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Original Research

Mites in Dust Samples Collected from Sleeping Places in Apartments

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Abstract

The aim of this study was to determine the species composition and concentrations of mites in dust collected from sleeping places in urban and rural apartments of northwestern Poland. In the dust samples from both urban and rural apartments the following mites were determined: *Dermatophagoides farinae* Hughes, *D. pteronyssinus* (Trouessart), *Euroglyphus maynei* (Cooreman), *Hirstia* sp., *Chortoglyphus arcuatus* (Troupeau), *Lepidoglyphus destructor* (Schrank), *Gohieria fusca* (Oudemans), and *Cheyletus* sp. The obtained results confirm high concentrations of mites in sleeping places both in urban and rural apartments, and the influence of environmental conditions and the age and building type on the composition of acarofauna.

Keywords: acarofauna, allergenic mites, Glycyphagidae, Pyroglyphidae

Introduction

House dust mites occur commonly in human environments. They have been observed in dust samples collected from hospitals, libraries, dormitories, theatres, schools, hotels, offices, military bases, farm stores, commercial stores, flour mills, and in public transportation (in the seats of planes, trains, cars, cabins of ocean liners) and in utility buildings [1-5].

Mites that have been most frequently observed in dust belong to the families Pyroglyphidae, Glycyphagidae and Acaridae. The greatest role in causing allergies is played by Pyroglyphidae, which constitute 60-90% of acarofauna in apartments in temperate climate. Dust from apartments usually contains species of *Dermatophagoides pteronyssinus*, *D. farinae,* and *Euroglyphus maynei* [2, 3, 6-11].

The allergenic activity of house dust mite on humans can be manifested by symptoms of respiratory and skin diseases such as bronchial asthma (*asthma bronchiale*), runny nose (*rhinitis*) and atopic eczema (*eczema atopicum*). Moreover, it has been proved that mites may be involved in the pathogenesis of urticaria (*urticaria dermatitis*) and the inflammation of the cornea and conjunctiva (*keratoconjunctivitis*) [12-16]. Less commonly reported are allergic reactions observed after the consumption of food contaminated by mites, although in extreme cases it can cause anaphylactic shock [17-18].

The greatest concentration of mite allergens occurs in sites that are most preferred by mites for colonization, i.e. sheets, mattresses, carpets, and upholstered furniture [19]. One gram of dust may contain hundreds and even thousands of mites in various developmental stages. The communities can include 2-3 species or more.

It has been observed that temperature and relative humidity are the main factors governing the abundance of the mite population [20, 21]. They live in temperatures ranging from -18ºC to +50ºC, with optimal 25ºC [22]. Mites require high air humidity, from 60% to 80%. In rooms with humidity below 45% they desiccate and die [8]. The species that is most resistant to low humidity is *D. farinae*, which is why it is more common in apartments with central heating [23].

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Although there are reports on the occurrence of house dust mites in Poland, they usually concern only some parts of the country, mainly the central and southern parts [11, 24-26]. This is why it seems necessary to include other areas of the country. In this paper, it was NW Poland that was examined with regard to the composition and concentration of allergenic mites in sleeping places in urban and rural apartments. Moreover, the aim was to determine any relationship between environmental factors, such as temperature and relative humidity, and the occurrence of mites in house dust. It was examined whether the age and type of building had any significance on the sampled mite fauna.

Materials and Methods

Collection of Samples

In this study, samples were collected once a month in the last quarters of the years 2004-06 (October, November, December). A total of 66 dust samples were collected from 30 urban apartments (Szczecin, Police, Pyrzyce, and Łobez) and 36 rural quarters (Przelewice, Brzesko Szczecin, Bylice, Krasne, Kąkolewice, Wierzchowo, Przeradz, and Kłodzino) from the West Pomeranian province in NW Poland. Apartments in which dust samples were collected were divided into four groups, depending on the type of the building where the mites were found:

(1) tenements (here the tenement refers to any apartment building made from brick or stone, at least one story high (n=18),
(2) blocks of flats (n=22),
(3) houses (n=5), and
(4) houses connected with farm buildings (n=21).

Buildings also were divided into four groups with regard to their age:

A_1 0-10 years (n=2),
A_2 11-20 years (n=8),
A_3 21-50 years (n=40) and
A_4 above 50 years (n=16).

Dust samples were collected from sleeping places (couches, beds, and mattresses), using a Progress 83S vacuum cleaner (Germany, 1000 W) with a 10 x 10 cm cotton-filter to collect dust together with mites. In each sample the vacuum cleaner covered a surface of 1 m^2 for 2 minutes.

In the examined rooms, temperature was measured at 1.3-1.5 m from the floor using a mercury-in-glass thermometer, which in the statistical analysis was divided into three sections (T_1: 18ºC-21ºC, T_2: 22ºC-25ºC, and T_3: 26ºC-27ºC). Also, the relative humidity of air was measured at 0.4 m-0.7 m from floor level (the average height of bed places), using a hygrometer (hygrometer synthetic, 0-70ºC, Fischer, GDR), and in the statistical analysis the values were grouped into three sections (RH_1: 62-70%, RH_2: 71-80%, and RH_3: 81-93%).

The Isolation of Mites

The dust samples were weighed and flooded with a saturated NaCl solution and several drops of detergent and left for 24 hours. After this time, the liquid from above the sediment (supernatant) was filtered. After re-filtering, the blotting-paper filter was placed on the Petri dish and again flooded with NaCl solution. After 1-2 days each dish was examined under a stereoscopic microscope (40x) to detect any mites. This procedure was determined by Arlian et al. [27]. The acarological analysis concerned only intact individuals, as it was assumed that the damaged mites were already dead at a moment of sampling.

After isolating mites, acarological keys were used for species determination [4, 8, 28-31], using an OLYMPUS light microscope with a phase contrast system [32].

Statistical Analysis

The statistical analysis of mites present in the collected dust samples was based on the concentration coefficient (K), which describes the number of mites per/g of dust. Descriptive analyses were performed for the concentrations of the most frequently occurring mites: *D. farinae, D. pteronyssinus, Ch. arcuatus,* and *Cheyletus* sp., using the arithmetical mean (x), the standard deviation (SD), the coefficient of variance (V), minima, and maxima. The statistical analysis also concerned the relationship between the occurrence of allergenic mites in the dust and the origin of samples (urban or rural), temperature, relative humidity, and the age and type of the building. Comparisons of means were carried out in pairs, with differences deemed statistically significant at $p \leq 0.05$.

The Student t-test was applied and the relationships between the selected parameters were determined using the Pearson correlation coefficient (r). When the distribution of the experimental data was in compliance with the expected normal distribution, a non-parametric Kolmogorov-Smirnov test was used, and the relationship between the selected properties were expressed using the Spearman correlation coefficient (rs). Statistical analysis was performed using the computer programme Statistica 8.

Results

Taxonomic Composition of Acarofauna from Dust Samples Collected from Sleeping Places in Urban and Rural Locations

The mites identified in dust samples collected from sleeping places from urban and rural locations of NW Poland belonged to the following taxa: *Dermatophagoides farinae*, *Dermatophagoides pteronyssinus, Chortoglyphus arcuatus*, *Cheyletus* sp., *Euroglyphus maynei*, *Hirstia* sp., *Gohieria fusca,* and *Lepidoglyphus destructor*.

The species *D. farinae* were observed in 38 examined locations, i.e. in 57% of samples (Table 1). The maximum

Table 1. Mean concentrations of the most frequent mite taxa in dust sampled from urban and rural apartments in northwestern Poland.

Taxon	Samples from urban apartments (U)		Samples from rural apartments (R)		K-S test U vs. R	U+R	
	n	Concentration x±SD V (%) (min. – max.)	n	Concentration x±SD V (%) (min. – max.)		n	Concentration x ± SD V (%) (min. – max.)
Dermatophagoides farinae	18	20.28±28.41 140.05 (7.7 – 111.4)	20	21.38±21.34 99.80 (7.1 – 100.8)	NS	38	20.86±24.59 117.90 (7.1 – 111.4)
Dermatophagoides pteronyssinus	6	11.23±2.24 19.96 (9.2 – 14.0)	8	6.76±3.63 53.67 (2.3 – 11.2)	NS	14	8.68±3.78 43.57 (2.3 – 14.0)
Chortoglyphus arcuatus	4	5.30±1.89 35.73 (3.2 – 7.8)	6	3.70±3.33 89.92 (1.1 – 10.3)	NS	10	4.34±2.83 65.28 (1.1 – 10.3)
Cheyletus sp.	13	16.40±8.75 53.33 (3.4 – 37.8)	19	15.96±10.20 63.93 (4.2 – 44.8)	NS	32	16.14±9.49 58.82 (3.4 – 44.8)

The presented statistics concern the concentration of mites per/g of dust sampled from sleeping places between October and December in urban (U) and rural (R) apartments; n – number of positive samples, x – arithmetical mean, SD – standard deviation, V – variance coefficient, min. – minimum, max. – maximum; significance of statistical differences between U and R (K-S test – Kolmogorov-Smirnov test was used), NS – non significant difference.

concentration of this species exceeded 110 mites per/g of dust. In urban and rural apartments the mean concentration of this mite was similar: 20-21 mites per/g of dust. Mites from the genus *Cheyletus* were detected in 32 examined locations (48% of samples) with a maximum concentration of 45 mites in 1g of dust. The mean concentration of this species in urban and rural apartments was similar, with about 16 mites per/g of dust. Species *D. pteronyssinus* and *Ch. arcuatus* were characterized by a considerably smaller mean concentration than *D. farinae* and *Cheyletus* sp. Mite *D. pteronyssinus* was observed in 14 examined locations (21% of samples) with the maximum concentration of 14 mites per/g of dust. *Chortoglyphus arcuatus* was observed in 10 locations (15% of samples) with a maximum concentration a little above 10 mites per/g of dust (both these species did not exhibit statistically confirmed differences between urban and rural locations). The remaining mite species isolated from dust samples were detected only sporadically and were subsequently not subjected to any statistical analysis.

Analyzing mean values of mite concentration in dust samples, it was observed that standard deviations were greater than the mean, and respective variance coefficients concerning this parameter range from 20% to 100%. The values of variance coefficients suggest that the distribution does not conform to the expected normal distribution, as confirmed by testing hypothesis H_0. It was assumed that an agreement of the distribution of empirical data with the expected normal distribution exists (H_0). Thus hypothesis H_0 was rejected, because the χ^2 test concerning the concentration of *D. farinae* mites had a value of 52.63 at p=0.00001. In the case of the remaining species, the χ^2 test could not be applied due to the insufficient number of detected mites – below 50.

Influence of Temperature and Relative Humidity on the Composition and Concentration of Mites

Table 2 presents data concerning the occurrence of mite taxa in dust samples collected from sleeping places in locations against the determined temperature and relative humidity. *Dermatophagoides farinae* and the genus *Cheyletus* were observed in locations belonging to all categories of measured temperature and relative humidity. *Dermatophagoides farinae* were found most frequently in locations at 22°C to 25°C, and relative humidity 71% to 80%, while the greatest concentration was found in locations at 22°C to 25°C and relative humidity 81% to 93%. The genus *Cheyletus* were most often found and attained the greatest concentration in locations at 22°C to 25°C, while the greatest number of these mites was recorded in locations with relative humidity 71% to 80%, and the greatest mean concentration was observed in locations with relative humidity 62% to 70%. The species *D. pteronyssinus* and *Ch. arcuatus* were found in rooms at 18ºC to 25ºC and relative humidity 62% to 93%. *Dermatophagoides pteronyssinus* was most common and had the greatest value of mean concentration in rooms at 22ºC to 25ºC and relative humidity 71% to 80%. The species *Ch. arcuatus* was most often ascertained in rooms at 22ºC to 25ºC; the greatest mean concentration of this species was recorded in apartments at 22ºC to 27ºC. This species was most common in rooms with relative humidity 71% to 80%, and the greatest concentration was recorded at 62% to 70% humidity. Mites from the genus *Hirstia* and the species *G. fusca* were ascertained in apartments at 18°C to 25°C and relative humidity 91% to 93%. The species *L. destructor* and *E. maynei* were detected only in

Table 2. The effect of temperature and relative humidity on concentrations of the most frequent mite taxa collected from sleeping places in northwestern Poland.

Taxon	Temperature (ºC)			Relative humidity (%)		
	T_1 x±SD (n)	T_2 x±SD (n)	T_3 x±SD (n)	RH_1 x±SD (n)	RH_2 x±SD (n)	RH_3 x±SD (n)
Dermatophagoides farinae	13.37±5.75 (6)	22.64±26.88 (31)	10.80 (1)	22.32±18.75 (4)	16.50±18.26 (26)	34.30±39.72 (8)
Dermatophagoides pteronyssinus	8.50±3.74 (5)	8.78±4.02 (9)	– 0	9.05±7.00 (2)	9.19±3.22 (10)	5.75±4.88 (2)
Chortoglyphus arcuatus	4.58±2.42 (4)	4.18±3.29 (6)	– 0	7.75±3.61 (2)	2.97±1.31 (6)	5.05±3.89 (2)
Cheyletus sp.	14.07±7.93 (6)	17.03±9.87 (25)	6.40 (1)	17.43±11.49 (3)	16.20±9.31 (21)	15.49±10.61 (8)

This table presents the mean concentration of mites per/g of dust collected in the 4th quarter of the year in sleeping places in three temperature ranges: T_1 (18ºC-21ºC), T_2 (22ºC-25ºC) and T_3 (26ºC-27ºC), and three ranges of relative humidity RH_1 (62%-70%), RH_2 (71%-80%) and RH_3 (81%-93%); n – number of positive samples, x – mean, SD – standard deviation.

single samples coming, respectively, from rooms at 18°C to 21°C and 22°C to 25°C, with relative humidity in either case 81% to 93%.

In order to determine any relationships between the investigated physical parameters and the concentrations of mite taxa most common in dust samples (*D. farinae, D. pteronyssinus, Ch. arcuatus* and *Cheyletus* sp.), Spearman's rank coefficient was calculated (r_S) and significance assumed. Statistically significant ($p \leq 0.05$) were correlations between the concentration *Cheyletus* sp. and temperature prevalent in bedrooms (r_S=0.304), and between the concentration *Ch. arcuatus* and relative humidity (r_S=-0.629). It was concluded that the concentration of mites from the genus *Cheyletus* is connected with the temperature 22ºC to 25ºC. Relative humidity of 62% to 70% favours the increase of the species *Ch. arcuatus*.

Influence of Parameters of Buildings on the Composition and Concentration of Mites

Table 3 presents data concerning the occurrence of mite taxa in relation to the age and type of a building. The greatest number of mite taxa was found in houses connected with utilities, with 7 out of 8 taxa, namely: *D. farinae, D. pteronyssinus, Ch. arcuatus, Cheyletus* sp., *Hirstia* sp., *G. fusca,* and *L. destructor* (only *E. maynei* was not found). In dust samples collected in tenements and blocks there were respectively 6 and 4 mite taxa. In detached houses (not adjacent to any utility buildings) in towns and rural areas only two taxa were observed, which could be connected with a smaller number of the examined samples in comparison with other types of buildings. In tenements most of the aforementioned mites were found, except *G. fusca* and *L. destructor*.

Table 3. Concentrations of the most frequent mites collected from sleeping places in apartments in buildings of various ages and types.

Taxon	Building age				Building type			
	A_1 x±SD (n)	A_2 x±SD (n)	A_3 x±SD (n)	A_4 x±SD (n)	D_1 x±SD (n)	D_2 x±SD (n)	D_3 x±SD (n)	D_4 x±SD (n)
Dermatophagoides farinae	55.45±4.13 (2)	32.90±34.10 (8)	15.50±14.80 (26)	7.75±0.92 (2)	18.24±30.15 (18)	15.80±18.01 (16)	8.30 (1)	7.77±0.65 (3)
Dermatophagoides pteronyssinus	11.85±0.92 (2)	8.51±3.11 (7)	6.77±5.36 (4)	8.00 (1)	8.00±3.93 (11)	11.20±2.83 (2)	– 0	11.10 (1)
Chortoglyphus arcuatus	3.20 (1)	5.68±3.36 (5)	3.56±1.48 (3)	1.10 (1)	4.64±2.93 (8)	5.20 (1)	– 0	1.10 (1)
Cheyletus sp.	22.40 (1)	18.23±6.68 (6)	13.92±8.57 (22)	26.13±16.63 (3)	18.41±8.78 (15)	11.55±6.41 (13)	11.80 (1)	26.13±16.63

The table presents the mean concentration of mites per/g of dust collected in the 4th quarter of the year in sleeping places in apartments from four age ranges: A_1 – 0-10 years, A_2 – 11-20 years, A_3 – 21-50 years, A_4 – above 50 years and four types of construction: D_1 – tenement, D_2 – flat, D_3 – house, D_4 – house adjacent to farm buildings; n – number of positive samples, x – mean, SD – standard deviation.

All the types of buildings had *D. farinae,* and *Cheyletus* sp. *Dermatophagoides farinae* was most often observed in tenements and apartment buildings, with 18 and 16 positive samples, respectively. The greatest mean concentration of this species (above 18 mites per/g of dust) was recorded in samples from tenements. Two other species most frequently found in tenements were: *D. pteronyssinus* and *Ch. arcuatus*, in 11 and 8 samples, respectively. The greatest mean concentration of *D. pteronyssinus* (above 11 mites per/g of dust) was recorded in samples from blocks, *Ch. arcuatus* in tenements (about 5 mites per/g of dust). Also, in the case of representatives from the genus *Cheyletus* the greatest number of positive samples was found in tenements (n = 15), but the greatest mean concentration (above 26 mites per/g of dust) was recorded in houses with a passage to adjacent farm buildings. Comparisons were made within mean concentrations of individual mites per/g of dust from the examined types of buildings, but no essential differences were found.

The analysis of relationships between the concentration of mites and types of buildings showed a statistically significant relationship in the case of *D. farinae* (r_S=0.471, $p \leq 0.05$). The greatest concentration of this species in 1 g of dust was found in tenements. The remaining species did not exhibit any distinct regularities in this regard.

Table 3 presents dependencies between the age of buildings and the occurrence of allergenic mites. In all the four groups of houses (A_1, A_2, A_3 and A_4; < 10 years, 11-20, 21-50, and more than 50 years), sleeping places showed the presence of *D. farinae*, *D. pteronyssinus*, *Ch. arcuatus,* and *Cheyletus* sp. Two species, *G. fusca* and *L. destructor,* were recorded only in two samples coming from apartments in the oldest group of the analyzed buildings (A_4). *Dermatophagoides farinae* was most often ascertained in A_3 houses (26 samples), but the greatest mean concentration of mites from this species was recorded in youngest buildings A_1 (above 55 mites per/g of dust) where the number of positive samples from these apartments was small. *Dermatophagoides pteronyssinus* most often was found in A_2 buildings (in 7 samples), but the greatest mean concentration (about 12 mites per/g of dust) was observed in A_1 buildings. The greatest number of positive samples in which *Ch. arcuatus* was present originated from A_2 buildings (in 5 samples), but the greatest mean concentration (about 6 mites per/g of dust) was recorded in apartments in A_3 buildings. Mites from the genus *Cheyletus* sp. were most often ascertained in group A_3, and the greatest mean concentration was recorded in A_4 buildings (26 mites per/g of dust).

We did not observe statistically confirmed differences between the concentrations of mites with regard to buildings age, but a negative correlation was found between the concentration of *D. farinae* and the building age (r_S=-0.498, $p \leq 0.05$). The younger the building, the greater the *D. farinae* concentration in bedrooms. Moreover, a weak negative relationship was found between the total number of *D. farinae* and the building age (r_S=-0.265, $p \leq 0.10$).

Discussion of Results

The Taxonomic Composition of Acarofauna from Dust Samples Collected from Sleeping Places in Urban and Rural Locations

This study showed that in dust samples coming from sleeping places in apartments of NW Poland, half of the isolated mites belonged to the order Astigmata, Pyroglyphidae family. These were the following species: *Dermatophagoides farinae*, *D. pteronyssinus, Euroglyphus maynei* and *Hirstia* sp. Two other families from the same order were also found: Chortoglyphidae (*Chortoglyphus arcuatus*) and Glycyphagidae (*Gohieria fusca, Lepidoglyphus destructor*). Moreover, we recorded the presence of representatives of the order Prostigmata, Cheyletidae families (*Cheyletus* sp.). A similar composition of acarofauna was ascertained by Solarz [11] in dust samples collected from apartments of southern Poland (Katowice, Sosnowiec, Mysłowice, Chorzów, Tarnowskie Góry, Bytom, and Zabrze). Three taxa: *D. farinae*, *D. pteronyssinus* and *Cheyletus* sp. present in dust samples from apartments in the western Pomeranian province were identified and described in a later survey conducted in northern Poland in Gdańsk and Gdynia [3].

This study, contrary to Solarz [26] (who examined Upper Silesia in southern Poland), observed the occurrence of the species *Ch. arcuatus*. However, we did not record the species *Gymnoglyphus longior* from the Pyroglyphidae family found in Poznań by Chmielewski [24] and in Upper Silesia by Solarz [26]. We also did not find *Glycyphagus domesticus* from the Glycyphagidae family previously found in Bydgoszcz [25], Poznań [24], and Upper Silesia [26], or mites from the Acaridae family (eg. *Tyrophagus putrescentiae*) found in apartments of Katowice and neighbouring cities [26]. In samples from NW Poland, mites from two other lines were also not found, namely Oribatida and Mesostigmata, which were previously found in southern Poland [26].

In this study the prevailing species was *D. farinae,* which corresponds to findings by Solarz [26] conducted in Upper Silesia and Racewicz [3] in Gdynia. In samples from urban and rural aparments in western Pomerania, the mean concentration of *D. farinae* was about 20 mites per/g of dust. Similar results were obtained by Racewicz [3] in Gdańsk and Gdynia, and by Solarz [11] in Wodzisław (respectively 24 and 17 mites per/g of dust). Distinctly greater concentrations of *D. farinae* from the aforementioned levels were observed in cities of Upper Silesia. The mean of concentrations of this species in apartments in Katowice, Chorzów, Sosnowiec, and Mysłowice were, respectively, about 274, 87, 43, and 40 mites per/g of dust [11]. Moreover, it was also greater in apartments of Gdańsk [33] and Kraków [11] (respectively 62 and 34 mites per/g of dust). A survey conducted in Łódź showed *D. farinae* occurred at a considerably smaller concentration compared with apartments in NW Poland and other parts of the country, with fewer than 2 mites per/g of dust [11].

Another commonly present species in dust samples from apartments of NW Poland was *D. pteronyssinus*. The mean concentration of this species in samples was 8 mites per/g of dust and similar to the value presented by Racewicz [3] in Gdańsk, Gdynia, and Sopot. A smaller concentration of this species was ascertained by Solarz [11] in Katowice, Chorzów, and Sosnowiec (respectively 6.5, 3.4, and 0.4 mites per/g of dust). A greater mean concentration of *D. pteronyssinus* than the aforementioned levels was observed in samples collected from apartments in Katowice, Bielsko-Biała, Wodzisław and Łódź (respectively about 18, 340, 74, and 60 mites per/g of dust) [11]. Also, other parts of the world show greater concentrations of this species, for example in apartments in cities of the USA (Cincinnati, San Diego, New Orleans, Galveston, and Los Angeles), examined by Arlian et al. [34], the mean concentration of *D. pteronyssinus* (together with *D. farinae*) reached 500 mites per/g of dust. However, the greatest concentrations of this species are reported from Brazil [35] and Malaysia [36], with 875 and 500 *D. pteronyssinus* mites per/g of dust from samples from sleeping places.

In some dust samples collected from sleeping places in NW Poland two other mite taxa were observed: *Cheyletus* sp. and *Chortoglyphus arcuatus*, so-called warehouse-mites [37], although they can also appear in apartment dust [34]. In this study the mean concentration of *Cheyletus* sp. in dust samples was, respectively, about 50 and 30 times smaller than in Upper Silesia [11], and in Gdańsk and Gdynia [3]. In western Pomerania and other parts of Poland, *Ch. arcuatus* was rarely detected [4, 11] or not observed at all [3]. In comparison with our results, Solarz [11] observed a 50% smaller mean concentration of this species (about 2 mites per/g of dust). *Chortoglyphus arcuatus* also was ascertained in the dust from apartments in other parts of the world, for example in Korea [10] and Russia [38].

Dust samples from apartments in NW Poland also showed the rare presence of *Euroglyphus maynei*, *Hirstia* sp., *Lepidoglyphus destructor,* and *Gohieria fusca*. The first of them, *Euroglyphus maynei,* has a large medical significance, but is seldom observed in Poland [11], although Samoliński et al. [39] reported this species in small numbers in 18.5% of the examined apartments in Warsaw. Mites from the genus *Hirstia*, similarly to western Pomerania, were seldom detected in southern Poland [4, 11], and not detected in Gdańsk and neighbouring towns [3]. *Hirstia chelidonis* mites were recorded in apartments in the former USSR [7] and Norway [40].

In several apartments of NW Poland we observed species from the family Glycyphagidae (*L. destructor* and *G. fusca*), similar to apartments in Upper Silesia [11, 26]. *G. fusca* also has been reported in acarofauna in house dust in Turkey [41] and Brazil [42].

Influence of Temperature and Relative Humidity on the Species Composition and Concentration of Mites

Differences in the prevalence of mites are connected with conditions in rooms, mostly temperature and relative humidity [43]. Optimum conditions for the development of *D. farinae* are 25°C to 30°C and 50% to 75% relative humidity [44, 45]. In this study, we noticed that the species *D. farinae* was found most frequently at 22°C to 25°C and 71% to 80% relative humidity, while the greatest concentrations were found in locations at 22°C to 25°C and 81% to 93% relative humidity. The occurrence of *D. farinae* in temperatures and relative humidity other than that defined as optimal for its development could be due to the fact that these optimum values for *D. farinae* were determined experimentally and its adaptive abilities can be considerably greater.

For the second most common species, *D. pteronyssinus*, optimum conditions of development are lower temperatures (15-20°C) and higher relative humidity (75% to 80%) [45]. It is confirmed by a study that showed *D. pteronyssinus* attaining the greatest concentrations at 18°C to 25ºC and 62% to 80% relative humidity. The prevalence of *D. farinae* over *D. pteronyssinus* (and remaining mite taxa) can be explained by the fact that they are more resistant to low relative humidity [11].

Many reports showed a correlation between the concentration of *D. farinae* and *D. pteronyssinus* with the temperature of their habitats [8, 34]. The correlation between the concentration of *D. farinae* and relative humidity of air in the apartment was shown by Lascaud [46] in a study carried out in France, and a relationship between the concentration of *D. pteronyssinus* and relative humidity in studies realized in Denmark by Harving et al. [47]. Hart and Whitehead [48] showed that when relative humidity is above 64% one may observe distinctly more *D. pteronyssinus* mites. The data analysis concerning NW Poland did not show a statistically significant relationship between the concentrations of *D. farinae* and *D. pteronyssinus* and relative humidity and temperature, contrary to Solarz [11, 26], who showed such relationships in other parts of Poland.

It is generally accepted that mites from the family Chortoglyphidae are more sensitive to the influence of relative humidity and temperature than the family Pyroglyphidae [6, 8]. Mites belonging to the genus *Cheyletus* can only develop in very high relative humidity and therefore are more common in the tropics than in Europe [10]. According to Boczek [32], *Cheyletus eruditus* prefers higher temperature and its development can occur even at 32ºC. The optimum temperature for the development of *Cheyletus malaccensis* occurring in Greece is round 33ºC [49]. In this study, mites from the genus *Cheyletus* lived in apartments at 22ºC-25ºC. The species *Ch. arcuatus* was found in greater numbers in apartments with 62% to 70% relative humidity. *Cheyletus* mites include many predatory species and therefore its concentration largely depends on the availability of victims [49]. In this study, however, the biotic factor was not taken into account.

The sporadic occurrence of *E. maynei* in the examined habitat may be due to its high sensitivity to changes in relative humidity. The development of this species was inhibited by relative humidity below 70% [23]. Some reports showed a relationship between the number of *E. maynei* and both temperature [8, 34] and relative humidity [48].

In this study, only one individual of this species was observed, in an apartment in Szczecin, at 87% relative humidity. In some countries or regions of temperate climate, but with a little higher relative humidity such as Great Britain [50], Holland [51], and the Scandinavian countries [40], *E. maynei* appears much more often than in Poland.

The Influence of Parameters of Buildings on the Composition and Concentration of Mites

It has been observed that the type of building and its construction can influence the concentration of mites [6]. In our study, we recorded relationships ($p \leq 0.05$) between the concentration *D. farinae* and the age and type of the building. It was observed that the newer the building, the greater the concentration of *D. farinae* mites. The greatest mean concentration of this species was observed in tenements. An inverse dependence was ascertained by Solarz [11] in apartments in southern Poland for mites from the Pyroglyphidae family, and by Aloszko et al. [33] in apartments of Gdańsk, Gdynia, and Sopot for *D. pteronyssinus,* where they observed a smaller mean concentration of mites in new buildings and in blocks in comparison to old houses. Similar to apartments in Szczecin and its region, in a study carried out in Russia in Penza by Zheltikova et al. [38], the concentration *D. farinae* was greater in older houses and older buildings.

However, it should be noticed that in West Pomerania, most samples with *D. farinae* were obtained from apartments in older buildings (21-50 years old). Similar observations were made by Takaoka and Fujimoto [52] - mites from the Pyroglyphidae family were more common in older houses (3+ years). Ree et al. [10] in his investigation of apartments in Korea did not ascertain statistically confirmed relationships between the concentration of the aforementioned mite species and the age and type of building.

Conclusions

1. In dust from urban and rural apartments of NW Poland, mites representing following species and genera were observed: *Dermatophagoides farinae*, *D. pteronyssinus*, *Euroglyphus maynei*, *Hirstia* sp., *Chortoglyphus arcuatus*, *Lepidoglyphus destructor, Gohieria fusca*, and *Cheyletus* sp.
2. Identified taxa with the greatest concentration included: *D. farinae, D. pteronyssinus*, *Ch. arcuatus,* and *Cheyletus* sp.
3. The concentration of *D. farinae* mites was greater in rural-apartments than urban apartments.
4. Mites from the genus *Cheyletus favour* at 22ºC to 25ºC, and the species *Ch. arcuatus* favours 62% to 70% relative humidity.
5. The following statistically significant correlations were observed:

- the concentration of *D. farinae* and the age of the building (the newer the building, the more mites),
- the concentration of *D. farinae* and the type of the building (the greatest concentration of mites was recorded in apartments of tenements).

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