Abundance and spatial distribution of house-dust mites in their natural environment (Acari: Sarcoptiformes & Trombidiformes)

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Concentration and spatial distribution of house-dust mites *(Dermatophagoides* spp.) on the surface of plain mattresses have been investigated. The concentration of mites in different regions of the mattresses did not show any general tendency. The spatial distribution of the adult individuals of *D. pteronyssinus* and *D. farinae* differed significantly on the only mattress where both species coexisted. *D. farinae* showed the highest frequency in the edge region at the wall side of the mattress, while *D. pteronyssinus* showed the highest frequency towards the room side of the mattress.

The density of mites, both living and dead, showed a significant positive correlation with the quantity of mattress dust. When humidity is sufficiently high the quantity of dust is the most important factor for growth of mites.

A cheap and easy avoidance program for elimination of house-dust with its content of mites must therefore be recommended to protect allergic patients.

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Introduction

House-dust mites, *Dermatophagoides* spp., are sources of one of the most potent allergens present in house-dust. This allergen is mainly responsible for house-dust allergy and asthma in persons sensitive to house-dust (Voorhost et al., 1964; Voorhost et al., 1967; Spieksma & Spieksma-Boezeman, 1967; Tovey et al., 1981).

The greatest concentrations of house-dust mites are found in dust from the bed environment: mattresses, eiderdowns, pillows, etc. (Maunsell et al., 1968; Sesay & Dobson, 1972; Wraith & Connington, 1975). Investigations of the distribution of *Dermatophagoides* spp. on mattress surfaces have shown that the mites are located especially around and beneath buttons, hems and welt cordings (Blythe, 1976; Mumcuoglu, 1976; Lang & Mulla, 1977 and Lang & Mulla, 1978) found the greatest number of mites in the head region.

Mite-sensitive persons are often recommended to take antidust measures to reduce exposure to the house-dust mite allergen. Avoidance measures could be replacing the mattress with one of foam rubber (Mumcuoglu, 1976; Abbott et al., 1981), vacuuming the bed and bedroom carpet or replacing the carpet with smooth floor coverings (Sarfield et al., 1974). However, the effect of such procedures has been doubted (Burr et al., 1980; Korsgaard, 1982).

The aim of this investigation was to analyse the distribution of species, numbers and stages of *Dermatophagoides* spp. on the surface of mattresses (without welt cordings or buttons, especially foam rubber mattresses). The knowledge of the distribution of mites will improve the understanding of their ecology and create a basis for more effective control.

Materials and methods

Five beds (I, II, III, IV and V) from different houses in Copenhagen, Denmark, were examined for house-dust mites once during the period of 13. August – 5. october 1982. The population of house-dust mites in Western Europe has a maximum in this period

(Spieksma-Boezeman, 1967; Korsgaard, 1983). A pilot study showed that the beds contained house-dust mites.

Before the collections were made the relative humidity and temperature in the bedroom were measured with a psychrometer (Table 1). Each mattress was sectioned with masking tape (1.5 cm wide) into 4 x 7 = 28 areas. The size of each sampling area varied from bed to bed depending on the size of the person using the bed. A vacuum cleaner (Vorwerk Kobold; mod. VK 116, Type 1H) with a removable nozzle in which a filter (Cilia teafilter) could be placed was used for the collections. Each sampling area was vacuumed for one minute and the filter was placed in a numbered plastic jar. Table 2 shows the age, sex and height of the test person, the type of mattress (material), whether the mattress was covered with blankets, sheets etc., the total sampling area and the total amounts of dust collected.

Less than 5 hours after collection the dust from the filters was weighed and transferred to dram glasses with a few ml of lactic acid (90%) with lignin pink (Haarløv & Alani, 1970; Sesay & Dobson, 1972). The samples were incubated at 45-55°C for two days. Samples from beds I to IV were diluted with 70% ethanol to 10 ml. Each sample was then shaken for one minute (Whirlimixer) and 2 ml transferred from the suspension to

Date of collection *Indsamlingsdato*	August 13	August 25	September 10	September 23	October 5
Bedroom no. *Soveværelsets nr.*	I	II	III	IV	V
Air temperature *Lufttemperatur*	21.8 °C	20.5 °C	18.4 °C	18.6 °C	18.8 °C
Relative air humidity *Relativ luftfugtighed*	62%	68%	70%	69%	64%
Absolute air humidity *Absolut luftfugtighed*	11.8 g/m^3	12.0 g/m^3	10.9 g/m^3	10.9 g/m^3	10.2 g/m^3

Table 1. Air temperature, relative and absolute humidity in each bedroom on the day of collection.

Tabel 1. Lufttemperatur, relativ og absolut luftfugtighed i hvert soverum på indsamlingsdagen.

Test person *Forsøgsperson*					Test mattress *Forsøgsmadras*	
No *Nr.*	Age *Alder*	Sex *Køn*	Height *Højde*	Covering and bed type *Senge- madras- og belægningstype*	Total sampling area (cm^2) *Totalt indsamlings-areal (cm^2)*	Total amount of dust collected (mg) Totalmængden af indsamlet støv (mg)
I	10	♂	136	A	12737	1595
II	31	♂	172	A	17057	1162
III	28	♀	166	B	13279	540
IV	37	♂	175	C	14014	501
V	2	♂	90	D	14427	5031

Table 2. Test persons and mattresses. A: Sheet on a single; foam rubber; cotton cover. B. Sheet on a half double; foam rubber; cotton cover. C: Sheet on a single; cotton quilt (thickness 2 cm) covering an innerspring. D. Blanket (wool) on a single; foam rubber.

Tabel 2. Forsøgspersoner og madrasser. A: Enkeltseng; skumgummi; bomuldsbetræk og -lagen. B: Halv dobbeltseng; skumgummi; bomuldsbetræk og -lagen. C: Enkeltseng; rullemadras (tykkelse ca. 2 cm) på en springmadras; lagen D: Enkeltseng; skumgummi; uldtæppe.

petri dishes (Ø 5 cm) with counting grids. Bed V contained so much dust that the samples had to be diluted to 20 ml. After two minutes shaking 2 ml was transferred to petri dishes. A X^2- test (chi-square) for each bed showed that the 2 ml subsample was representative for each sample.

Twenty-five mites chosen by chance from each subsample were mounted on slides in Hoyer's medium for identification, stage-distribution and mortality. Mites were registered as dead if they lacked mouth parts and/or limbs or part of a limb. Ova were registered as live. Protonymphs and tretinymphs were registered as nymphs as it was not always possible to see the genital-ponts.

The remaining mites in the subsample were counted non-specific under a stereomicroscope (30 x magnification).

Bed V contained both *Dermatophagoides pteronyssinus* Trouessart, 1897 and *D. farinae* Hughes, 1961 and a total of 20 mature mites were picked op by chance from each of the 28 samples for estimation of the proportion between the two species.

The results were analysed statistically according to Siegel (1956).

Results

Table 3 lists all the genera and/or species of mites and the number and the percentage of

	Mattress no. *Madras nr.* I		II		III		IV		V	
Family, genus or mite species *Midefamilie, slægt eller art*	No of mites *Antal mider*	alive *levende*	No of mites *Antal mider*	alive *levende*	No of mites *Antal mider*	alive *levende*	No of mites *Antal mider*	alive *levende*	No of mites *Antal mider*	alive *levende*
Dermatophagoides farinae	19660	389%	1405	14.6%	0		0		0	
Dermatophagoides pteronyssinus	0		0		4599	34.7%	2106	35.8%	0	
Dermatophagoides farinae & pteronyssinus	0		0		0		0		19808	70.4%
Tarsonemus rakowiensis	322	13.2%	35	0 %	159	0 %	177	2.8%	463	11.1%
Cheyletus spp.	196	0 %	0		10	0 %	5	100%	422	58.3%
Lepidoglyphus spp.	61	0 %	0		10	0 %	0		130	14.5%
Glycyphagus spp.	376	22 %	0		30	0 %	0		0	
Demodex spp.	0		10	50 %	10	100 %	22	77.3%	27	100 %
Acaridae	434	22.4%	10	0 %	0		5	0 %	0	
Eriophyidae	98	0 %	10	50 %	5	100 %	5	0 %	80	19.4%
Tydeus sp.	0		5	0 %	0		0		0	
Bryobia sp.	0		5	0 %	0		0		0	

Table 3. List of species, genera and/or families of mites, the total number and the percentage of alive specimens on each mattress.

Tabel 3. Oversigt over midefund (art, slægt og/eller familie), det totale antal mider og den procentvise andel af levende dyr på hver madras.

living animals from each mattress. House-dust mites belonging to the genus *Dermatophagoides* comprise more than 90% of the total mite fauna and the results below only refer to this genus. Immature stages and ova make up the main part of the living populations in all mattresses.

Table 4 shows the mean concentration of living and dead house-dust mites per 100 cm² in different regions (head-, leg-, centre-,

Bed no. *Seng nr.*	Species *Art*	Head *Hovedende*	Foot *Fodende*	Centre *Midten*	Long-edges *Langsider*
		Regions of mattress surface *Madrasoverfladens regioner*			
I	*Dermatophagoides*				
	farinae	n = 12	n = 12	n = 14	n = 14
	alive/*levende*	$\bar{x}$ = 51.2	$\bar{x}$ = 55.5	$\bar{x}$ = 82.5	x = 37.5**
		s.d. = 33.6	s.d. = 29.1	s.d. = 45.8	s.d. = 14.3
	dead/*døde*	$\bar{x}$ = 82.3	$\bar{x}$ = 88.2	$\bar{x}$ = 133.2	x = 55.8*
		s.d. = 64.3	s.d. = 51.0	s.d. = 80.3	s.d. = 30.2
II	*Dermatophagoides*				
	farinae	n = 12	n = 12	n = 14	n = 14
	alive/*levende*	$\bar{x}$ = 1.5	$\bar{x}$ = 1.2	$\bar{x}$ = 1.2	$\bar{x}$ = 1.2
		s.d. = 0.8	s.d. = 0.9	s.d. = 1.0	s.d. = 0.9
	dead/*døde*	$\bar{x}$ = 7.9	$\bar{x}$ = 7.3	$\bar{x}$ = 7.9	$\bar{x}$ = 6.1
		s.d. = 3.5	s.d. = 4.6	s.d. = 4.5	s.d. = 3.3
III	*Dermatophagoides*				
	pteronyssinus	n = 12	n = 12	n = 14	n = 14
	alive/*levende*	$\bar{x}$ = 15.7	$\bar{x}$ = 6.9**	$\bar{x}$ = 10.7	$\bar{x}$ = 13.1
		s.d. = 6.7	s.d. = 4.4	s.d. = 6.6	s.d. = 7.3
	dead/*døde*	$\bar{x}$ = 16.3	$\bar{x}$ = 25.8	$\bar{x}$ = 22.1	$\bar{x}$ = 23.3
		s.d. = 10.0	s.d. = 21.1	s.d. = 14.6	s.d. = 20.3
IV	*Dermatophagoides*				
	pteronyssinus	n = 12	n = 12	n = 14	n = 14
	alive/*levende*	$\bar{x}$ = 4.0	$\bar{x}$ = 6.1	$\bar{x}$ = 5.6	$\bar{x}$ = 5.1
		s.d. = 2.6	s.d. = 4.0	s.d. = 3.5	s.d. = 3.8
	dead/*døde*	$\bar{x}$ = 7.3	$\bar{x}$ = 10.7	$\bar{x}$ = 11.6	$\bar{x}$ = 7.7
		s.d. = 4.6	s.d. = 8.6	s.d. = 7.3	s.d. = 6.7
V	*Dermatophagoides*				
	farinae and				
	pteronyssinus	n = 12	n = 12	n = 14	n = 14
	alive/*levende*	$\bar{x}$ = 100.8	$\bar{x}$ = 80.1	$\bar{x}$ = 91.4	$\bar{x}$ = 95.4
		s.d. = 43.7	s.d. = 21.6	s.d. = 34.1	s.d. = 50.0
	dead/*døde*	$\bar{x}$ = 45.1	$\bar{x}$ = 37.7	$\bar{x}$ = 42.5	$\bar{x}$ = 39.4
		s.d. = 17.5	s.d. = 14.7	s.d. = 15.3	s.d. = 17.9

Table 4. Mean concentration of living and dead house-dust mites, *Dermatophagoides* spp., per 100 cm² in different regions of the surface of each mattress. Means without *: within each frame are not significantly different ($P > 0.05$). Means followed by * ($P < 0.001$) or ** ($P < 0.001$) within each frame differ significantly from each other according to a Mann-Whitney's U-test. n = number of samples. $\bar{x}$ = mean number of specimens per 100 cm². s.d. = standard deviation.

Tabel 4. Den gennemsnitlige koncentration af levende og døde husstøvmider, Dermatophagoides *spp., pr. 100 cm² i forskellige regioner af hver madrasoverflade. Gennemsnit i hver ramme uden * afviger ikke signifikant fra hinanden ($P > 0.05$). Gennemsnit i hver ramme efterfulgt af * ($P < 0.01$) eller * ($P < 0.001$) afviger signifikant fra hinanden (Mann-Whitney's U-test). n = antal prøver. $\bar{x}$ = gennemsnitligt antal individer pr. 100 cm². s.d. = standardafvigelse.*

and long-edge-region) of the surface of each mattress. For each bed the numbers of house-dust mites per 100 cm^2 in the different regions of the bed were compared to see if there were significant differences from region to region. The head-region was compared to the foot-region ($n_1 = 12$, $n_2 = 12$), and the centre was compared to the long-edges ($n_1 = 14$, $n_2 = 14$) (Mann-Whitney's U-test). A significant deviation was observed in the number of mites between the regions in two of the beds – bed I with the densest concentration of both living ($P < 0.001$) and dead mites ($P < 0.01$) in the centre of the mattress, and bed III with the largest number of living mites ($P < 0.001$) in the head-region. A general tendency for the concentration of mites in the different regions of the mattresses cannot be shown.

Fig. 1 shows the distribution of mature individuals of *D. farinae* and *D. pteronyssinus* on the surface of mattress V. The distribution of the two species differed significantly. (Total number of mites: $X^2 = 44.9$, df = 1, n = 558 ($P < 0.001$), and number of live mites: $X^2 = 36.2$, df = 1, n = 297 ($P < 0.001$)). The frequency of *D. farinae* was highest at the wall side of the mattress and decreased gradually towards the room, while *D. pteronyssinus* showed the highest frequency towards the room and the lowest at the wall.

A significant positive correlation was found between the number of house-dust mites per 100 cm^2 and the amount of mattress dust per 100 cm^2 (Fig. 2). The correlation for the living house-dust mites: Spearman rank correlation coefficient corrected for ties (rs): rs = 0.7009, n = 140 ($P <$ 0.001 two-tailed test for rs = 0), and the correlation for the dead house-dust mites: rs = 0.6893, n = 140 (P : 0.001 two-tailed test for rs = 0).

No significant correlation was found (Spearman rank correlation coefficient (rs), n = 5 ($P > 0.05$ two-tailed test for rs = 0)) between the mean concentrations of living mites per 100 cm^2 and relative air humidity (rs = -0.50), absolute humidity (rs = -0.60), temperature (rs = -0.20), age of the mattress (rs = -0.30), age of the material of the mattress (excluding the sheet) (rs = 0.80), and the age of the test person (rs = -0.90).

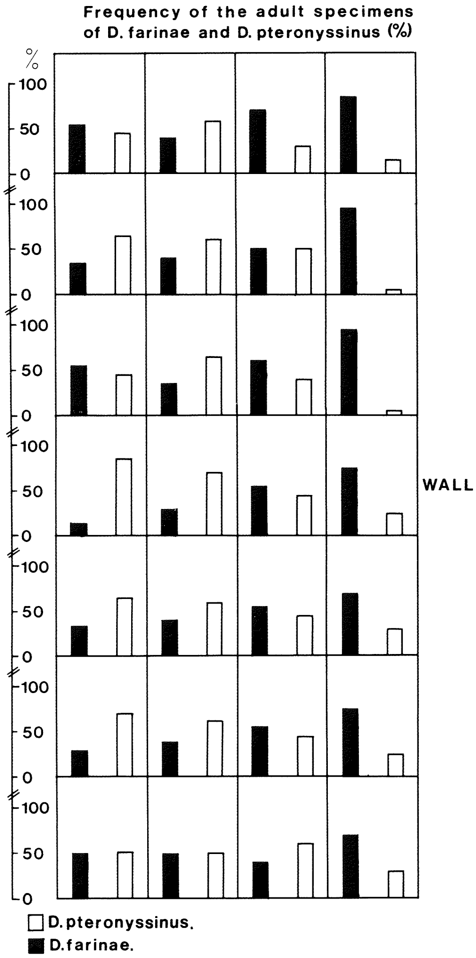

Fig. 1. Frequency of adults of the house-dust mites *Dermatophagoides farinae* and *D. pteronyssinus* in each sampling area on the surface of the same mattress (V).
Fig. 1. Frekvensen af de voksne husstøvmider Dermatophagiodes farinae *og* D. pteronyssinus *i hvert indsamlingsareal på samme madras (V).*

Discussion

Among many as well biological as physical factors contributing to the growth of the mite population, humidity is one of the most important. The largest mite concentrations are found in damp houses (Spieksma & Spieksma-Boezeman, 1967; Maunsell et al., 1970; Cunnington, 1980), and seasonal variation of house-dust mites corresponds to fluctuation in the humidity of the indoor air (Spieksma & Spieksma-Boezeman, 1967; Korsgaard, 1983).

In the present analysis the mattresses contained large populations of mites and both the relative and the absolute indoor air humidity were high on the day of collection (Table 1). Nevertheless, a great variation in the density of mites on each mattress and from mattress to mattress was seen (Table 4). The position of the test person on the mattress was apparently unimportant for the distribution of the mites and the mites showed no general preference for special parts of the surface of the mattress. An exception is mature specimens of *D. farinae* and *D. pteronyssinus,* whose spatial distribution differed significantly from one another (Fig. 1). *D. farinae* showed the highest frequency in the edge-region at the wall side of the mattress, while *D. pteronyssinus* showed the highest frequency towards the room side of the mattress. Various investigations have shown that the two species coexist (Spieksma & Spieksma-Boezeman, 1967; Haarløv & Alani, 1970; Mulla et al., 1975) but their mutual distribution in natural environments has not been thoroughly examined before. In the laboratory Wharton (1971) found that the behaviour of the two species differ slightly: *D. farinae* tends to crawl on the substrate, while *D. pteronyssinus* tends to stay under it. He concludes that the ecological niches of the two species are different and further he states that they show a tendency to exploit different environments. The present study confirms this conclusion.

The density of mites showed a positive correlation with the quantity of dust (Fig. 2). Thus, when humidity is sufficiently high, the quantity of dust is the most important factor for the growth of mites. This is in accordance with the results of Lang & Mulla (1977) and with investigations (Blythe, 1976; Lang & Mulla, 1978) of the distribution of mites on the surface of mattresses provided with buttons, hems and welt cordings, which form depressions and sheltered areas. The dust is mainly deposited beneath such depressions and the density of mites is highest here. A reduction of the quantity of dust is therefore necessary to obtain a decrease in the mite population.

The effect of vacuuming in reducing the mite population on mattresses has been studied. Blythe (1976) examined the density of house-dust mites (numbers per unit

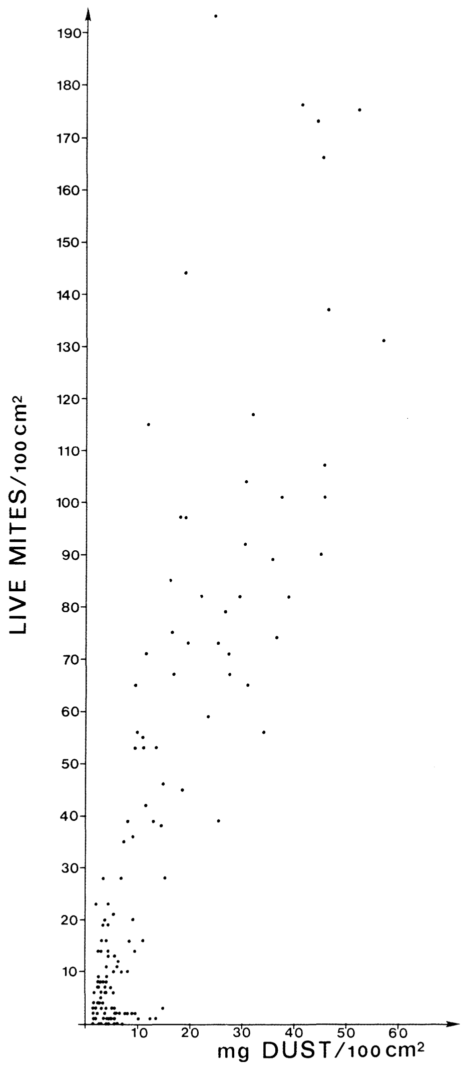

Fig. 2. Relationship between the quantity of mattress dust and the number of live house-dust mites, *Dermatophagoides* spp.
Fig. 2. Forholdet mellem mængden af madrasstøv og antallet af levende husstøvmider (Dermatophagoides spp.).

weight of dust) on mattresses from nine houses, where one mattress from each place was vacuumed regularly. The concentration of house-dust mites on the vacuumed mattress was in all but one case lower than on the corresponding non-vacuumed mattresses from the same place. Blythe (1976) also indicates a complication when expressing mites as numbers per unit weight of dust. The method is suitable when the allergenicity of dust samples is investigated, but in ecological studies and when following the progress of control technique it has a drawback: an extra variable – the quantity of dust on the substrate – is introduced. Therefore the density of mites in a sample will be »diluted« when the dust weight is high and »concentrated« when the dust weight is low. This effect can be seen from Tables 2 and 3. If the density of mites is expressed as numbers of individuals per 100 mg dust, bed V (with the highest absolute number of mites) would have nearly the lowest density of mites.

Korsgaard (1982) compared the density of mites on mattresses in a group of patients involved in an anti-dust program with the density of mites on mattresses in a control group. In contrast to Blythe (1976), Korsgaard found that in spite of most frequent cleaning, patients with the antidust program had more house-dust mites per unit weight of dust than the control group. Patients, however, were compared with a control group with lower relative indoor air humidity (median values: 50% RH in the group of patients and 43% RH in the control group). An extra variable which may hide the effect of cleaning has been introduced into the comparison. Furthermore, significantly less dust was collected from the patients' mattresses, and as the density of mites is expressed in numbers per unit weight of dust, the data may be too »concentrated«.

Rao et al. (1975) found that strict hygienic measures may prevent the growth of mites on mattresses. Carefully cleaned hospital mattresses were compared with mattresses from private homes. The relative humidity: 53-64%, and the temperature: 20,5-23.5°C, were measured only in the hospitals. In dust samples from 100 hospital mattresses, only 6 contained mites, a total of 7 specimens of *D. pteronyssinus,* whereas dust samples from 50 private mattresses all contained large concentrations of mites. As the brushing method was used for collection, direct comparison with results obtained with vacuum-cleaning is not possible. However, if, as claimed by Korsgaard (1982), only humidity is decisive for beds being infested with mites, and if cleaning of beds only plays a minor role, far more hospital beds should have contained mites.

Sarsfield et al. (1974) have also found that avoidance measures in bedrooms of allergic patients, are highly effective. Symptom scores and counts of house-dust mites before and after the avoidance program showed that the mites nearly disappeared and the symptoms decreased considerably.

To protect allergic patients such a cheap and easy avoidance program for elimination of house-dust mites must be recommended – even more so, if humidity can be reduced.

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Sammendrag

Husstøvmiders antal og fordeling i deres naturlige omgivelser.

Koncentrationen og fordelingen af husstøvmiderne, *Dermatophagoides* spp., på overfladen af madrasser uden fremspringende kanter eller knapper (fortrinsvis skumgummimadrasser) er blevet undersøgt.

For madrasserne som helhed viste midekoncentrationerne i de forskellige regioner (hoved-, ben-, center- og kantregion) ingen generel tendens. På den ene madras, hvor de to arter af husstøvmider, *D. pteronyssinus* Trouessart, 1897 og *D. farinae* Hughes, 1961, blev indsamlet, var der en signifikant forskel i fordelingen af de voksne individer. Frekvensen af *D. farinae* var højest i den del af madrassen, der stødte op mod en væg, hvorefter den gradvis aftog. Det modsatte var tilfældet for *D. pteronyssinus* – med størst frekvens mod rummet og mindst mod væggen.

Forholdet mellem mængden af madrasstøv og antallet af både levende og døde mider viste en signifikant positiv korrelation. Når kravet om tilstrækkelig fugtighed derfor er opfyldt for miderne, bliver støvmængden den væsentligste faktor for midernes vækst.

Et billigt og nemt saneringsprogram til eliminering af husstøv med dets indhold af mider må derfor anbefales til allergiske patienter.

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