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SEASONAL DYNAMICS OF HOUSE DUST MITE POPULATONS IN BED/MATTRESS DUST FROM TWO DWELLINGS IN SOSNOWIEC (UPPER SILESIA, POLAND): AN ATTEMPT TO ASSESS EXPOSURE

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Abstract: For the first time in Poland, seasonal dynamics and age structures of pyroglyphid dust mite populations were investigated in three beds from two dwellings in Sosnowiec (Upper Silesia). Simultaneously, the relative humidity and temperature of ambient indoor air was recorded during two years of the study (1984-1985). Generally, the increase of mite density was observed from April to November, and was related to the increase of indoor humidity. The mites were more abundant in the dwelling with central heating than in that with stove heating. *Dermatophagoides farinae* was the numerically dominant species (62.7% of the total mites), followed by *D. pteronyssinus* (28.8%). The analysis of the age population structure and its dynamics showed the marked differences between particular pyroglyphid mite species and the beds examined. In total, *D. farinae* populations showed the dominance of immature stages, whereas in populations of *D. pteronyssinus* and *E. maynei*, the dominants were adult mites.

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INTRODUCTION

Mites from the family *Pyroglyphidae (Acari: Acaridida: Psoroptidia: Pyroglyphoidea)* are among the most important indoor allergens. These microarthropods usually form 60–90% of house dust acarofauna in the temperate climate regions throughout the world [23, 25]. They are most often found in indoor habitats intimately associated with man, such as beds, couches, sofas, other upholstered furniture, clothing, floors and carpets [11, 28]. This family of astigmatic mites includes to date 47 species belonging to 19 genera [46]. Among these mites, only 14 species have been detected so far in houses and house dust samples [22, 46]. Six pyroglyphid mite species are known from Poland to date: *Dermatophagoides pteronyssinus, D. farinae, D. evansi, Hirstia passericola, Euroglyphus maynei* and *Gymnoglyphus longior* [43]. Three of them, worldwide most commonly occurring in house dust samples - *D. pteronyssinus, D. farinae* and *E. maynei* - play the main role as a source of house dust allergens, causing bronchial asthma, rhinitis and dermatitis (house-dust-mite atopy) [4, 17, 22, 25, 37, 38, 39, 47].

The pyroglyphid dust mites produce multiple antigens and allergens. Extracts of these mites - both "culture medium extracts" (Ag-CME)[a] and "whole body extracts" (Ag-WBE)[b] - have been shown to contain more than 30 allergens of which about a dozen (major allergens) are

[a] Also known as WMC (Whole Mite Culture) extracts.
[b] Also known as PMB (Purified Mite Bodies) extracts.

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significant as a cause of atopic allergy [1, 4, 17, 37, 38, 39]. Mite allergens are often ubiquitously distributed throughout dwellings. They are found at many sites which are free of mites, although sites which the mites most often colonise (beds, carpets, soft furnishings and clothing) generally have higher levels of the allergens [45].

In Europe, the main sources of pyroglyphid mites and their allergens are beds [2, 10, 19, 20, 26, 41, 45]. For this reason, the bed and the bed/mattress microhabitat focused an attention of all researchers studying house dust mite atopy problem [6, 16, 18, 19, 20, 23]. In samples of dust from beds and other beddings (as couches, sofas) occur most abundant populations of pyroglyphid mites, also in Poland (Upper Silesia) [29, 30, 42].

In the case of house dust mites, the commonly used indicators for assessing exposure and risk, are antigens, whole animals (by isolation and microscopy analysis) and guanine levels [39]. The latter are not fully reliable because of low specificity [6, 17, 18, 36]. Analysis can be semiquantitative (e.g., "absence or presence" and "low, medium or high level/number") [39]. Two threshold levels for risk of exposure to house dust mite allergens were proposed: exposure to levels of *Der p* I allergen >2 µg/1 g of dust (= 100 mite specimens per 1 g of dust) found to be associated with increased risk of sensitization, and exposure to levels >10 µg/1 g (= 500 mite specimens per 1 g) found to be associated with a risk of acute asthma symptoms [38, 45].

The reasons why a particular site at home is more favourable to pyroglyphid dust mite breeding than another are not yet entirely clear. Therefore, it would be reasonable to sample mite densities, especially in sites where skin scales are suspected to be in greater abundance, for example in beds. During the studies of mite abundance we must take into consideration mainly the high use areas, such as mattresses, bedroom floors, and family or TV room floors and couches [6].

In Poland, including the Silesian region, the knowledge of the occurrence of pyroglyphid house dust mites in dwellings and their seasonal dynamics is still poor.

The aim of the present work was to investigate the age structure and seasonal dynamics of mite populations in dust from individual beds. Such studies have not been performed in our country to date.

MATERIAL AND METHODS

Seasonal dynamics of house dust mite populations was analysed in two flats located in Sosnowiec (Upper Silesia, Poland) from January 1984 to December 1985. The data were obtained on the basis of the analysis of house dust samples from three beds (or bedding accommodations). The places were vacuumed approximately once a month during two years of investigations. Dust samples were collected with a portable car vacuum cleaner (Predom-Zelmer, Model #126, Rzeszów, Poland), on a specially constructed dust trap-filter attached to the end of the cleaner hose. For each sample a new filter was used and each sample was kept separately. The mites were isolated with the method described by Arlian *et al.* [9], with modifications. Briefly, dust samples were weighed and suspended in 30 ml of saturated NaCl with a few drops of the microbiological detergent Brij, stirred with a magnetic stirrer ATM #MM5 and held for 24 hrs of flotation. Then, the suspension was filtered through a mesh sieve. The mesh sieve with the material retained was placed onto a bottom of Petri dish, and suspended in saturated NaCl. After 1–2 hrs the Petri dish was analysed for mites. All isolated mites were mounted on slides and determined with the aid of a compound microscope. Mite density was calculated as a number of specimens per 1 gram of dust. The indoor temperature and relative humidity were measured at the time of sampling. Relative humidity was measured with a hair hygrometer.

Following places were examined by this technique:

1. The mattress (M1) of the child's bed (crib) in the bedroom of the flat in Sosnowiec (central heating, new type of building, lived in for 16 years, during the study period by five adults and one child), see Figure 1.

2. The mattress (M2) of the sofa-bed in the bedroom of the same flat (Fig. 2).

3. The surface of the couch (M3) in the family-room of the another flat in Sosnowiec (stove heating, old building, lived in for 35 years, during the study period by two adult persons, no signs of damp), see Figure 3.

Results were analysed using the χ^2 test and paired Student's *t*-tests (matched pairs).

RESULTS AND DISCUSSION

Seasonal changes in mite density. Table 1 and Figures 1, 2 and 3 present seasonal changes in pyroglyphid mite abundance in the beds examined. These Figures also show fluctuations of values of relative humidity and temperature in both flats during the study.

Generally, during both years of investigations in M1 and M2 beds the increase of mite density (calculated per 1 g of dust) was observed from July/August, and its peak in October or November (Figs 1, 2). Moreover, in M1 two other peaks of pyroglyphid mite density were observed in June and July of the first year of examinations, and in May during the second year (Fig. 1). In M3 (the stove heated flat), peaks of the mite density were observed in January, May, August and December during the first year of the study, and in July and November during the second year (Fig. 3).

The increase of relative humidity levels in May was observed in both dwellings either during two years of the study (M1, M2) or during the first year (M3). However, the distinct increase of mite densities was found only in the M1 mattress.

The temperature maintained on the level that is favourable for pyroglyphid mites (18.2-26.0ºC).

Relatively high numbers of mites in samples collected from all beds (especially M2 and M3) in January 1984, at the beginning of investigations, arise from the fact that these beds were vacuumed for the first time (in the case of M2 and M3 - after many years of use). Analogous relatively high numbers of mites in a first month of similar studies were also observed by other authors [9, 20, 31, 44].

Generally, it should be stressed that significant relationship was found between the mite numbers and the levels of temperature and RH values, in all of the beds examined (χ^2 test: $\alpha < 0.0001$, $\alpha < 0.0001$ and $\alpha < 0.0004$ for M1, M2 and M3, respectively).

The samples with the highest mite densities were collected in May (386.6 mite specimens per 1 gram of dust; M1), July (375.0 mites per gram of dust; M1), August (255.0 mites/g; M1), November (200.0 mites/g; M2, and 166.6 mites/g; M1), October (145.5/g; M1) and once more in July (133.0/g; M1) (Tab. 1). Except for the single November sample, all the remaining samples were taken from bed M1. The most abundant in winter were two samples with 26.0 and 21.0 mite specimens per 1 g of bed dust (January and February, respectively; M2) and the sample with 13.3 mites per 1 g of dust (December; M3). In total, the increasing tendency of mite abundance during the study period was observed in all beds examined, especially in M1 and M2 (Figs 1–3).

Table 1. Mite densities in the beds examined and values of indoor air ambient temperature and relative humidity.

Months	Number of mites per 1 gram of dust			Temperature (◦C)		Relative humidity (% RH)	
	M1	M2	M3	M1and M2	M3	M1and M2	M3
1984							
January	4.0	26.0	9.0	24.5	22.5	46.0	51.5
February	1.0	21.0	2.0	23.5	22.0	51.0	51.0
March	ND	ND	3.6	ND	21.0	ND	49.5
April	ND	ND	ND	ND	ND	ND	ND
May	0.0	0.0	5.8	22.0	24.0	85.0	83.0
June	20.0	ND	0.0	18.2	23.0	64.0	59.0
July	133.0	25.5	2.0	20.5	20.3	62.0	57.5
August	60.0	25.5	8.6	23.4	24.5	66.0	60.0
September	50.0	47.0	ND	24.5	ND	56.0	ND
October	145.5	100.0	0.0	22.0	23.0	84.0	70.0
November	33.3	33.3	ND	22.0	ND	60.0	ND
December	27.8	22.2	13.3	22.0	22.3	53.0	47.0
1985							
January	ND	4.5	7.5	22.8	23.0	47.0	52.0
February	0.0	ND	ND	23.0	ND	50.0	ND
March	33.3	5.9	0.0	22.0	24.0	42.0	51.0
April	ND	ND	ND	ND	ND	ND	ND
May	386.6	20.0	0.0	23.0	26.0	66.0	53.0
June	20.0	ND	ND	20.5	ND	50.0	ND
July	375.0	20.0	13.3	22.0	22.0	64.0	60.0
August	255.0	15.0	1.7	23.0	25.2	82.0	87.0
September	ND	ND	ND	ND	ND	ND	ND
October	ND	ND	ND	ND	ND	ND	ND
November	166.6	200.0	4.0	22.0	22.0	52.0	59.0
December	7.7	6.2	ND	23.8	ND	46.0	ND

ND - not determined.

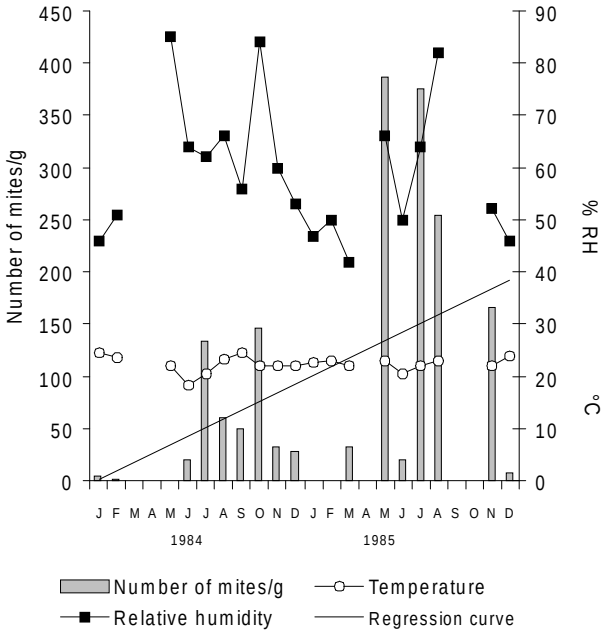

Figure 1. Seasonal dynamics of dust mites in bed dust samples from the bed M1, from January 1984 to December 1985, in relation to measurements of temperature and relative humidity. Regression curve for total domestic mites.

Analysing the data on mite density fluctuations stated in this study, it should be concluded that the highest peak of mite abundance and mite exposure exists in summer/autumn season (June, July, August, September, October and November) and sometimes in May or December. This result is in agreement with literature data for temperate climate regions [11, 20, 28]. However, as relatively high densities (calculated per 1 g of dust) were detected also during the winter heating seasons (Tab. 1), it should be stressed that exposure to mites and mite allergens existed also in winter in both flats studied.

Similar investigations into seasonal variation of mite numbers in bed mattress dust conducted in other countries showed also changes with the season. For example, in Groesteek (The Netherlands) the mites were most abundant in mattresses in July/August and their number was closely correlated with the absolute indoor and outdoor humidity. Population densities of the dominant species *D. pteronyssinus* were observed to increase when the absolute indoor humidity rose above 12 g/m^3 (10 g/m^3 of outdoor humidity) [10, 11]. In the populations of *D. farinae*, the absolute indoor humidity needed to increase the mite numbers may be lower, about 10 g/m^3 at room temperature [11, 19].

In Prague (Czech Republic) *D. farinae* was most abundant in mattress dust samples from June to December, with two peaks observed in August and in November/December during the first and the second year of the study, respectively [19]. This result is very similar to that actually obtained in the case of M3. More recent investigations performed in Prague [20] showed the highest peak of mite densities in mattress dust samples in July, both for *D. farinae* and *D. pteronyssinus* populations. Moreover, the other distinctly lower peaks

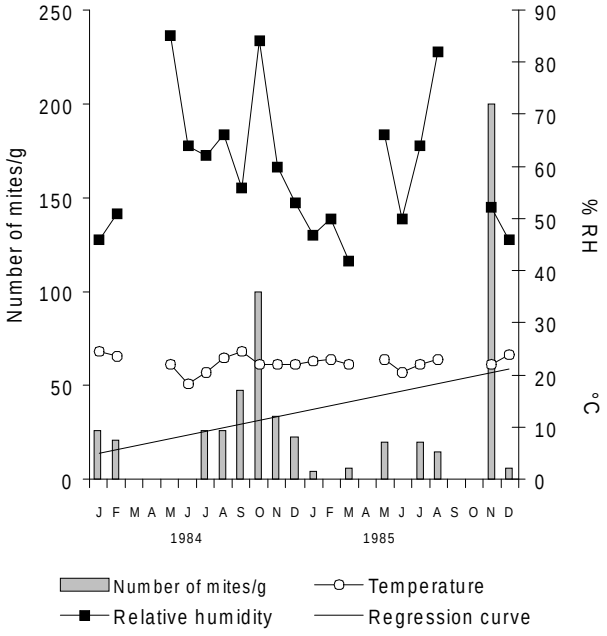

Figure 2. Seasonal dynamics of dust mites in bed dust samples from the bed M2, from January 1984 to December 1985, in relation to measurements of temperature and relative humidity. Regression curve for total domestic mites.

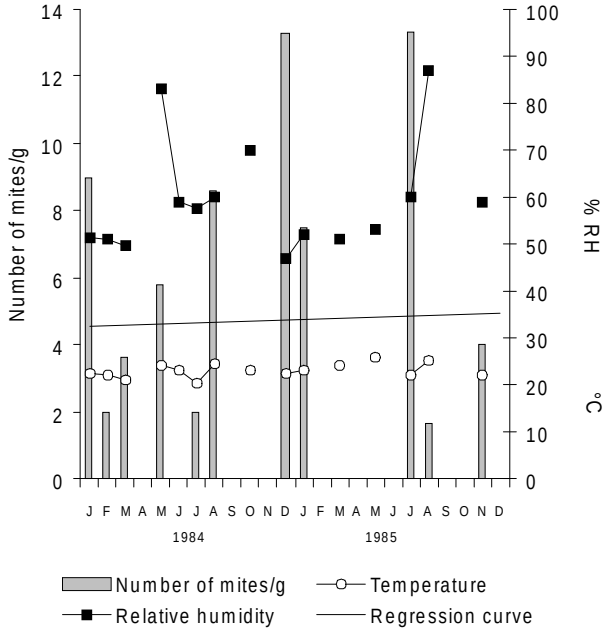

Figure 3. Seasonal dynamics of dust mites in bed dust samples from the bed M3, from January 1984 to December 1985, in relation to measurements of temperature and relative humidity. Regression curve for total domestic mites.

Table 2. Mean numbers of mites per 1 gram of dust and mean values of temperature and relative humidity in the examined flats.

	Number of mites per 1 gram of dust: total mites (pyroglyphid mites)			Temperature (◦C)		Relative Humidity (% RH)	
	M1 (n = 18)	M2 (n = 16)	M3 (n = 15)	M1 and M2 (n = 19)	M3 (n = 15)	M1 and M2 (n = 19)	M3 (n = 15)
$\bar{x} \pm$ SD	95.49 ± 121.92 (89.61 ± 120.74)	35.70 ± 48.03 (33.13 ± 43.13)	4.72 ± 4.51 (4.57 ± 4.48)	22.35 ± 1.45	22.99 ± 1.49	59.26 ± 12.73	59.37 ± 11.51
Median	33.3 (33.3)	21.61 (20.50)	3.6 (2.4)	22.0	23.0	56.0	57.5
Range	0.0 - 386.6 (0.0 - 386.6)	0.0 - 200.0 (0.0 - 175.0)	0.0 - 13.33 (0.0 - 13.33)	18.2 - 24.5	20.3 - 26.0	42.0 - 85.0	47.0 - 87.0

were also observed, in January for the *D. farinae* population, and in January and April for the *D. pteronyssinus* population.

In Bucharest (Romania) two peaks of mite densities were observed, the main peak from August to November, and the second, smaller in February/March [11]. A peak in spring was noted also in England [31], whereas in the Netherlands in February/March and May the lowest mite densities were observed [10, 11], with relatively high mite numbers in December (about 80 mites / 1 g of mattress dust). The latter results were similar to those in M3 during the first year of the study. In Spain, the maximum number of pyroglyphid mites was found in early summer, in June (the first peak) and in autumn (October; the second peak), with correlation to outdoor humidity as the limiting factor [11].

Outside Europe, for example in Delhi (India; hot climate with dry winters), the lowest mite numbers were observed in April and May, when the indoor relative humidity and air temperature were approximately 30% and 32ºC, respectively. Mite densities were highest in the period from July to September, when the mean relative humidity was 70-80% and temperature - again about 30ºC [11].

The influence of indoor climate on mite population density in home habitats, was also clearly showed in surveys in Hawaii (warm and humid climate). Mite numbers were lowest in July, when the mean indoor relative humidity and temperature were 62% and 28ºC, respectively, and highest in December, January and February, in conditions of 68% and 23ºC [11]. In Dayton and Cincinnati (Ohio, U.S.A.) in 1977–1979 the mean mite number increased from May to September and was maximal in August (1977) or June/July (1978) when relative humidity of ambient indoor air was also highest [9]. Mite population density declined during the autumn and was lowest from December to April [7, 9]. Also in Virginia (U.S.A.) the peak of mite density was recorded in August [22].

Thus, it is commonly known that differences in the mite population density in different topographical and climatic regions are associated with the differences in outdoor and, especially, indoor humidity levels [6, 11, 27, 32, 33, 34, 35, 40]. A reduction of RH in homes, even only from 85 to 75%, reduces feeding and faecal production, fecundity and mite population size for both mite species, *D. farinae* and *D. pteronyssinus* [5].

Environmental factors influencing density of mites. According to much literature data, in dwellings with central heating, less densities of mites are observed than in those with stoves [11, 26, 47].

By contrast, in the present study the density of the mite population was distinctly higher in the flat with central heating, especially in the mattress of the child's bed (M1). The arithmetic mean numbers of mites per 1 g of dust in samples from M1 (95.49 ± 121.92; n = 18) and M2 (35.70 ± 48.03; n = 16) (dwelling with central heating) were significantly higher ($p < 0.05$) than in the samples from M3 (4.72 ± 4.51; n = 15) (dwelling with stoves) (Tab. 2). The difference between mean mite numbers in two beds from the dwelling with central heating (M1 and M2) was not statistically significant ($p > 0.2$). Probably, some environmental factors (humidity, temperature, quantity and quality of skin scales) were more favourable for mites in M1 than in M2. The bed M1 was a typical crib with mattress and stable mite microhabitat, whereas M2 was a sofa-bed with folding mattress and bed-clothes taken off every morning.

In the flat with the couch (M3), slightly greater deviations of temperature values and higher mean temperature were observed than in that with M1 and M2 (Tab. 2). These facts were probably decisive for the lower mite numbers in M3 despite slightly higher mean humidity (Tab. 2). Stability of temperature in optimal scope (20-30ºC) is a very important factor for densities of mite populations. The amplitude of changes and frequency of their fluctuation is obviously more important for mites as absolute values of temperature, and frequent changes of the temperature values may negatively influence the mite population density in beds [20, 21]. It was also suggested that temperature may decide how quickly mites can develop, whereas humidity determines a number of mites able to live in a dwelling [34]. Moreover,

indoor humidity above 60% RH which is the most favourable for mites, was rarely noted in the flat with M3 compared to that with M1 and M2 (Tab. 1).

The type of heating is considered as a significant factor influencing mite occurrence and abundance. For example, results of surveys in Dayton and Cincinnati (Ohio, U.S.A.) revealed the dominance of *D. pteronyssinus* only at homes without central heating, but with a single central space heater which heated peripheral rooms by convection (RH was significantly higher than in centrally heated homes, particularly during summer seasons) [7]. These findings are consistent with the results obtained in this study which showed that *D. pteronyssinus* was a dominant species in the dwelling without central heating (M3), heated only by the single central stove (Fig. 4). In the Czech Republic [21] both *Dermatophagoides* spp. were found mostly in older buildings heated by coal stoves, whereas *E. maynei* prevailed in private recreation houses inhabited periodically, and in hospitals.

Influence of the age of the house on mite density was not observed during the present study. No relationship between age of the house and the total number of pyroglyphid mites in dust samples was also observed in Dronten (Flevoland, The Netherlands) by van der Hoeven *et al.* [28]. Surveys by Hart and Whitehead [26] in Oxfordshire (U.K.), however, indicated that older homes contained higher total mite numbers (especially *D. pteronyssinus*) than houses less than 10 years old. In that study the new houses were markedly drier and warmer than old houses and detrimental to mite survival. Efficient insulation and central heating in new houses were the possibly reasons of conditions unfavourable for dust mites [26]. Similar influence of age of homes on mite abundance was observed in Bogota (Colombia) by Charlet *et al*. [13].

The important factor influencing higher mite densities in the flat with beds M1 and M2 may be the greater number of members in this flat. This is in accordance with the results obtained by Arlian *et al.* [8], who showed average mite densities proportional to the number of members in the household. Also Carswell *et al.* [12] found significantly more mites in the mattresses of bedrooms occupied by more than one person. Van der Hoeven *et al.* [28] divided examined households into two classes: "small households" with 1 or 2 members, and "large households" with 3, 4 or 5 members. In the present study, the flat with beds M1 and M2, and higher mite densities, was in the "large household" category (6 members, including the small child who was sleeping in M1), whereas that with the bed M3 - in the "small" category (only 2 members, without children). Higher mite abundance in the flat with M1 and M2 may be related to the fact that larger households are likely to produce more skin scales (the food for pyroglyphid house dust mites) and, usually, higher humidity (cooking fumes, wet

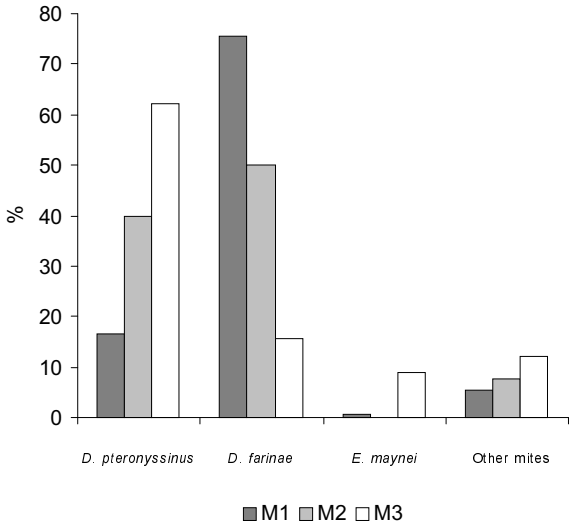

Figure 4. Rate of abundance (percent of all mites from each bed) of pyroglyphid mite species and other mites, for each of the beds examined.

Table 3. Seasonal dynamics of the population structure of pyroglyphid mites (*Dermatophagoides pteronyssinus, D. farinae* and *Euroglyphus maynei)* found in examined beds*.

Beds	Mite species	Life stage	Time of sampling – months / seasons (mean values for two years)			
			D/J/F Winter	M/A/M Spring	J/J/A Summer	S/O/N Autumn
M1	DP	I	25	0	25	35.3
		M	25	100	0	17.6
		F	50	0	75	47.1
	DF	I	100	91.4	66.1	55.6
		M	0	6.9	12.3	22.2
		F	0	1.7	21.6	22.2
	EM	I	0	0	0	0
		M	0	0	0	0
		F	100	0	0	0
M2	DP	I	47.4	100	42.8	20
		M	21.0	0	14.3	40
		F	31.6	0	42.9	40
	DF	I	44.5	100	49	28.6
		M	44.4	0	0	35.7
		F	11.1	0	51	35.7
M3	DP	I	33.4	14.3	0	0
		M	33.3	57.1	33.3	0
		F	33.3	28.6	66.7	100
	DF	I	100	0	49	0
		M	0	0	51	0
		F	0	0	0	0
	EM	I	0	0	0	0
		M	100	0	0	0
		F	0	0	0	0

* population structure is expressed as percent of a total mite population of each of the species detected; DP = *D. pteronyssinus*; DF = *D. farinae*; EM = *E. maynei*; I = immature stages; M = males; F = females.

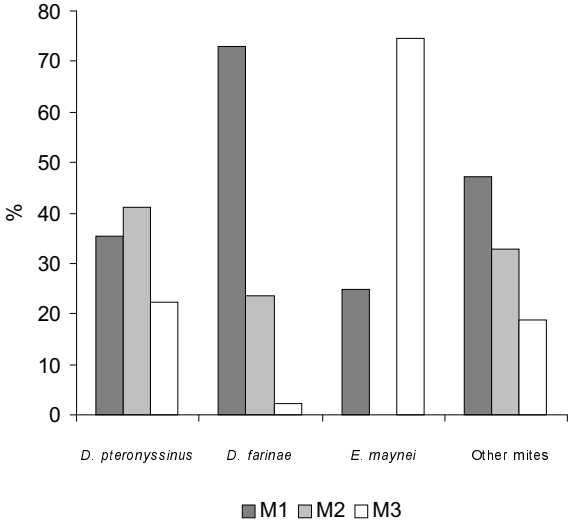

Figure 5. Rate of dominance (percent of all specimens of each species) of pyroglyphid mite species and other mites, for each of the beds examined.

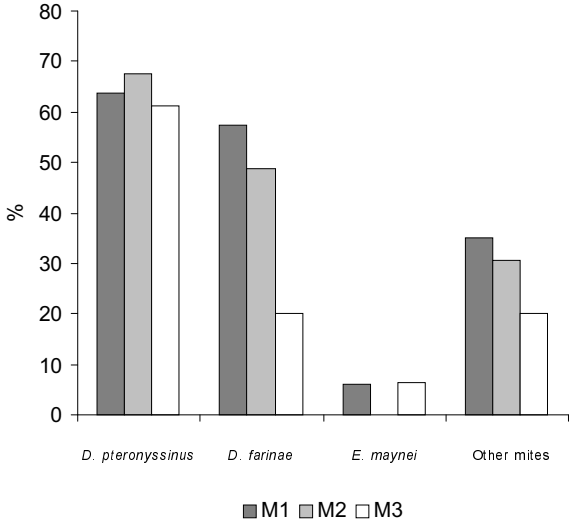

Figure 6. Rate of occurrence (percent of all samples from each bed) of pyroglyphid mite species and other mites, for each of the beds examined.

laundry, exhalation vapour) [28]. Moreover, it was also suggested that the presence of one or more small children in the "large household" means an overall higher usage of the dwelling in terms of space and time [28]. In addition, the presence of a small child is associated with higher frequency of washing and therefore higher indoor humidity, which is favourable for these mites.

None of the inhabitants of the examined flats showed the symptoms of house-dust-mite atopy.

Species composition and age structure of mite populations. Generally, *D. farinae* was the numerically dominant species (62.7% of the total mite population) before *D. pteronyssinus* (28.8%). This fact conforms to results of the previous surveys on house dust acarofauna in the Upper Silesian region [29, 30, 42]. *E. maynei* was found only in two dust samples collected from M1 and M3 and formed 1.4% of the total count. Remaining 7.1% of the isolated mite population, was composed of *Tyrophagus putrescentiae* (*Acaridae*) (1.7%), *Gohieria fusca* (*Glycyphagidae*) (1.0%), pygmephorid mites (*Pygmephoridae, Tarsonemida*) (0.3%), tarsonemid mites (*Tarsonemidae, Tarsonemida*) (0.3%), *Cheyletia papillifera* (*Cheyletidae, Actinedida*) (0.3%), *Cheyletus* spp. (*Cheyletidae, Actinedida*) (1.4%) and *Gamasida* (2.1%). It is commonly known that mites of the families *Acaridae* and *Glycyphagidae* are much more sensitive to desiccation and harsh conditions [11, 22, 23].

D. pteronyssinus was especially abundant in M3, where also 75% of isolated specimens of *E. maynei* were found (Fig. 4). This is consistent with literature data concerning environmental requirements of both species, especially in relation to higher humidity [3, 14, 15, 19]. *D. farinae* was distinctly more abundant in dust from M1 and M2 than from M3 (Fig. 4). This species appears to survive better in drier habitats than *D. pteronyssinus* and *E. maynei* [3, 19]. The population density of *D. farinae* may increase in indoor environment at the mean monthly relative humidity of ambient air only 47-50% [19].

As much as 41.2% of the specimens of *D. pteronyssinus* were isolated from M2, 35.3% from M1 and only 23.5% from M3. In the case of *D. farinae*, 73.5% of these mites were isolated from M1, 23.8% from M2, whereas only 2.7% from M3 (Fig. 5).

D. pteronyssinus occurred with almost equal frequency in all beds examined, especially in M1 and M2 (M1 - 64.7%, M2 - 68.8%, M3 - 53.3%) (Fig. 6). The mite *D. farinae* was most frequent in samples from M1 and M2 (58.8% and 50.0%, respectively) while present in only 20.0% of samples from M3. *E. maynei* occurred in 5.9% and 6.7% of the samples from M1 and M3, respectively.

The obtained results suggest a marked divergency in the age structure and dynamics existing between the particular pyroglyphid mite species and the beds examined (Tab. 3). In the populations of *D. pteronyssinus* the most abundant stages throughout the year were both of adults, especially in M1 and M3. In populations of *D. farinae*, immatures were more abundant than in the former species, and in M1 they were the dominants, particularly in winter/spring months. In the case of *E. maynei* only adults were found (Tab. 3). In contrast, in the Czech Republic no essential differences were observed in the seasonal dynamics between *D. pteronyssinus* and *D. farinae* [20, 21].

The previous studies of age structure of pyroglyphid populations showed that in August the dominant stages of *D. pteronyssinus* were adults before nymphs and larvae, whereas in *D. farinae* - both stages of nymphs

(protonymphs together with tritonymphs) before adult stages and larvae [19, 24, 47]. While the structure of *D. pteronyssinus* had a lower number of protonymphs than tritonymphs or adults, in the *D. farinae* populations the protonymphs, tritonymphs, males and females were represented almost equally and their ratio varied slightly in the course of a year [20, 42]. In both species low numbers of larvae were observed [19, 24, 47]. In contrast, more recent investigations have shown that the most common age structure of *D. pteronyssinus* populations was that in which immatures were dominant [16]. For populations of *E. maynei*, the most common age structures were those with the dominance of adults, especially females, before nymphs and larvae [16, 47].

CONCLUSIONS

In the Upper Silesian region, the microclimatic requirements of *D. farinae* and *D. pteronyssinus* are reflected by the prevalence of the former species, especially in flats with central heating. *D. pteronyssinus* was abundant only in the dwelling with stoves.

The present findings concur with many other reports in demonstrating that relative humidity has an influence on development and growth of house dust mite populations. The other important factor influencing the abundance and density, and therefore favouring sensitization to house dust mites, appears to be the number of members of the flat. The greater number of members ("large household") enhances the risk of exposure to mite allergens.

Generally, the peaks of mite density were observed in May, July and from August to December. These are the risk periods for sensitization to house dust mites in the Upper Silesia region.

REFERENCES

1. Abe T, Ishii A: Comparison of *Dermatophagoides pteronyssinus* allergens from culture medium extract and whole body extract by using the same probe of pooled human serum. *Allergy* 1987, **42**, 352-358.
2. Andersen A: Abundance and spatial distribution of house-dust mites in their natural environment (*Acari: Sarcoptiformes* and *Trombidiformes*). *Entomol Med* 1984, **52**, 25-32.
3. Arlian LG: Biology and ecology of house dust mites, *Dermatophagoides* spp. and *Euroglyphus* spp. (Airborne allergens). *Immunol Allergy Clin North Am* 1989, **9**, 339-356.
4. Arlian LG: House-dust-mite allergens: A review. *Exp Appl Acarol* 1991, **10**, 167-186.
5. Arlian LG: Water balance and humidity requirements of house dust mites. *Exp Appl Acarol* 1992, **16**, 15-35.
6. Arlian LG, Bernstein D, Bernstein IL, Friedman S, Grant A, Lieberman P, Lopez M, Metzger J, Platts-Mills T, Schatz M, Spector S, Wasserman SI, Zeiger RS: Prevalence of dust mites in the homes of people with asthma living in eight different geographic areas of the United States. *J Allergy Clin Immunol* 1992, **90**, 291-300.
7. Arlian LG, Bernstein IL, Gallagher JS: The prevalence of house dust mites, *Dermatophagoides* spp., and associated environmental conditions in homes in Ohio. *J Allergy Clin Immunol* 1982, **69**, 527-532.
8. Arlian LG, Brandt RL, Bernstein R: Occurrence of house dust mites, *Dermatophagoides* spp. (*Acari: Pyroglyphidae*) during the heating season. *J Med Entomol* 1978, **15**, 35-42.
9. Arlian LG, Woodford PJ, Bernstein IL, Gallagher JS: Seasonal population structure of house dust mites, *Dermatophagoides* spp. (*Acari: Pyroglyphidae*). *J Med Entomol* 1983, **20**, 99-102.
10. Bronswijk JEMH van: *Dermatophagoides pteronyssinus* (Trouessart, 1897) in mattress and floor dust in a temperate climate (*Acari: Pyroglyphidae*). *J Med Entomol* 1973, **10**, 63-70.
11. Bronswijk JEMH van: *House Dust Biology (for Allergists, Acarologists and Mycologists).* NIB Publishers, Zoelmond 1981.
12. Carswell F, Robinson DW, Oliver J, Clark J, Robinson P, Wadsworth J: House dust mites in Bristol. *Clin Allergy* 1982,**12**, 533-545.
13. Charlet LD, Mulla MS, Sanchez-Medina M: Domestic *Acari* of Colombia: Abundance of the European House Dust Mite, *Dermatophagoides pteronyssinus* (*Acari: Pyroglyphidae*), in homes in Bogota. *J Med Entomol* 1977, **13**, 709-712.
14. Colloff MJ: Population studies on the house dust mite *Euroglyphus maynei* (Cooreman, 1950) (*Acari: Pyroglyphidae*). **In:** Schuster R, Murphy PW (Eds): *The Acari: Reproduction, Development and Life-History Strategies,* 497-505. Chapman and Hall, London 1991.
15. Colloff MJ: A review of the biology and allergenicity of *Euroglyphus maynei* (Cooreman, 1950) (*Acari: Pyroglyphidae*). *Exp Appl Acarol* 1991, **11**, 177-198.
16. Colloff MJ: Age structure and dynamics of house dust mite populations. *Exp Appl Acarol* 1992, **16**, 49-74.
17. Colloff MJ, Ayres J, Carswell F, Howarth PH, Merrett TG, Mitchell EB, Walshaw MJ, Warner JO, Warner JA, Woodcock AA: The control of allergens of dust mites and domestic pets: a position paper. *Clin Exp Allergy* 1992, **22**, Suppl 2, 1-28.
18. Colloff MJ, Stewart GA, Thompson PJ: House dust acaro-fauna and Der p I equivalent in Australia: the relative importance of *Dermatophagoides pteronyssinus* and *Euroglyphus maynei*. *Clin Exp Allergy* 1991, **21**, 225-230.
19. Dusbabek F: Population structure and dynamics of the house dust mite *Dermatophagoides farinae (Acarina, Pyroglyphidae)* in Czechoslovakia. *Folia Parasitol* (Praha) 1975, **22**, 219-231.
20. Dusbabek F: Dynamics and structure of mixed populations of *Dermatophagoides farinae* and *D. pteronyssinus. Recent Advances Acarol* 1979, **2**, 173-177.
21. Dusbabek F: Present state of research on house dust mites (*Pyroglyphidae*) in the Czech Republic. *Wiad Parazytol* 1995, **41**, 337-342.
22. Fain A, Guerin B, Hart BJ: *Mites and Allergic Disease.* Allerbio, Varennes en Argonne 1990.
23. Feldman-Muhsam B, Mumcuoglu Y, Osterovich T: A survey of house dust mites (*Acari: Pyroglyphidae* and *Cheyletidae*) in Israel. *J Med Entomol* 1985, **22**, 663-669.
24. Gridelet D, Lebrun P: Contribution a l'etude ecologique des acariens des poussieres de maisons. *Acarologia* 1973, **15**, 461-476.
25. Hallas TE: The biology of mites. *Allergy* 1991, **46**, Suppl 11, 6-9.
26. Hart BJ, Whitehead L: Ecology of house dust mites in Oxfordshire. *Clin Exp Allergy* 1990, **20**, 203-209.
27. Harving H, Korsgaard J, Dahl R: House-dust mites and associated environmental conditions in Danish homes. *Allergy* 1993, **48**, 106-109.
28. Hoeven WAD, van der, de Boer R, Bruin J: The colonisation of new houses by house dust mites (*Acari: Pyroglyphidae*). *Exp Appl Acarol* 1992, **16**, 75-84.
29. Horak B: Preliminary study on the concentration and species composition of bacteria, fungi and mites in samples of house dust from Silesia (Poland). *Allergol Immunopathol* 1987, **15**, 161-166.
30. Horak B, Dutkiewicz J, Solarz K: Microflora and acarofauna of bed dust from homes in Upper Silesia, Poland. *Ann Allergy Asthma Immunol* 1996, **76**, 41-50.

31. Hughes AM, Maunsell K: A study of a population of house-dust mite in its natural environment. *Clin Allergy* 1973, **3**, 127-131.

32. Korsgaard J: House-dust mites and absolute indoor humidity. *Allergy* 1983, **38**, 85-92.

33. Lang JD, Mulla MS: Distribution and abundance of house-dust mites, *Dermatophagoides* spp., in different climatic zones of Southern California. *Environ Entomol* 1977, **6**, 213-216.

34. Lang JD, Mulla MS: Seasonal abundance of house-dust mites, *Dermatophagoides* spp., in homes in Southern California. *Environ Entomol* 1978, **7**, 281-286.

35. Lascaud D: Etude ecologique des acariens pyroglyphides de la poussiere de maison dans la region grenobloise. Approche qualitative et incidence de differents parametres: saisons, altitude, temperature et humidite relative, sur leur multiplication. *Ann Parasitol Hum Comp* 1978, **53**, 675-695.

36. Mosbech H, Gravesen S, Heinig JH, Korsgaard J, Schou C, Ostergaard PA: Diagnostic procedures - exposure and environment. *Allergy* 1991, **46**, **Suppl. 11**, 23-25.

37. Platts-Mills TAE, Thomas WR, Aalberse RC, Vervloet D, Chapman MD: Dust mite allergens and asthma: Report of a Second International Workshop. *J Allergy Clin Immunol* 1992, **89**, 1046-1060.

38. Platts-Mills TAE, de Weck AL: Dust mite allergens and asthma - a worldwide problem. Report of an International Workshop, Bad Kreuznach, Federal Republic of Germany, September, 1987. *J Allergy Clin Immunol* 1989, **83**, 416-427.

39. Pope AM, Patterson R, Burge H (Eds): *Indoor Allergens. Assessing and Controlling Adverse Health Effects.* National Academy Press, Washington 1993.

40. Rijckaert G, Bronswijk JEMH van, Linskens HF: House-dust community (fungi, mites) in different climatic regions. *Oecologia (Berlin)* 1981, **48**, 183-185.

41. Sesay HR, Dobson RH: Studies on the mite fauna of house dust in Scotland with special reference to that of beddings. *Acarologia* 1972, **14**, 384-392.

42. Solarz K: Fauna alergogennych roztoczy (*Acari*) kurzu domowego w wybranych środowiskach Górnego Śląska. Thesis, Silesian Medical Academy, Katowice (Poland) 1987.

43. Solarz K, Szilman E, Szilman P: *Dermatophagoides evansi* Fain, Hughes et Johnston, 1967 - the new for Polish fauna species of mite of the family *Pyroglyphidae (Acari: Astigmata: Psoroptidia). Prz Zool* 1995, **39**, 271-277.

44. Spieksma FTM: Ecological distribution of house-dust mites in Europe. *Proceedings of the 3rd International Congress of Acarology held in Prague (Czechoslovakia), August 31 – September 6, 1971*, 551-556. Academia, Prague 1973.

45. Tovey ER: Allergen exposure and control. *Exp Appl Acarol* 1992, **16**, 181-202.

46. Vargas MV, Smiley RL: A new species of *Hughesiella* (*Acari: Astigmata, Pyroglyphidae*) from Costa Rica. *Internat J Acarol* 1994, **20**, 123-131.

47. Voorhorst R, Spieksma FTM, Varekamp H: *House-dust Atopy and the House-dust Mite Dermatophagoides pteronyssinus (Trouessart, 1897).* Stafleu's Scientific Publishing Co, Leiden 1969.