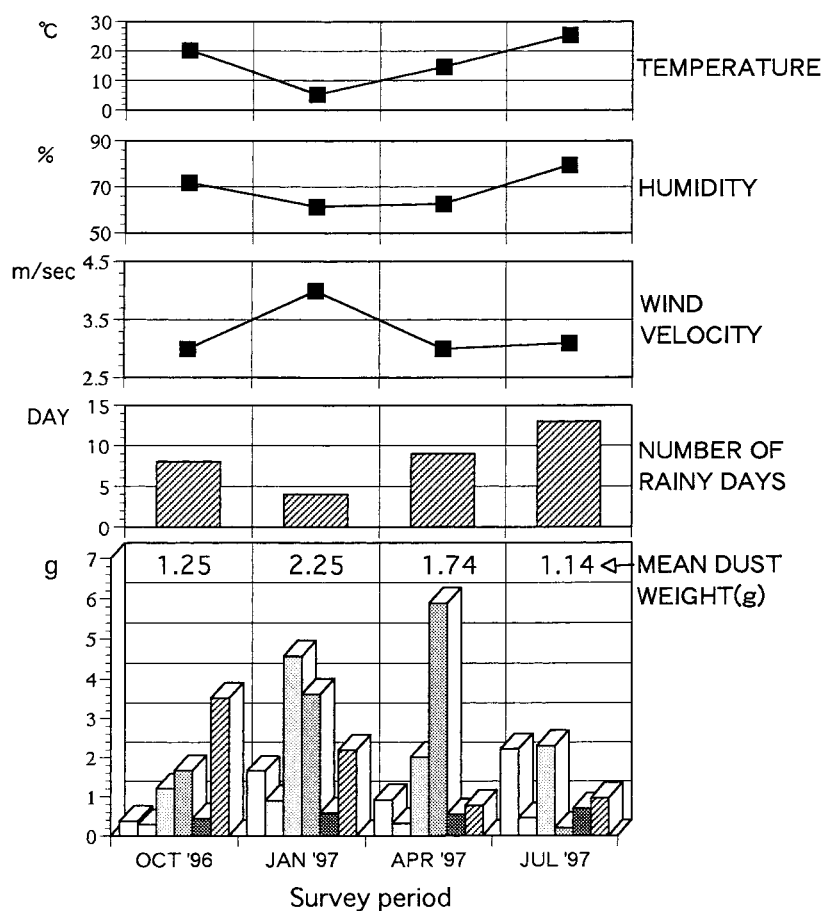


Figure 3. Climatic conditions in Kobe and dust weight data during the survey period from October 1996 through July 1997. From the top, the mean temperature, the mean relative humidity, the mean velocity of the wind, the number of rainy days with precipitation over 1 mm, and the dust weight data are shown. In the dust weight data, bars indicate the mean dust weight (g m^{-2}) obtained with each of six commuter trains (Com-A to Com-F from the left) and numerals indicate the mean dust weight obtained with all of six commuter trains.

fine dust weight in January 1997 (2.25 g) was higher than other seasons ($p < 0.05$ by the U-test). The velocity of the wind in January was strongest among all seasons ($p < 0.05$), whereas the relative humidity in January was lower than those in October ($p < 0.001$) and July ($p < 0.001$). These weather records indicated that January had more dry and windy days than other seasons, suggesting a relation to the highest mean fine dust weight observed in commuter trains in January. Com-E, a subway which is considered to be less affected by the weather than other trains, showed the lowest mean dust weight among six commuter trains in January.

Discussion

This survey revealed significant mite contamination among train cars in Japan. As determined by the present immunological method, most samples obtained from commuter trains showed relatively high mite antigen levels of $> 10 \mu\text{g m}^{-2}$ (corresponding to > 100 mites) with extremely high levels (approximately $2,000 \mu\text{g m}^{-2}$ or over $60,000 \mu\text{g g}^{-1}$ of dust) in some trains. Although the surface of upholstered seats were subjected to a routine cleaning process (for example, once a month in the Com-A), mite contamination especially in commuter trains seems to be an important public health problem for mite allergic patients.

Data expressed as mite antigen level per square meter were markedly different from those expressed per gram of dust. The surface area-based mite level is considered to be more related to the actual exposure for allergic patients than the dust weight-based mite level. Therefore, if weight-based expression is used, the actual exposure may be overestimated or underestimated for small or large amounts of the dust, respectively. On the other hand, area-based expression seems to vary according to the dust collection protocol, such as power of vacuum cleaner, time period spent for collection per square meter, etc.

Commuter trains showed different seasonable variations of mite levels from those shown by express and night trains. The difference may be due to the structure of train cars and the weather during the survey period. Cars used for express and night trains have fewer entrance/exit doors than commuter-train cars, providing a more stable indoor environment than commuter-train cars. In this sense, it is considered that express and night trains have a similar environment to homes in terms of mite growth and showed higher antigen levels in July and October as observed in homes (Konishi and Uehara, 1994). In commuter trains, the highest antigen levels per squared metre observed in January may be attributed to the highest dust weight, which could be explained by the car structure and climatic condition.

A previous survey of mite contamination among passenger trains (Colloff, 1987) indicated that individual mites and mite antigens were deposited on the seat of train cars via the clothing of passengers. However, the mite contamination observed in our present study does not seem to depend only on the deposition via the clothing of passengers, since extremely high levels of mite antigens (e.g. over 60,000 $\mu\text{g g}^{-1}$ of dust) observed in some train cars are unlikely to be achieved by transporting antigens from outside. Although attempts to observe mite bodies in dust samples collected from train cars (using a low electric power cleaner) have failed, upholstered seats are the suitable mite habitat in movie theaters, in which we previously revealed high mite antigen levels (Konishi and Uehara, 1999) and another group detected live mites (Kataoka *et al.*, 1995).

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