

Review**Seasonal dynamics and distribution of house dust mites in China**

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Summary

House dust mites are widely distributed in the human habitat and work environment and produce very powerful allergens. The most important allergy-causing mites found in homes worldwide are the house dust mites *Dermatophagoides farinae* and *D. pteronyssinus* and the storage mite *Blomia tropicalis*. It is important to know which mite species are present in a geographical area when performing diagnostic testing and prescribing immunotherapy. We classified the breeding situations of house dust mites in dwellings in northern China. Mites are detectable in March and their number increases from April or May, reaching a peak from July to September. The seasonal distribution of different acaroid mite species may differ: temperature, humidity, and eating habits were the major limiting factors determining species composition and diversity of acaroid mite communities in house ecosystems; comparing to the field and the forest, in human living area including house and working place, acaroid mites showed less bio-diversity.

Keywords: House dust mites, allergens, seasonal dynamics, distribution

1. Introduction

Since 1964 house dust mites have been known to be the most common allergen causing asthma and other allergic diseases, thanks to the work of Reindert Voorhorst *et al.* (1), which drew attention in the international medical and immunological community to acaroid mite allergies.

House dust mites (also called domestic mites) are widely distributed in human habitats and work environments. As very powerful allergens, house dust mites can induce mite asthma, allergic rhinitis, atopic dermatitis, chronic urticaria, and other harmful effects on human health, especially in children (2).

One hundred and seventy-five asthmatic and 100 healthy children in Kunming were tested with the internationally recognized method of the skin prick test by Chen Yanhua. About 82.9% of asthmatic children were found to be sensitive to the house dust mite

(compared to 48.6% found sensitive to silk and 45.7% to sea shrimp). The rates of sensitivity were higher in asthmatic children than in the controls (3). Yi *et al.* investigated the pathogenesis of children with asthma in the Shanghai district from 2002 to 2006. Dust mites accounted for the highest incidence of positive skin prick tests: 77.67% of asthmatic children were sensitive to *Dermatophagoides pteronyssinus* and 77.0% to *Dermatophagoides farinae* (4). Sensitization to house-dust mites is a major independent risk factor for asthma in all areas where the climate is conducive to mite population growth. It appears that the mite allergens present in homes "overshadow" other allergens as a risk factor for sensitization and subsequent development of allergic diseases (5). The most important allergy-causing mites found in homes worldwide are the house dust mites *D. farinae*, *D. pteronyssinus*, *Euroglyphus maynei*, and the storage mite *Blomia tropicalis*. Therefore, it is important to know which mite species are present in a geographical area when performing diagnostic testing and prescribing immunotherapy (6).

There are seven zoogeographic regions in China: Northeast China, North China, the Meng-Xin region, Qingzang province, Southwest China, Central China, and South China. The first four regions belong to the

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Palearctic realm, and the last three regions belong to the Oriental realm (7). Reports about house dust mites in China are still insufficient and are focused on the North China, Central China, and South China regions. Huainan is on the border of the North China and Central China regions, Fujian is on the border of the Central China and South China regions. We therefore classified the breeding environments of house dust mites in dwellings according to whether they were in North China, Huainan, Central China, Fujian, or South China (Table 1, Figure 1).

2. North China region

Yuan and Zhu investigated the prevalence of mites in different kinds of houses in Beijing City in 2003. The results showed that acaroid mites were found in 71.4% of surveyed houses in summer and in 66.7% in winter. Acaroid mites were found in 87.5% of multistory buildings and in 100% of bungalows in at least one season (8).

Zhao investigated the prevalence of house dust mites by different methods in Beijing City in 2004. By the screened smear method, mites were detectable in 38.6% of dust samples (33.3% from houses and 44.4% from beds). By the direct smear method, mites were detectable in 28.1% of dust samples (20.0% from houses and 37.0% from beds). In both winter and summer, the rates of detection were lower in houses than in beds. The overall detection rate for samples taken in both seasons was 29.7% (9). The results between two

methods differed significantly.

House dust mites from pillows and mattresses in Zhangjiakou Medical College dormitory bedrooms was studied by Gui *et al.* in 1992. House dust mites were found in 11.0% of samples, significantly lower than the figure reported from other cities and provinces; the reason may be the cold weather and dry climate, which is unfavorable to the growth of house dust mites (10).

Ji *et al.* investigated the mites in private houses and hotels in Jining City in 2004. The result showed that *Tyrophagus putrescentiae*, *Acarus siro*, *D. farinae*, *D. pteronyssinus*, and *E. maynei* were detected in floor dust. The predominant species were *D. farinae* and *D. pteronyssinus*. Mites were present in detectable numbers in March, their numbers increased from April, reached maxima during September and October, and became undetectable from November to March. However, mites can be detected in carpets even in the winter season (11).

Han and Zhao investigated the prevalence of mites in private houses, hotels, stored foodstuffs, and medical supply warehouses in Qingdao City in 2005. The result showed that *A. siro*, *D. pteronyssinus*, *D. farinae*, and *T. putrescentiae* were widely distributed in floor dust. Mites were present in detectable numbers in March, their numbers increased from April, reached a peak during August and September, and could not be detected from December to March (12).

Shen and Li investigated the acaroid mite population in houses in the Huaibei area from April to May in 2006. Samples were collected from the houses, undergraduate dormitories, and hotels, where acaroid mites were detectable in 85.0%, 72.5%, and 75.0% of samples, respectively. Fifteen kinds of acaroid mites were detected from the collected samples, belonging to 5 families and 11 genera. The predominant species were *D. pteronyssinus* and *D. farinae*. Their data showed that acaroid mites are most common not only in terms of the "species richness index" (the number of different species in a given area) but also in terms of a species diversity index (a measure of the relative

Table 1. Differences in distribution of house dust mites in five regions of China

Region	District	Year	House dust mite detection rate (%)		
			Average	Floor	Mattress
North China	Beijing	2003	41.1	/	/
	Beijing	2004	29.7	24.2	38.9
	Zhangjiakou	1992	11.0	/	/
	Jining	2004	75.7	/	/
	Qingdao	2005	70.9	/	/
	Huaibei	2006	77.5	/	/
Huainan	Huainan	1995	60.0	/	/
	Huainan	2002	56.5	47.8	63.7
	Huainan	2004	44.9	52.0	69.0
Central China	Anhui	2005	26.6	/	/
	Hefei	2007	74.4	/	/
	Chuzhou	2006	40.8	64.5	53.0
	Shanghai	1988	66.7	/	/
	Wuhan	1999	78.0	67.7	89.2
	Zhangjiagang	2005	52.3	/	/
Fujian	Hengyang	2006	60.1	40.0	80.5
	Fujian	2008	38.0	/	/
South China	Guangzhou	1988	83.8	69.3	90.6
	Guangzhou	2006	98.8	/	100.0
	Nanning	1996	67.6	/	/
	Beihai	1996	50.0	/	/
	Guilin	1996	77.8	/	/
	Haikou	2005	43.8	24.8	52.4

"/" means data were not showed in articles.

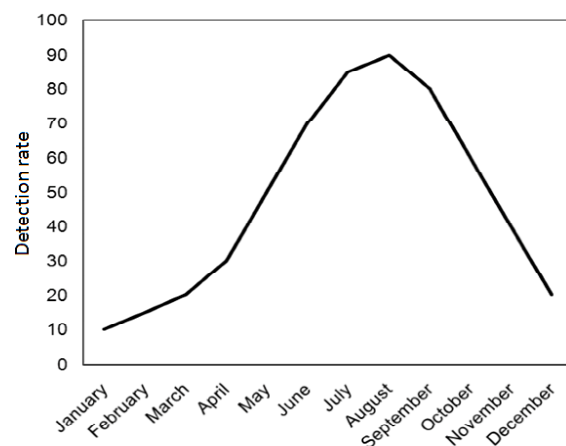


Figure 1. Seasonal dynamic pattern of house dust mites.

abundance of each species): in this case, the species evenness index (a measure of the closeness of the proportions among the numbers of individuals of each species present) in acaroid mite communities was the highest in undergraduate dormitories, while the species dominance index (the disproportion among the numbers of individuals of different species) was highest in hotels (13).

3. Huainan regions

Zhang *et al.* investigated the mites in the Huainan region from December 1995 to November 1996 to find out the seasonal distribution and habitat of *D. farinae*. They found that *D. farinae* was widely distributed, with its highest densities in flour collected from the floor, in domestic animal feed, and in some traditional Chinese medicinal herbs. The number of the mites increased from May, reached maxima during July and August, and started to decrease in October, maintaining a high level for five of the twelve months of the study (14).

Cui *et al.* collected dust samples from beds, clothes, and houses every month on the same campus in Huainan City from March 2002 to February 2003; the samples were examined microscopically to identify mites. Mites were detectable in dust samples collected from 63.7% of beds, 41.7% of clothes, and 47.8% of houses; the overall detection rate was 56.5%. Identified by microscopy, the mites separated from dust samples belonged to 15 species, 13 of which belonged to Acaridida mites. Mites were detected every month, at rates ranging from 19.7% to 91.6%, with the highest detection rates from June to August. Most mite species in the Huainan region belonged to Acaridida, whose reproductive peaks seemed to be from June to August (15).

Li *et al.* collected dust samples from storage places, human dwellings, and working places in Huainan City from May to July 2003. From these three environments, 26 species of acaroid mites were identified, belonging to 19 genera and 7 families. The composition and diversity of acaroid mite communities in the three different environments showed significant differences, presumably attributable to temperature, humidity, and human interference (16).

Li *et al.* then investigated the composition and diversity of acaroid mite communities in the house ecosystem of the Huainan area from May to September in 2004. The results showed that the overall rate of acaroid mite detection was 44.9%, varying in different breeding places: mites were detected in 69.0% of samples of bed dust, 52.0% of floor dust, 32.5% of clothing dust, and 26.0% of furniture dust. In total, 14 species were detected, belonging to 11 genera and 5 families. Temperature, humidity, and eating habits were the major limiting factors determining the species composition and diversity of acaroid mite communities in house ecosystems. Comparing to the field and

the forest, in human living area including house and working place, acaroid mites showed less bio-diversity and the *D. farinae* and *D. pteronyssinus* were the overwhelming majority mites (17).

From May to August in 2005, Tao and Li studied the community structure and diversity of acaroid mites from four different habitats in southern Anhui Province. The acaroid mites found belonged to 7 families, 20 genera, and 32 species. The rates of detection of mites in dust samples were in this order: warehouses (51.9%) > human habitats (26.6%) > work environments (12.7%) > external environments (8.8%). *D. pteronyssinus*, *D. farinae*, and *T. putrescentiae* are the predominant species in human habitats and work environments. Diversity analysis showed that the species number, species richness index, and species diversity index of acaroid mites in these habitats were in the order: warehouses > external environments > human habitats > work environments. The species evenness index of acaroid mite communities was highest in the external environment, while the highest species dominance index was observed in work environments. Acaroid mite communities in work environments differed the most from those in external environments. The results suggested that habitat conditions directly influence the community structure and diversity of acaroid mites, and comparing to the field and the forest, in human living area including house and working place, acaroid mites showed less bio-diversity (18).

Wang *et al.* investigated the breeding densities and the seasonal distribution of four common storage acaroid mites in Bengbu City from February 2006 to January 2007. *T. putrescentiae*, *A. siro*, *Lepidoglyphus destructor*, and *D. farinae* had high breeding densities in ham, wheat, seed, and house dust. The number of mites increased from April or May, peaked during July and August, and declined from September or October. The seasonal distribution of the individual acaroid mites might differ (19).

Wang *et al.* also explored the breeding density and diversity of acaroid mites in storage foodstuffs, Drug storage and houses in Hefei City. Twenty-six species of acaroid mites were identified, belonging to 17 genera and 6 families. Acaroid mites can be detected in 74.4% of three different habitats. The detection rates of mites in dust samples collected from storage foodstuffs, Drug storage and articles of daily use, such as clothing and furniture were 84.7%, 74.7%, and 64.1%, respectively (20).

From June to July in 2006, Lv *et al.* investigated the composition and diversity of acaroid mite communities in house ecosystems in the Chuzhou area. The results showed that the overall acaroid mite detection rate was 40.8%, but this varied according to the particular location from 64.5% in beds to 53.0% on floors, 34.0% in clothing, and 24.5% in furniture dust. The 14 species detected belonged to 11 genera and 5 families (21).

4. Central China regions

From September 1984 to August 1985, a faunal survey of the house dust mites was carried out in Shanghai by Cai and Wen. Every four weeks, dust samples were collected by vacuum cleaner from pillows, sofas, mattresses, woolen jackets, and room floors around the beds in 15 occupied houses and 2 inns. The specimens were identified as 21 species belonging to 4 suborders, 9 families, and 16 genera. *D. pteronyssinus* was the predominant species (49.2%); *Hirstia domicola* (15.0%) was second, followed by *Glycyphagus privatus* (10.2%), *D. farinae* (8.0%), and *E. maynei* (5.5%). Mites appeared in the dust samples throughout the year; the greatest number of species (17 species) was found in August and the least (7 species) in January and December. The mite population reached a peak in summer with as many as 103 mites/m² and a trough in January and February (22).

Zhong *et al.* investigated the breeding situations of acaroid mites in Wuhan City for five years. The overall detection rate of house dust mites was 78.0%. House dust mites were widely distributed in Wuhan City throughout the year, with a distinctive seasonal distribution. The overall mite detection rates during the 5-year study period were 67.4% from April to July, 22.4% from August to October, and 10.2% from November to March. The average mite detection rate in dust samples collected from beds was 89.2% and from furniture and floors was 67.7% (23).

Zhu and Zhuge investigated the breeding situations of acaroid mites in selected dwellings in Zhangjiagang City from April to July in 2005. The detection rate of acaroid mites in samples was 52.3%. The acaroid mites belonged to 15 species and 7 families. The highest breeding rate and relative abundance were 46.3% and 54.3% respectively; detected species belonged most frequently to the Pyroglyphidae family, followed by Acaridae (34.5%; 23.9%) and Glycyphagidae (19.3%; 18.1%). The predominant species in human habitats were *D. pteronyssinus* and *D. farinae* (24).

From October to November in 2006, Jiang *et al.* investigated the breeding situation of house dust mites in dust samples from beds, articles of daily use, floors, and toys in Hengyang City. The overall detection rate was 60.1%, and the mite detection rates in dust samples collected from college dormitories, kindergartens, and houses were 76.0%, 57.7%, and 44.4%, respectively (25).

5. Fujian region

House dust mites are important factors in allergic asthma and other diseases and often occur on a large scale in warm areas. However, the information available about them in Fujian, a subtropical province of China, has been rather scant.

Wu *et al.* sought to measure the presence of mites in houses in Fujian. Mites were detected in 38.0% of samples and identified as belonging to 55 species, 30 families, and 4 orders. The most frequently detected mite was *B. tropicalis* (found in 48.9% of all samples), followed by *Cosmochthonius reticulatus* Grandjean (16.7%). Next to them was *Tyrophagus* sp., *Haplochthonius* sp., and *D. farinae*. *Cheyletus malaccensis* was the dominant predaceous mite. Large numbers of house dust mites were found in Fujian, the dominant mite being *D. farinae*, whose density often surpassed the allergic sensitivity threshold (26). The findings differed from data from Shanghai and other areas in China where the dominant mite is *Dermatophagoides pteronyssinus*.

6. South China region

Lai *et al.* did a study on the breeding environment of house dust mites in Guangzhou City in 1988. The overall detection rate of house dust mites in all samples was 83.8%; mites were detected in 90.6% of dust samples collected from beds and in 69.3% of dust samples collected from other locations in houses. There was no statistical difference between the breeding densities of house dust mites found in different locations. House dust mites were widely distributed in Guangzhou City throughout the year; the seasonal distribution was distinctive: levels remained high from May to June and from September to November in the 12-month period studied. Sixteen kinds of acaroid mites were detected from the samples; *D. pteronyssinus*, *D. farinae*, and *B. freemani* were dominant (27).

Chen *et al.* surveyed the house-dust mite fauna in school dormitories in Guangzhou City from October to December in 2006. House dust mites were universally present in bed-dust of school dormitories in Guangzhou City. *D. pteronyssinus*, *D. farinae*, gamasid mites, scab mites, and Pyemotidae species were among the species found most frequently in the samples. In multistory dwellings, the mean number of mites found was highest on the lowest floors and lowest on the highest floors. The prevalence of mites in samples was 98.8% (28): higher than the findings of Lai *et al.* in 1988. However, as in Lai's study, *D. pteronyssinus* and *D. farinae* are the dominant mite species, and *D. pteronyssinus* was more common than *D. farinae*.

Li *et al.* randomly selected 90 dust samples from 394 dust samples collected from four different types of housing: dormitory, private house, hotel, and hospital in three different cities of Guangxi, China: Nanning, Beihai, and Guilin. The prevalence of mites in these samples was 65.6%. The mean number of mites per gram of dust was the highest in Guilin: about 2.5 times the number found in Nanning and about 7 times the number found in Beihai. Four orders and 5 families

of mites were found in the survey. Most of the mites collected in Nanning and Guilin belonged to the family Acaridae (Order Astigmata), whereas in Beihai, most of them belonged to the family Tarsonemidae (Order Prostigmata). The pyroglyphids found in the survey belonged to the genus *Dermatophagoides*. *D. pteronyssinus* was found in 3 cities; *D. farinae* was found only in Guilin City. Guangxi Province is in the southern part of China, and the sub-tropical climate is favorable to the growth of house dust mites. It is known that the threshold level for atopic symptoms is 100 mites per gram. The number of these genera was less than 100 mites per gram in private houses, dormitories, and hotels, but higher in hospitals (29).

From March to May in 2005, Rao *et al.* studied the breeding environments of dust mites in college dormitories in Haikou City. The overall detection rate was 43.8%, and the mite detection rates in dust samples collected from beds, pillows, tabletops, floors, and transoms were 52.4%, 54.6%, 18.4%, 24.8%, and 14.8%, respectively. The mite detection rates in dust samples from college dormitories for male and female students were 44.8% and 42.6%, respectively. In samples taken from the first floor to sixth floor, the detection rates decreased from 51.2% to 48.0%, 43.6%, 41.2%, 36.6%, and 33.9%, respectively; breeding rates appeared also to be higher, the lower the floor. Fifteen species of mites were identified, 12 of which belonged to Astigmata. *B. tropicalis* appears to be preponderant in this area (71.6% of all samples); *D. pteronyssinus* was found in only 15.7% and *D. farinae* in only 0.6% (30).

7. Conclusions

The density of house dust mites is affected by temperature, humidity, and human interference. Temperature and humidity in the immediate environment of domestic mites has a decisive impact on their prevalence.

Our study showed that domestic mites were widely distributed in the warm and humid Huainan, Central China, Fujian, and South China regions, but less densely distributed in cold and dry areas such Zhangjiakou City in North China.

Mites are found in detectable numbers in March, and their number increases from April or May, reaching a peak during July and August and decreasing in October, a trend clearly affected by temperature and relative humidity.

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