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Original Research

Acarological Characteristics of Dust Originating from Urban and Rural Houses in Northwestern Poland

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Abstract

The aim of this study was to determine the species composition of allergenic mites found in West Pomerania in northwestern Poland. Mites were found in approximately 30% of urban and 53% of rural samples. In both groups, the following mites were found: *Dermatophagoides farinae* (Hughes), *D. pteronyssinus* (Trouessart), *Chortoglyphus arcuatus* (Troupeau), *Cheyletus* sp., and *Hirstia* sp. In addition to these taxa, *Euroglyphus maynei* (Cooreman) was found only in urban apartments, and the species *Gohieria fusca* (Oudemans) and *Lepidoglyphus destructor* (Schrank) were found only in rural apartments. Among the identified taxa in the two groups of apartments, the most frequent and numerous were: *D. farinae, D. pteronyssinus, C. arcuatus*, and *Cheyletus* sp. The dominant species was *D. farinae* (dominances were 68.4% and 57.1%, respectively for urban and rural areas). The average number of *D. farinae* was higher in rural than in urban apartments.

Keywords: Acari, mites, Pyroglyphidae, northwestern Poland, urban and rural houses

Introduction

House dust mites commonly occur in the immediate environment of humans. They have been reported in dust samples collected from hospitals, cinemas, schools, libraries, workplaces, theatres, student hotels, offices, military barracks, and also in public transportation (in the seats of planes, trains, cars, cabins of ocean liners) and in utility buildings [1-4]. Mites are pests of stored agricultural products. In products stored by people, one can find mites belonging to five 5 orders: Gamasida, Actinedida, Tarsonemida, Acaridida, and Oribatida [5, 6]. The storage mites are found in hay, straw, and vegetable products in farming environments, but also in house dust [6-12].

In Poland, as well as in countries with a similar climate, house dust contains most frequently mites from the Pyroglyphidae family. In the world, 15 house dust mite species have been described: *Hughesiella africana*, *H. valerioi*, *Euroglyphus maynei*, *Gymnoglyphus longior*, *Dermatophagoides pteronyssinus*, *D. farinae*, *D. microceras*, *D. evansi*, *D. neotropicalis*, *D. siboney*, *Sturnophagoides brasiliensis*, *Malayoglyphus intermedicus*, *M. carmelitus*, *Hirstia chelidonis*, and *H. domicela* [5, 7]. In Poland, 6 species have been identified so far: *D. pteronyssinus*, *D. farinae*, *E. maynei*, *D. evansi*, *H. chelidonis*, and *G. longior* [13-15].

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Mites belonging to the families Pyroglyphidae, Glycyphagidae, and Acaridae are the source of antigens responsible for atopic diseases in humans. They can contribute to the development of perennial rhinitis, atopic asthma, atopic dermatitis (eczema), and urticaria hand oculorhinitis [13, 16-19]. It is estimated that worldwide approximately 5% of people are allergic to allergens of these mites [20], and the prevalence of allergy is increasing in men over 18 years [21]. Extracts of faeces and purified mite bodies are particularly allergen rich [5, 19, 22].

As the main food of Pyroglyphidae mites is shed human epidermis, hair, and nails [23], the greatest concentration of dust mite allergens in homes usually occurs in beds, mattresses, sofas, chairs, and carpets [20, 24]. One gram of dust may contain hundreds or even tens of thousands of mites in different stages of development and belonging to several species.

Although there are quite a number of reports on the prevalence of house dust mites in Poland, they relate only to certain areas of the country, mostly in the central and southern parts [13-15, 25]. It is therefore justified to examine house dust mites in other areas. To date, Szczecin and its vicinity have not been subject to wider research on house dust mites. Therefore, the objective of this study was to determine the species composition and to assess frequency (percentage of the total count of samples examined) and dominance (percentage of the total count of isolated mites) and the of allergenic mites occurring in apartments of urban and rural areas in northwestern Poland.

Materials and Methods

Sampling

In the period from November 2004 to May 2007, a total of 289 house dust samples were collected, comprising 107 samples from 33 urban apartments (Szczecin, Police, Pyrzyce, and Łobez) and 182 samples from 37 apartments in rural areas (Przelewice, Brzesko, Bylice, Krasne, Kakolewice, Wierzchowo, Przeradz, Kłodzino), in West Pomerania. In 25 of the urban apartments, samples were collected three times, and in 8 of the urban apartments four times. In 34 rural apartments sample were collected five times, and in 3 of the rural apartments four times.

Samples were collected from sleeping places, bedroom carpets, living room chairs, kitchen floors, and floor coverings in the hall (one sample each). Dust samples were obtained during a single vacuuming with a vacuum cleaner (Progress Model 83S, 1000 W, Germany) with a cap fitted with a 10 x 10 cm cotton filter to collect dust. Each time vacuuming covered an area of l m^2 in 2 minutes, and the mean size of a sample ranged from 0.6 to 0.9 g.

The Isolation of Mites

Dust samples were weighed and immersed in a saturated NaCl solution with an additional few drops of detergent. They were left for 24 hours and the supernatant filtered several times. The absorbent paper filter was placed in a Petri dish and covered with saturated NaCl solution. After one to two days each dish was viewed under a stereoscopic microscope (40x magnification) in order to detect mites. This procedure was determined by Arlian et al. [26]. The acarological analysis took into account only the intact specimens of mites as it was assumed that the collected dead mites had been dead prior to the collection of material [27]. After isolation, the mites were determined using acarological keys [5, 11, 27-30] using an OLYMPUS light microscope with the phase contrast system [7].

Ecological Parameters

Ecological parameters were based on two main factors: dominance (D) and frequency (F). Frequency (F) determines the percentage of total count of samples examined, calculated according to the formula:

$$F = \frac{100 \cdot P}{\sum p}$$

...where: F – frequency, P – the number of samples in which a taxon occurred, Σp – the total number of samples.

Dominance (D) expresses the percentage of total count of isolated mites, calculated according to the formula:

$$D = \frac{100 \cdot \delta}{\sum s}$$

...where: D – dominance, δ – the number of individuals of a taxon, Σs – the sum of all individuals in a sample (s).

Characteristics of the dominance of mites was based on the corresponding dominance coefficients by Solarz [31]. Accordingly, 5 groups can be distinguished:

1) eudominant; species forming more than 10% of all identified mites,
2) dominant; species forming from 5.1% to 10% of all identified mites,
3) subdominant; from 2.1 to 5% of all identified mites,
4) recedent; species forming from 1.1% to 2% of all identified mites,
5) subrecedent; species forming less than 1.1% of all identified mites.

Statistical Analysis

Concentrations in 1g of dust were determined for the four most commonly found taxa of mites. A Mann-Whitney test was used for a comparision between the concentrations of mites in rural and urban apartments.

Results

In 289 samples of dust from urban and rural apartments in northwestern Poland, mites were detected in 128 samples,

Table 1. Frequency and dominance of mite specimens from various species in house dust samples collected from urban (U) and rural (R) apartments in northwestern Poland.

Taxon	Number of specimens examined			Frequency (%)			Dominance (%)		
	U	R	U+R	U	R	U+R	U	R	U+R
Dermatophagoides farinae	653	1,028	1,681	29.9	45.6	39.8	68.4	57.1	61.0
Dermatophagoides pteronyssinus	83	113	196	8.4	15.4	12.8	8.7	6.3	7.1
Chortoglyphus arcuatus	43	113	108	5.6	12.1	9.7	4.5	3.6	3.9
Cheyletus sp.	169	556	725	16.8	39.6	31.1	17.7	30.9	26.3
Euroglyphus maynei	1	-	1	0.9	-	0.3	0.1	-	0.03
Hirstia sp.	6	9	15	1.9	45.6	2.4	0.6	57.1	0.5
Gohieria fusca	-	12	12	-	15.4	0.7	-	6.3	0.4
Lepidoglyphus destructor	-	16	16	-	12.1	0.7	-	3.6	0.6
Total	955	1,799	2,754	29.9	39.6	44.3			

which represented 44.3% of all the investigated samples. A total of 2,754 isolated specimens belonged to the order Astigmata, families Pyroglyphidae (*Dermatophagoides farinae*, *D. pteronyssinus*, *Euroglyphus maynei*, and *Hirstia* sp.), Chortoglyphidae (*Chortoglyphus arcuatus*), and Glycyphagidae (*Gohieria fusca*, *Lepidoglyphus destructor*), as well as the representatives of the order Prostigmata, family Cheyletidae (*Cheyletus* sp.) (Table 1). The most frequent were representatives of *D. farinae* and *Cheyletus* sp., with frequencies (F) of approximately 40% and 30% (Table 1). The species *D. pteronyssinus* and *C. arcuatus* had a frequency of about 10%, and representatives of the order *Hirstia* 2%. Other species detected in dust samples were characterized by a much smaller frequency (<1%).

The largest coefficient of dominance (D) was *D. farinae*, while the lowest was *E. maynei*. The species *D. farinae* and *Cheyletus* sp. could be categorized as eudominants, *D. pteronyssinus* dominant, and *C. arcuatus* subdominant. Other taxa (*E. maynei*, *Hirstia* sp., *G. fusca*, and *L. destructor*) were classified as subrecedents.

Acarological Characteristics of Dust Mites from Urban Apartments

Out of 107 samples collected from 33 urban dwellings, mites were detected in 32 samples (35%). A total of 955 specimens were isolated, representing 6 taxa (Table 1). The following were detected: *D. farinae*, *D. pteronyssinus*, *C. arcuatus*, *E. maynei*, *Cheyletus* sp., and *Hirstia* sp. The highest coefficients of frequency and dominance were *D. farinae*. This species was observed in approximately 30% of samples, and had a D coefficient of about 70% (Table 1). The smallest frequency (F=0.9%) and dominance (D=0.1%) were observed for *E. maynei* – with only one specimen found in a sample from an apartment in Szczecin (Table 1).

Acarological Characteristics of Dust from Rural Apartments

The presence of mites was observed in 96 samples (83%) out of 182 collected from 37 rural homes (Table 1). A total of 1,799 specimens were isolated, belonging to 5 species (*D. farinae*, *D. pteronyssinus*, *C. arcuatus*, *G. fusca*, and *L. destructor*) and representative of two orders – *Cheyletus* and *Hirstia*. The dust from living quarters in rural areas most frequently contained *D. farinae* (F=45.6%), while the rarest were two species *G. fusca* and *L. destructor* (for both species F=0.7%).

The greatest dominance was observed for *D. farinae* (D=57.1%), while the lowest was for *Hirstia* sp. (D=0.5%).

Comparison of Taxonomic Composition and Acarofauna Coefficients in Dust from Urban and Rural Apartments

Comparing the occurrence of mites in dust samples collected from urban and rural apartments, it was found that the differences concerned not only taxonomic composition, and the number of collected specimens, but also the coefficients of frequency and dominance of individual taxa.

The concentrations of the four most common mites (geometric mean per 1 g of dust) were as follows: in urban (U) apartments *D. farinae* 14.5, *D. pteronyssinus* 11.6, *C. arcuatus* 5.5, and *Cheyletus* sp. 11.2; in rural (R) apartments *D. farinae* 10.3, *D. pteronyssinus* 3.3, *C. arcuatus* 3.1, and *Cheyletus* sp. 7.4. The concentrations of these taxa were compared between urban (U) and rural (R) samples. In all cases, the concentrations of these taxa were greater in urban than in rural samples, which was confirmed statistically (p ranged from 0.0001 to 0.04 for *D. pteronyssinus* to *Cheyletus* sp.).

In rural apartments 1,799 specimens were found, while in urban apartments only 955 specimens were found.

In both groups, 5 taxa of mites were found: *D. farinae*, *D. pteronyssinus*, *C. arcuatus*, *Cheyletus* sp., and *Hirstia* sp. The species *G. fusca* and *L. destructor* were found only in rural areas (two samples). The species *E. maynei* was found only in one sample from an urban apartment.

In both groups, the dominant taxa were *D. farinae* and *Cheletus* sp., but their coefficients of frequency and dominance varied between urban and rural samples. The species *D. farinae* had a much larger frequency in rural samples compared to urban samples (respectively F=45.6% and F=29.9%). The coefficient of dominance for *D. farinae* was higher in urban samples than in rural ones (respectively D=68.4% and D=57.1%). The same was true with respect to *D. pteronyssinus*, 8.7% and 6.3%, respectively, and *C. arcuatus*, respectively 4.5% and 3.6%. The frequency of *Cheyletus* sp. (F=39.6% in rural samples, F=16.8% in the urban samples) showed a great difference. In rural samples, *Cheyletus* sp. mites were a few dozen percent more dominant than in urban homes (respectively D=30.9% and D=17.7).

Discussion of Results

The samples of house dust from urban and rural apartments in northwestern Poland contained mites belonging to the order Astigmata, families Pyroglyphidae (*D. farinae*, *D. pteronyssinus*, *E. maynei*, and *Hirstia* sp.), Chortoglyphidae (*Chortoglyphus arcuatus*), and Glycyphagidae (*Gohieria fusca*, *Lepidoglyphus destructor*), as well as representatives of the order Prostigmata, family Cheyletidae (*Cheyletus* sp.). The taxonomic composition of the house dust was similar to homes in Upper Silesia, southern Poland [13]. In addition, *D. farinae*, *D. pteronyssinus*, and *Cheyletus* sp. found in this study, have also been found in Gdańsk and Gdynia in northern Poland [3]. In this study we did not observe *Gymnoglyphus longior* from the Pyroglyphidae family or *Glycyphagus domesticus* Glycyphagidae, which have previously been found in both Poznań, Central Poland [25] and in Upper Silesia (southern Poland) [32]. We also did not find Acaridae mites (e.g. *Tyrophagus putrescentiae*), which have been found in house dust in Katowice and surrounding cities [32, 33]. This study demonstrated the presence of only two orders of mites in northwestern Poland, namely Astigmata and Prostigmata, while in other parts of the country two different orders have been detected: Oribatida and Mesostigmata [32].

This study shows that in urban and rural apartments of northwestern Poland, the most frequent mite was *D. farinae*. In urban apartments its frequency was approximately 30% and in rural apartments 45.6%. Similar or higher frequencies of this species were found by Solarz [13, 32] in urban apartments of Upper Silesia, and by Racewicz [3] in Gdynia (Table 2). In comparison to this research and the aforementioned authors, much smaller coefficients of frequency of *D. farinae* were recorded in house dust samples in Warsaw [34] and Upper Silesia, tested in the early 21st century [35]. Interestingly, studies conducted in Bydgoszcz did not show the presence of this species in house dust [36].

Dermatophagoides farinae had the greatest coefficient of dominance, both in urban and rural apartments in northwestern Poland. Samoliński gives a similar value [34] for samples of dust collected in homes in Warsaw, where he found two species, including *D. farinae* and *D. pteronyssinus* (Table 2). In addition, *D. farinae* had a similar dominance in Upper Silesia, in the cities of Katowice [33] and Bytom [37]. The dominance coefficient of *D. farinae* was greater in Gdańsk [3] and Upper Silesia [13]. However, in contrast to the aforementioned data, Solarz [38], in his earlier studies in Upper Silesia (Katowice), recorded a much lower rate of dominance for this species. It seems that while changes in the coefficient of dominance for *D. farinae* are very dynamic over time; the directions of these changes are different. It is shown by a summary of the dominance coefficient established for house dust samples in the city of Katowice, published between 1983-2007 (Table 2).

The results of similar studies conducted in Europe and other continents suggest that *D. farinae* is fairly common in house dust and most frequent in relation to other mite taxa. Even greater frequency coefficients than in this study have been presented in Russia and Korea (Table 2). Much lower values were found in Brazil, Iran, Israel, Spain, and China (Table 2).

Another frequently mentioned species in the dust samples collected from apartments in northwestern Poland was *D. pteronyssinus*. Frequency and the dominance of *D. pteronyssinus* were clearly lower than for *D. farinae*. The frequency of *D. pteronyssinus* in urban apartments of West Pomerania was 8.4%. A similar frequency of this species was observed by Racewicz [3] in the northern Polish cities of Gdańsk and Gdynia, and by Wu et al. [47] in China. Much higher coefficients of frequency were found in Upper Silesia [32] and Warsaw [34], as well as in Spain, Iran, Brazil, Israel, the United Kingdom, Russia, and Korea (Table 2).

In house dust samples collected from the apartments in northwestern Poland, the coefficient of dominance for *D. pteronyssinus* was approximately 6% for rural and approximately 9% for urban areas. In other Polish cities in different regions, this coefficient was higher (Table 2). The high coefficient of dominance of *D. pteronyssinus* has also been noted in many places around the world, including Russia and Korea (Table 2). In Brazil, da Silva et al. [50] found the dominance of this species to be eight times higher, and Gülegen et al. [49] found it was six times higher in Turkey than in Szczecin and its environs.

In this study the average number and frequency of *D. farinae* and *D. pteronyssinus* in house dust samples or was higher in rural areas than in urban ones. Similar results were obtained by Turos [53] in studies conducted in Stockholm. It was found that the incidence of mites from the family Pyroglyphidae in farm houses was approximately 10 times higher than in Stockholm, which could have been related to the type of heating. Most urban apartments were centrally heated while rural houses were heated by stoves. Solarz [54] suggests that the type of heating can have a significant impact on the concentration of mites from the family Pyroglyphidae. He showed that *D. pteronyssinus* are pre-

Table 2. Frequency and dominance of dust mites in dust samples from various parts of Poland and other countries (in parenthesis are given source).

Country	Region	Taxon and its	
		frequency (%)	dominance (%)
Dermatophagoides farinae			
Poland	southern part (Upper Silesia)	17.65 [35]	36.1 [39]
		34.87 [32]	40.19 [32]
		37.61 [13]	66.99 [13]
		44.1 [39]	
	southern part (Katowice)		25.5 [38]
			40.2 [32]
			62.7 [33]
			67.0 [13]
			73.3 [35]
	southern part (Bytom)		62.6 [37]
	northern part (Gdańsk and Gdynia)	31.3 [3]	78.9 [3]
	central part (Warsaw)	19.4 [34]	69.1 [34] *Dermatophagoides* spp.
Russia	southern part (Penza)	75.0 [40]	68.5 [41]
Korea		63.5 [41]	
Brazil	southern part (Uberaba)	12.3 [42]	
	southeastern part (Juiz de Fora)	5.0 [43]	
Iran	southern part (Bandra-Abbas)	11.6 [44]	
Israel		7.9 [45]	
Spain	northwestern part (Galicia)	5.2 [46]	
China		3.0 [47]	
Taiwan	central part		13.0 [48]
Turkey	northwestern part (Bursa)		4.16 [49]
Dermatophagoides pteronyssinus			
Poland	southern part (Upper Silesia)	34.03 [32]	18.6 [35]
		33.7 [39]	23.0 [37]
			27.4 [39]
			29.0 [38]
			30.4 [34]
			45.1 [32]
			91.83 [13]
	northern part (Gdańsk and Gdynia)	6.0 [3]	16.1 [3]
	central part (Warsaw)	43.7 [34]	69.1 [34] *Dermatophagoides* spp.
Spain	Galicia	97.6 [46]	
Iran	southern part (Bandra-Abbas)	86.0 [44]	
Brasil	southern part (Uberaba)	72.0 [43]	
	southern part (Londrina)	84.0 [50]	72.0 [50]

Table 2. Continued.

Country	Region	Taxon and its	
		frequency (%)	dominance (%)
Dermatophagoides pteronyssinus			
Israel		85.6 [51]	
Great Britain		44.0 [52]	
Russia	southeastern part (Penza)	39 [40]	20.0 [40]
Korea		29.6 [41]	70.0 [41]
China		7.0 [47]	
Taiwan	central part		77.0 [48]
Turkey	northwestern part (Bursa)		58.34 [49]
Cheyletus sp.			
Poland	southern part (Upper Silesia)	10.08 [32]	7.2 [39]
		1.4 [39]	2.74 [32]
	northern part (Gdańsk and Gdynia)	5.2 [3]	2.0 [3]
Spain	northwestern part (Galicia)	47.7 [46]	
Brazil	southern part (Uberaba)	33.9 [59]	
		1.5 [42]	
Puerto Rico		19.3 [60]	
Chile	southern part (Valdivia)	6.5 [61]	
Iran	southern part (Bandra-Abbas)	2.4 [44]	
Turkey		2.0 [62]	
Israel		1.0 [51]	
Chortoglyphus arcuatus			
Poland	southern part (Upper Silesia)	14.2 [39]	8.32 [13]
		0.89 [13]	4.1 [39]
Spain	northwestern part (Galicia)	35.5 [46]	
Brazil	southeastern part (Juiz de Fora)	0.2 [43]	
Korea		0.01 [41]	

sent in higher concentrations in apartments heated by tiled stoves compared to those with central heating. This was also confirmed by studies conducted in Turkey [49], where dust samples from houses without central heating had three times more of these mites. Russian data are consistent with this observation [40].

In this study, in addition to the aforementioned species, relatively high rates of frequency were observed for two other taxa of mites, *Cheyletus* sp. and *C. arcuatus*. These species are commonly known as storage mites, but may also occur with varying frequency in house dust [55-57]. These are outstandingly allergenic species [58]. In studies conducted in northwestern Poland, the frequency of *Cheyletus* mites was higher than in Upper Silesia and Gdańsk and Gdynia in northern Poland (Table 2). A frequency similar to our study was found in Spain, Brazil, and Puerto Rico (Table 2). By contrast, a lower frequency was found in house dust in Chile, Iran, Turkey, and Israel (Table 2). *Cheyletus* mites include many predatory species, so their concentration largely depends on the availability of prey [63]. In this study, however, the biotic factor was not taken into account.

Both in the West Pomeranian voivodship and in other parts of Poland, *Chortoglyphus arcuatus* has rarely been detected in house dust [13], or not at all [3]. A similar frequency and dominance of *C. arcuatus* was observed in southern Poland [39]. Compared to our results, Solarz [13] showed a lower frequency and greater dominance of this species. *Chortoglyphus arcuatus* has also been found in dust from homes in other parts of the world, for example in Spain, Brazil, and Korea (Table 2).

Dust samples collected in houses in West Pomerania occasionally contained mites representing the following taxa: *Euroglyphus maynei*, *Hirstia* sp., *Lepidoglyphus destructor*, and *Gohieria fusca*. They all occurred at a fre-

quency of less than 2%, and a dominance index less than 1%. A similar frequency of *E. maynei* was observed by Solarz in different locations in Poland [13], while in Warsaw flats, this species was observed in 18.5% of samples [34]. *Hirstia* mites, rare in West Pomerania, were also rarely detected in southern Poland [13, 54].

Other distinctly allergenic species belonging to the family Glycyphagidae *L. destructor* and *G. fusca* [58, 64] were found only in rural houses of Western Pomerania, which is consistent with studies by Solarz [4, 13] carried out in Upper Silesia.

In Brazil, in contrast to these results, *G. fusca* had a much greater frequency (over 20%) [58], and *L. destructor* was a dominant taxon [65].

Conclusions

1. The examined dust from urban and rural apartments contained specimens representing the following genera and species: *Dermatophagoides farinae*, *D. pteronyssinus*, *Euroglyphus maynei*, *Hirstia* sp., *Chortoglyphus arcuatus*, *Lepidoglyphus destructor*, *Gohieria fusca*, and *Cheyletus* sp. Of these taxa, those distinctly allergenic are *D. farinae*, *D. pteronyssinus*, *E. maynei*, *G. longior*, *L. destructor*, *G. domesticus*, *Acarus siro complex*, *T. putrescentiae*, *T. longior*, and *C. arcuatus*.
2. In the examined dust from urban and rural apartments, mites were found in nearly 30% and 53% of the analyzed samples, respectively.
3. Among the identified taxa, the highest frequencies were found for *D. farinae*, *D. pteronyssinus*, *C. arcuatus*, and *Cheyletus* sp.
4. In urban and rural apartments the dominant species was *D. farinae* (with respective coefficients of dominance of 68.4% and 57.1%).
5. The average number of individuals of *D. farinae*, *D. pteronyssinus*, *C. arcuatus*, and *Cheyletus* sp. were higher in rural than urban houses, which was confirmed statistically.

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