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Fauna and geographical distribution of house dust mites in Korea

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Abstract: During the period of 1933-1994, house dusts were collected from 65 homes at 10 different localities by operating electric vacuum cleaners. House dust mites were isolated from 10 g dust by applying the modified wet sieving method. Total 7,257 mites were collected and 23 species were identified. Among them, *Dermatophagoides farinae* (DF) was predominant (65.3% of the total), followed by *D. pteronyssinus* (DP) (20.6%) and *Tyrophagus putrescentiae* (TP) (6.5%). *Rhizoglyphus robini*, *Sancassania phyllophagianus*, *Cheyletus traussarti* and *Scheloribates latipes* were the first findings from Korea. DF was predominant in Seoul (66.8%), Kwangju (63.6%), inland of Pusan (79.6%), Inchon (96.5%), Taejon (83.9%), Chonju (87.15) and Chongju (95.2%), whereas DP was predominant in Yongkwang-ub (72.5%) and Yongdo (island) of Pusan (64.9%), and TP in Chunchon (38.2%). The localities where DP and TP were predominant showed higher relative humidity in air (> 73% RH). Among 62 study homes, DF, DP and TP were found in 24.6% of the homes, co-habitat of two species in 48.1% and one species in 27.3%. DF was predominant in 63.5% of the homes studied, DP in 29.6% and TP in 6.9%. In 10 g of the house dust, less than 99 mites were found in 49 homes (70.0%), 100-499 mites in 11 homes (15.7%), 500-999 mites in 3 homes (4.3%) and more than 1,000 mites in 2 homes (2.9%). No mite was found in 5 homes (7.1%). In order to evaluate environmental factors affecting the population density of house dust mites, house type, age of house construction, size of the house, number of the family and frequency of the cleaning were compared with the number of mites, and none of the above factors were statistically correlated with the mite density.

Key words: house dust mite, fauna, geographical distribution, Korea.

INTRODUCTION

Since it was demonstrated that house dust contained an allergen (Kern, 1921; Cooke, 1922), much attentions have been paid to house dust allergens. House dust contains a heterogenous mixture of various allergenic substrances, such as mites, insects, fungal spores or mycelium and other products of animal or vegetable origin including feathers, wool and natural fibers. The view that mites could be responsible for asthma was first stated by Ancona (1923), and the role of house dust mites in etiology of atopic allergies was confirmed by Bronswijk and Sinha (1971),

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Bronswijk (1972) and Wharton (1976).

House dust mites consist of various species of Astigmata, Cryptostigmata, Prostigmata and Mesostigmata (Acari). Bronswijk (1981) reviewed 74 taxonomic references of house dust mites which were studied in various parts of the world and listed 149 species of mites. Thereafter, much more species have been continuously added to the fauna of house dust mites in many countries. Takaoka (1988) reported that more than 100 species of mites from house dust were recognized in Japan. It is important to study the fauna of house dust mites, their population densities and geographical distributions in order to identify the specific allergens and treat allergic patients. Nevertheless, little studies have been done in Korea. The purpose of this study was to find out the mite fauna occurring in house dust and their geographical distribution in Korea.

MATERIALS AND METHODS

House dusts were collected from electric vacuum cleaners which were operated by house keepers. They mostly cleaned floors of bed rooms, sitting rooms and kitchens, carpets, sofas, and some others, but not mattress, quilts and pillows. The study locations were Seoul, Pusan, Kwangju, Taejon, Inchon, Chonju and Chongju in Chollabuk-do, Chunchon in Kangwon-do, and Yongkwang-ub in Chollanam-do.

Ten grams of the house dust in each filter bag from the vacuum cleaners were weighed, and put into 50% ethanol in a 500 ml beaker, stirred and left for 30 minutes. The suspension was sieved through 28 mesh and 200 mesh sieves, by flushing tap water for 3-5 minutes. The wet fine dust on the 200 mesh sieve was transferred in a 500 ml flask in which saturated salt water was put, and left for 30 minutes. The supernatant was centrifuged with 500 rpm for 10 minutes. The supernatant was evenly spread on filter papers and mites were picked up under a stereo-microscope. The mites collected were mounted on a slide with Hoyer's solution and identified under a high power microscope.

RESULTS

Fauna of house dust mites in Korea

Total 7,257 mites were collected from about 70 homes of 10 locations, and 23 species, 23 genera, 18 families, 4 suborders were identified, as shown in Table 1. Among them, *Dermatophagoides farinae* (DF) was predominant showing 65.3% of the total, followed by *D. pteronyssinus* (DP) occupying 20.6%. *Tyrophagus putrescentiae* (TP) was the third dominant species showing 6.5%. *Rhizoglyphus robini, Sancassania phyllophagianus, Cheyletus traussarti* and *Scheloribates latipes* were first findings in Korea. Eleven species were not able to identify the species, because they were collected in small numbers and the specimens were incomplete. Mesostigmatic mites were not identified, as they do not belong to house dust mites in strict sense.

Geographical distribution of three dominant species

Geographical distributions of the three major dominant species, DF, DP and TP are shown in Table 2. Though DF was predominant among major three species in total average number of the mites collected, either DP or TP was dominant in some locations. DF was predominant in Seoul (66.8%), Kwangju (63.6%), Inchon (96.5%), Taejon (83.9%), Chonju (87.1%) and Chongju (95.2%). At Yongkwang-ub, Chollanam-do, DP was predominant consisting of 72.5% of the total whereas DF was only 8.3%. In Chunchon, TP was the first major species (38.2%), followed by DP (21.9%), whereas DF was only 10.9%. In Pusan, the distribution pattern was different by location; DF was the main species showing 79.6% in most of the downtown area, whereas DP was predominant (64.9%) at Yongdo (island).

The pattern of the co-habitat of DF, DP and TP is shown in Table 3. Among 62 study homes, all three species were found in 24.6% of the homes, two species in 48.1% and one species in 27.3%.

The dominant species by home is given in Table 4. Among 59 homes investigated, DF

Table 1. Result of mite collections from house dusts in 1993-1994 at 10 locations in Korea

Suborder & Family	Species	No. collected	%
Astigmata:			
Pyroglyphidae	*Dermatophagoides farinae*	4,737	65.27
	Dermatophagoides pteronyssinus	1,496	20.61
	Dermatophagoides evansii	1	0.01
	Dermatophagaides sp.	1	0.01
Acaridae	*Tyrophagus putrescentiae*	471	6.49
	Acarus siro	2	0.03
	Acarus sp.	1	0.01
	Rhizoglyphus robini[a]	1	0.01
	Rhizoglyphus sp.	2	0.03
	Sancassania phyllophagianus[a]	1	0.01
	Suidasia sp.	12	0.17
	Unidentified Acaridae	13	0.18
Glycyphagidae	*Chortophagus domicola*	13	0.18
	Chortophagus arcuatus	1	0.01
	Glycyphagus domesticus	46	0.63
	Glycyphagus destructor	1	0.01
	Glycyphagus sp.	2	0.03
Saproglyphidae	*Calvolia domicola*	2	0.03
Prostigmata:			
Cheyletidae	*Cheyletus malaccensis*	11	0.15
	Cheyletus trouessarti[a]	2	0.03
	Cheyletus eruditus	2	0.03
	Unidentified Cheyletidae	3	0.04
Bdellidae	*Spinibdella* sp.	2	0.03
Cunaxidae	*Neocunaxoides whartoni*	2	0.03
Tenuipalpidae	*Brevipalpus* sp.	7	0.10
Tarsonemidae	*Tarsonemus fusarii*	1	0.01
	Daidalotarsonemus sp.	3	0.04
Cryptostigmata:			
Cosmochthoniidae	*Cosmochthonius reticulatus*	7	0.10
Haplochthoniidae	*Hptochthonius simplex*	11	0.15
Oribatulidae	*Oribatula sakamorii*	3	0.04
	Incabates sp.	1	0.01
	Scheloribates latipes[a]	2	0.03
	Zygoribatula truncata	1	0.01
	Zygoribatula sp.	2	0.03
Oribatellidae	*Oribatella* sp.	1	0.01
Nothridae	*Nothrus biciliatus*	1	0.01
Achipteriidae		1	0.01
Eremaeidae		17	0.23
Oppiidae		6	0.08
Tectocepheidae		3	0.04
Mesostigmata:		365	5.03
Total		7,257	100

[a]New recordes in Korea

Table 2. Average number (per cent) of three major species of house dust mites at 10 locations in Korea

Number/10 gm dust/home

Location	No. of homes	DF[a]	DP[a]	TP[a]	Others	Total
Seoul	9	130.8(66.8)	35.3(18.0)	2.4 (1.2)	27.4(14.0)	195.9(100)
Kwangju	7	162.0(63.6)	35.6(14.0)	42.9(16.8)	14.1 (5.5)	254.6(100)
Yongkwang	4	6.0 (8.3)	52.3(72.5)	0	13.8(19.1)	72.1(100)
Pusan (Yongdo)	7	20.9(14.9)	90.9(64.9)	2.0 (1.4)	26.3(18.8)	140.1(100)
Pusan (inland)	4	101.8(79.6)	8.3 (6.5)	9.3 (7.3)	8.5 (6.6)	127.9(100)
Chunchon	9	4.3(10.9)	8.6(21.9)	15.0(38.2)	11.4(29.0)	39.3(100)
Inchon	7	259.7(96.5)	2.3 (0.9)	0.1 (0.0)	6.9 (2.6)	269.0(100)
Taejon	7	64.3(83.9)	2.4 (3.1)	2.9 (3.8)	7.0 (9.1)	76.6(100)
Chonju	5	35.2(87.1)	4.6(11.4)	0 (0)	0.6 (1.5)	40.4(100)
Chongju	6	83.2(95.3)	0.3 (0.4)	1.8 (2.1)	2.0 (2.3)	87.3(100)
Total	65	868.2	240.6	76.4	118.0	1,303.2
Average	—	86.8	24.1	7.6	11.8	130.3
Ave.%		60.7	21.4	7.1	10.9	100

[a]DF: *Dermatophagoides farinae*; DP: *Dermatophagoides pteronyssinus*; TP: *Tyrophagus putrescentiae*

Table 3. Co-habitat of three predominant species (DF, DP and TP)[a] at 9 locations of Korea

Location	No. of homes	No. of homes		
		Three spp. co-habitat	Two spp. co-habitat	One species only
Seoul	10	5(50)[b]	2 (20)	3(30)
Kwangju	7	5(71.4)	2 (28.6)	0 (0)
Yongkwang	4	0 (0)	4(100)	0 (0)
Pusan	10	3(30)	6 (60)	1(10)
Chunchon	8	4(50)	2 (25)	2(25)
Inchon	6	0 (0)	4 (66.7)	2(33.3)
Taejon	8	0 (0)	3 (37.5)	5(62.5)
Chonju	4	0 (0)	3 (75)	1(25)
Chongju	5	1(20)	1 (20)	3(60)
Total	62	18	27	17
Ave.%		24.6	48.1	27.3

[a]DF: *Dermatophagoides farinae*; DP: *Dermatophagoides pteronyssinus*; TP: *Tyrophagus putrescentiae*
[b]Per cent in parenthesis.

was predominant in 63.5% of the homes, DP in 29.6% and TP in 6.9%. The localities where DF was predominant were Seoul, Kwangju, Pusan, Inchon, Taejon, Chonju and Chongju, whereas DP was predominant in Yongkwang-ub, Yongdo (island) in Pusan and Chunchon. The areas where DP was predominant showed higher relative humidity in the air (>73% RH in annual average).

The population density of the house dust mites is summarized in Table 5. In 10 g of the coarse house dust, more than 1,000 mites were found in 2 homes (2.9%) among 70 study homes, 500-999 mites in 3 homes (4.3%), 100-499 mites in 11 homes (15.7%), less than 99 mites in 49 homes (70.0%) and no mite in 5 homes (7.1%).

Comparison of some environmental factors and mite densities

The preliminary survey on environmental factors which may influence population

Table 4. Number (per cent) of homes in which DF, DP or TP was predominant species

Location	No. of coinhabited homes	Homes with predominat species			RH(%)[b]
		DF[a]	DP[a]	TP[a]	
Seoul	7	5 (71.4)	2(28.6)	0 (0)	65.8
Kwangju	7	4 (57.1)	2(28.6)	1(14.3)	69.3
Yongkwang	4	1 (25)	3(75)	0 (0)	77.5
Pusan(Yongdo)	7	0 (0)	6(85.7)	1(14.3)	76.9
Pusan(inland)	3	3(100)	0 (0)	0 (0)	65.8
Chunchon	8	2 (25)	5(62.5)	1(12.5)	73.0
Inchon	6	5 (83.3)	1(16.7)	0 (0)	69.5
Taejon	7	4 (57.1)	2(28.6)	1(14.3)	69.0
Taegu	1	1(100)	0 (0)	0 (0)	63.3
Chonju	4	4(100)	0 (0)	0 (0)	70.5
Chongju	5	4 (80)	0 (0)	1(20)	72.3
Total	59	33	21	4	
%		63.5	29.6	6.9	

[a]DF: *Dermatophagoides farinae*; DP: *Dermatophagoides pteronyssinus*; TP: *Tyrophagus putrescentiae*
[b]Anual average of 1992-1995.

Table 5. Number of homes with mite densities (average number of mites per 10 gm of the coarse house dust)

Location	No. of homes	No. of homes with corresponding mite densities				
		None	< 99	100-499	500-999	> 1000
Seoul	9	0	6	1	2	0
Kwangju	8	1	4	2	0	1
Yongkwang	4	0	3	1	0	0
Pusan	13	2	7	3	1	0
Chuncheon	10	1	8	1	0	0
Incheon	7	0	6	0	0	1
Taejeon	7	0	6	1	0	0
Taegu	1	0	1	0	0	0
Chonju	5	1	3	1	0	0
Chongju	6	0	5	1	0	0
Total	70	5	49	11	3	2
%		7.1	70.0	15.7	4.3	2.9

fluctuations of house dust mites were done in Seoul and Pusan. Comparison of house dust mite densities between apartments and private houses resulted that the mite densities were not significantly different between them showing 6.3 mites/10 g dust in the apartments and 5.1 mites/10 g dust in the private houses in Pusan, and 4.2 mites and 5.0 mites in apartments and private houses, respectively in Seoul, as shown in Table 6. The size of houses did not influence the mite density as shown in Table 7. The number of mites per 10 g dust per house were 6.0, 3.7, 6.8, 6.1 and 2.2 at <66 m^2, 67-99 m^2, 100-132 m^2, 133-165 m^2 and >166 m^2, respectively. Frequencies of using an electric vacuum cleaner were not correlated with the mite density, as shown in Table 8. The numbers of mites per home were 5.3, 4.1, and 4.2 in the homes where cleaning frequences were

Table 6. Comparison of house dust mite densities between apartments and private houses

Locality	Apartments		Private houses	
	No. of samples	Mean ± SD	No. of samples	Mean ± SD
Pusan	5	6.3 ± 12.5[a)]	14	5.1 ± 10.1[a)]
Seoul	24	4.2 ± 4.9[a)]	15	5.0 ± 6.6[a)]

[a)]Means with same letter within a column were not significantly different (P > 0.05).

Table 7. Comparison of house dust mite densities among different sizes of the houses

Size	No. of samples	Mean ± SD
≤ 66 m^2 (20 pyong)	4	6.0 ± 11.3[a)]
67-99 m^2 (21-30 pyong)	5	3.7 ± 3.8[a)]
100-132 m^2 (31-40 pyong)	12	6.8 ± 7.7[a)]
133-165 m^2 (41-50 pyong)	7	6.1 ± 5.0[a)]
≥ 166 m^2 (51 pyong)	13	2.2 ± 3.2[a)]

[a)]Means with same letter were not significantly different (P > 0.05).

Table 8. Correlation between house dust mite densities and cleaning frequencies of the houses

Cleaning frequence/week	No. of samples	Mean ± SD
≤ 2 times	17	5.3 ± 6.4[a)]
3 times	11	4.1 ± 5.5[a)]
≥ 4 times	12	4.2 ± 6.8[a)]

[a)]Means with same letter were not significantly different (P > 0.05).

Table 9. Comparison of house dust mite densities among different family sizes

No. of family members	No. of samples	Mean ± SD
2	4	3.5 ± 5.1[a)]
3	4	3.8 ± 3.1[a)]
4	19	4.7 ± 6.2[a)]
5	13	4.5 ± 6.4[a)]
6	4	6.0 ± 9.5[a)]

[a)]Means with same letter were not significantly different (P > 0.05).

<twice/week, 3 times/week and >4 times/week, respectively. The family size (number of family members) was not correlated with the mite density either, as shown in Table 9. The average number of mites per home was 3.5, 3.8, 4.7, 4.5 and 6.0 in the homes where family members were 2, 3, 4, 5 and 6, respectively. The age of the house building also showed no correlation to the mite density, showing 4.3, 0.9, 6.4 and 6.6 mites in the house age of <5 years, 6-10 years, 11-15 years and >16 years after construction, respectively, as shown in Table 10.

Table 10. Comparison of house dust mite densities among different ages of house construction

Construction age (years)	No. of samples	Mean ± SD
≤ 5	9	4.3 ± 5.0[a)]
6-10	10	0.9 ± 1.3[a)]
11-15	16	6.4 ± 7.3[a)]
≥ 16	5	6.6 ± 9.3[a)]

[a)]Means with same letter were not significantly different (P > 0.05)

DISCUSSION

It is known that most abundant mites in house dust are *Dermatophagoides farinae*, *D. pteronyssinus* and *Euroglyphus meynei*, which are responsible for the production of house dust allergen, a common cause of asthma and

allergic rhinitis, and the predominant species is diffferent by country and by location. DP was most abundant in the Netherland (Bronswijk, 1973), in northwestern Switzerland (Mumcuoglu, 1976), in England (Hewitt *et al.*, 1973), and in Malaysia (Ho and Nadchatram, 1985). In the United States, DF was predominant in Cincinnati, Ohio, Memphis, Greenville, and Delray Beach, whereas DP was predominant in New Orleans, Galveston, and San Diego (Arlian *et al.*, 1992). Munir *et al.* (1995) investigated the levels of mite allergen in house dust and found that DF allergen was higher in Central part and DP allergen was higher in Southern part of Sweden. In Japan, DF was predominant in Nagoya (Oshima, 1970; Suto *et al.*, 1991) and in Tokyo (Ishii *et al.*, 1979), whereas DP was predominant in Osaka, Sendai, Sapporo, Fukuoka, Tokushima and Hiroshima (Oshima, 1970).

In Korea, the study on house dust mites was for the first time carried out by Chu *et al.* (1967). They collected dust from houses, stores and schools in Seoul and identified five species: *Tyrophagus dimidiatus, Chibidania tokyoensis, Rhizoglyphus echinophus, Ornithonyssus nagayoi* and *Dermanyssus gallinae*. Kang and Chu (1975) collected 257 mites from 274 house dust samples in Seoul and reported five species, *Tyrophagus dimidiatus, Acarus siro, Glycyphagus domesticus, G. destructor* and *Carpoglyphus lactis*. Oddly enough, *Dermatophagoides* spp., the main house dust mites were not collected by the above authors. DF and DP were for the first time collected from house dust in Korea by Cho and Houh (1977). Cho (1980) collected 12,019 mites from 177 house dust samples in Seoul and Chonju city, and reported that among 18 species identified, 85.7% of the total mites was DP and only 3.5% was DF. Lee and Cho (1984) reported that 19 species were found from 211 house dust samples in 10 locations, and DP was predominant (23.6%), whereas DF was more widely distributed. Goo and Cho (1989) collected 157 house dust mites of 9 species from 50 clinical laboratories of hospitals in Seoul, of which three major species were TP (31.2%), *Tarsonemus fusarii* (30.6%) and *Androlaelaps casalis* (19.7%). Paik *et al.* (1992) reported that among 9,638 house dust mites collected from 7 houses in Seoul, 55.5% and 7.9% were DF and DP respectively. In the present study, DF and DP co-existed in most of the homes studied, showing that DF was predominant, being found in 55.9% of the homes and DP in 35.6% of the homes. Also predominant species was different by location; DF was predominant in Seoul, Kwangju, inland of Pusan, Inchon, Taejon, Chonju and Chongju, whereas DP was predominant in Yongkwang, Yongdo (island) of Pusan and Chunchon. This result evidently suggests that DP predominantly occurs in areas where the relative humidity in air is high (>73% RH) and DF is dominant in areas where the atmosphere is relatively dry.

It is important to study ecological and/or environmental factors influencing house dust mite densities for understanding their population dynamics. Takaoka and Fujimoto (1985) reported that pyroglyphid mites were relatively scarce in newly built houses (<3 years of age), and gradually increased in number with the age of the house. Suto *et al.* (1992a) conducted mite surveys in wooden Japanese-style houses in Nagoya and found that DF had a tendency to increase with the room ratio (the number of rooms in a house to the family size), whereas DP was not much affected by housing conditions. Suto *et al.* (1992b) conducted mite surveys in a 10th floors apartment building in Nagoya and found that number of DP was higher at upper floors (>4th floor) while number of DF did not vary by floor. They suggested that household activities and the distance from the ground level were limiting factors for the prevalence of house dust mites in apartments. Hashimoto *et al.* (1993) found that the largest numbers of mites were observed at 60-70% RH in DF and 80-90% RH in DP rising temperature promoted an increase of mites in number. In the present study, there was no correlation between the number of house dust mites and several environmental factors such as type of houses (apartment vs private house), age of houses, size of houses, family size and frequencies of house cleaning, which would be resulted from too small sample sizes and/or limited sample class, or such superficial factors may not

significantly affect population dynamics of house dust mites in Korea. Further studies are required, in particular, focused on ecological and/or micro-climatic factors of indoors in connection with human activities.

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=초록=

한국내 집먼지진드기의 지역분포상

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1993-1994년에 걸쳐 전국 10개 지역내 주택에서 수거한 집먼지내의 진드기류를 조사하였다. 집먼지는 평소 가정주부가 사용하는 전기진공청소기내 휠터에 모아진 집먼지 중 10 g을 채취하여 wet sieving method를 일부 보완하여 진드기류를 분리하였다. 채집된 총 7,257개체의 진드기를 동정한 결과 4아목, 18과, 23속, 23종을 확인하였는데, 그 중 *Rhyzoglyphus robini*, *Sancassania phyllophagianus*, *Cheyletus trouessarti* 및 *Scheloribates latipes*의 4종은 국내 미기록 종이었다. 전국적으로 가장 널리 분포되어 있고 서식밀도가 높은 종은 *Dermatophagoides farinae*(DF)로 전체의 65.3%였고 *D. pteronyssinus*(DP)가 20.6%, *Tyrophagus putrescentiae*(TP)가 6.5%를 차지하였는데, 이들 3종이 함께 서식하는 가정은 62개 조사대상 중 24.6%였고, 2개종이 공존하는 가정은 48.1%, 한종만 서식하는 가정은 27.3%였다. DF가 우점종인 가정은 59개 조사 가정 중 63.5%, DP가 우점종인 가정은 29.6%였고 TP가 우점종인 가정은 6.9%였다. 지역적으로는 서울, 광주, 인천, 전주, 청주 등지에서는 DF가 우세하였으나 영광, 춘천, 부산 영도 등 대기습도가 비교적 높은(〉 73% RH) 지역에서는 DP가 우세한 것으로 나타났다. 집먼지진드기의 서식밀도를 보면 집먼지 10 g 중 1,000개체 이상인 가정이 2.9%, 500-999개체의 가정이 4.3%, 100-499개체의 가정이 15.7%였고 99개체 이하의 밀도를 보인 가정이 70.0%를 차지하였으며 전혀 채집되지 않은 가정은 7.1%였다. 아파트와 단독주택, 건물면적, 청소횟수, 가족수, 건축년수 등과 집먼지진드기 서식밀도간에는 상관관계를 보이지 않았다.

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