Acta zoologica cracoviensia, **53B**(1-2): 39-64, Kraków, 30 June, 2010
doi:10.3409/azc.53b_1-2.39-64

Temporal changes in the composition of house-dust-mite fauna in Poland*

Krzysztof SOLARZ

Received: 15 April 2010
Accepted: 18 June 2010

SOLARZ K. 2010. Temporal changes in the composition of house-dust-mite fauna in Poland. *Acta zoologica cracoviensi*a, **53B**(1-2): 39-64.

Abstract. The house dust mites have been shown to produce allergens causing atopic allergies in human beings, known in medicine as house-dust-mite allergy or house-dust-mite atopy. A survey of dust samples from different indoor places was made to determine the diversity of the acarofauna, especially potential differences in various rooms and/or indoor microhabitats. Twenty seven years of surveys (1981-2008) in the southern part of Poland formed the basis for this analysis. A total of 1289 house dust samples from dwellings from 31 localities were studied including samples from beds (or other bedding accommodations), non-carpeted floors, carpets, upholstery furniture, wooden furniture, samples from bedrooms, living-rooms, kitchens and ante-rooms. Moreover, other indoor dust samples were studied: 281 from hospitals, 70 from libraries, 31 from research laboratories, 30 from drug-stores, 57 from offices and other workplaces. The majority of mites were found in samples from the dwellings, especially in dust from couches, sofas and beds. More than 20 astigmatid mite species were found of which the most abundant and common were pyroglyphids, especially *Dermatophagoides farinae* HUGHES, 1961. *Dermatophagoides pteronyssinus* (TROUESSART, 1897) was more abundant per gram of dust only in bed mattresses, whereas *D. farinae* in samples from the remaining indoor places examined. Highest mite densities per gram of dust were noted in dwellings. In hospitals: *D. farinae* was more frequent in samples from floors than from patients' beds, whereas *D. pteronyssinus* was collected more frequently from beds than from floors. Main sources of mites in libraries and drug-stores are shelves, desks, upholstery chairs and carpets, whereas in offices carpeted floors and upholstery furniture. This research, has revealed differences in the occurrence and prevalence of various species of domestic mites between geographical areas and between dwellings within the same geographical area, between particular places within the same dwelling, between the seasons of the year and between years and decades.

Key words: house dust mites, domestic mites, indoor mites, allergenic acarofauna, temporal changes, Poland.

Krzysztof SOLARZ, Department of Parasitology, Medical University of Silesia in Katowice, Jedności 8, 41-218 Sosnowiec, Poland.
E-mail: solarzk@sum.edu.pl

*This study was supported by the Ministry of Science and Higher Education through grant N401 153 32/3010.

I. INTRODUCTION

In total at least 150 species of mites have been found in dwellings, including plant parasites, animal parasites, predatory mites, oribatid mites and storage mites. But the most abundant mites in house dust are members of the family Pyroglyphidae Cunliffe, in particular *Dermatophagoides pteronyssinus* (TROUESSART, 1897), *Dermatophagoides farinae* HUGHES, 1961 and *Euroglyphus maynei* (COOREMAN, 1950). These house-dust mites are the major sources of indoor inhalant allergens facilitating both the sensitization of atopic subjects and asthmatic attacks in patients (KORSGAARD 1983b; ARLIAN 1991; VARGAS & MAIRENA 1991; ARLIAN et al., 1993a, b, 1999a, 2008; FAIN et al. 1990; COLLOFF et al. 1992; PLATTS-MILLS et al. 1992; POPE et al. 1993; ROBINSON et al. 1997; AALBERSE 1998; HALLAS 1998; HALLAS & KORSGAARD 1997, 1998; ARLIAN & PLATTS-MILLS 2001). The pyroglyphid mites usually make up 60-90% of the indoor acarofauna in temperate climate regions throughout the world (FELDMAN-MUHSAM et al. 1985; HALLAS 1991; CHEW et al. 1999). To date, only 15 species of these dust mites have been found in indoor environments: *Dermatophagoides pteronyssinus*, *D. farinae*, *Dermatophagoides evansi* FOLLOFF, HUGHES & JOHNSTON, 1967, *Dermatophagoides microceras* GRIFFITHS & CUNNINGTON, 1971, *Dermatophagoides siboney* DUSBABEK, CUERVO & DE LA CRUZ, 1982, *Dermatophagoides neotropicalis* FAIN & VAN BRONSWIJK, 1973, *Hirstia domicola* FAIN, OSHIMA & VAN BRONSWIJK, 1974, *Hirstia chelidonis* HULL, 1931, *Malayoglyphus intermedius* FAIN, CUNNINGTON & SPIEKSMA, 1969, *Malayoglyphus carmelitus* SPIEKSMA, 1973, *Sturnophagoides brasiliensis* FAIN, 1967, *Hughesiella africana* (HUGHES, 1954), *Hughesiella valerioi* VARGAS & SMILEY, 1994, E. *maynei* and *Gymnoglyphus longior* (TROUESSART, 1897) (FAIN et al. 1990; REE et al. 1997; MEHL 1998; COLLOFF 1998a; SOLARZ 2001a, b, 2004, 2006, 2009). Most often these species are found in habitats intimately associated with man, such as beds, couches, sofas, other upholstered furnitures, clothing and carpets (VAN BRONSWIJK 1981; SUGGARS 1987; FAIN et al. 1990; VAN DER HOEVEN et al. 1992; TOVEY 1992; HORAK et al. 1996; COLLOFF 1998b). The house dust mites have been reported from a wide variety of other habitats associated with man and his environment, both indoor and outdoor (e.g. in hospitals, libraries, movie theatres, schools, nursery schools, hotels, student hostels, offices, military barracks, workplaces and other public places, in recreation facilities, farming environments, passenger aircraft and trains, automobile seats, naval ships, ocean-going ships, bird nests, city pavements, among others) (OSHIMA 1964; BLYTHE et al. 1975; RAO et al. 1975; TUROS 1979; VOBRÁZKOVÁ et al. 1979, 1985, 1986; VAN BRONSWIJK 1981; SAMŠINÁK and VOBRÁZKOVÁ 1985; SAMŠINÁK et al. 1978; COLLOFF 1987; DUTKIEWICZ et al. 1988; KING et al. 1989; FAIN et al. 1990; FRIEDMAN et al. 1992; GREEN et al. 1992; BABE et al. 1995; ŚPIEWAK et al. 1995; ZOCK & BRUNEKREEF 1995; JANKO et al. 1996; SOLARZ 1998; SOLARZ & SOLARZ 1996; SOLARZ et al. 1997, 1999, 2004a, b, 2007; RACEWICZ 200 DAUTARTIENË 2002; NEAL et al. 2002). The natural sources of allergenic mites in dwellings or workplaces are still not known (HALLAS & IVERSEN 1996). The possible sources of these mites in house dust are nests of synanthropic birds and stored products (HUGHES 1976; WHARTON 1976; VAN BRONSWIJK 1981; FAIN et al. 1990). Additional studies in different countries and regions of the world are also required to give a balanced view of indoor mite diversity. An understanding of the seasonal dynamics, as well as environmental factors influencing mite populations, can be exploited in mite control. The potential exists for developing models for house-dust mite populations, environmental characteristics, and the effects of various approaches to mite control (HART 1998).

Most studies on house dust mites within dwellings have traditionally sampled beds, carpets and upholstered furniture as the 3 main types of indoor mite microhabitats (COLLOFF 1998b).

The research, as well as some other studies, has revealed differences in the occurrence and prevalence of different species of domestic mites between geographical areas and between dwellings within the same geographical area, between particular places within the same dwelling, between the seasons of the year and between years and decades.

The main aim of this analysis was to summarize the results of all own studies on the occurrence, prevalence and species composition of the allergenic mite fauna in dust samples from one-family homes, flats, hospitals, libraries, offices and chemists in Poland (especially in the region of Upper Silesia).

II. MATERIAL AND METHODS

Twenty seven years of surveys (1981-2008) in the southern part of Poland formed the basis for this analysis. A total of 1289 house dust samples from dwellings from 31 localities were studied including samples from beds (or other bedding), non-carpeted floors, carpets, linoleums, upholstered furniture, wooden furniture and some other places (pictures, shutters), samples from bedrooms, living-rooms, kitchens and ante-rooms. Moreover, other indoor dust samples were studied: 281 from hospitals, 70 from libraries, 31 from research laboratories, 30 from drug-stores, 43 from offices and 14 from other workplaces (a bakery, an archive and a Police Department).

Samples from dwellings. Dust from dwellings was taken in 258 houses or flats situated in Cracow and vicinity, Miechów and vicinity (Małopolskie Voivodship), Staszów, Sędziszów and vicinity, Skarżysko-Kamienna (Świętokrzyskie Voivodship), Katowice, Sosnowiec, Mysłowice, Czeladź, Siemianowice Śląskie, Bytom, Zabrze, Chorzów, Gliwice, Ruda Śląska, Wodzisław, Ogrodzieniec, Lubliniec and vicinity, Opole, Pszczyna, Świętochłowice, Jaworzno, Chrzanów, Dabrowa Górnicza, Bielsko-Biala, Szczyrk, Kęty, Tychy, Częstochowa (Silesian Voivodship), Iwonicz-Zdrój (South-West Poland) and Łódź (Central Poland).

Samples from hospitals, drug-stores, libraries, institutes, offices, social rooms and other workplaces and/or public places. The samples of dust from hospitals were vacuumed in 11 hospitals located in Katowice, Sosnowiec, Wodzisław and Chorzów (Upper Silesia, Katowickie Voivodship), always from 2 sites – floor and patients' mattresses. In 9 libraries from Katowice, Sosnowiec, Dąbrowa Górnicza (Upper Silesia, South-West Poland) and Czeremcha (near Białystok, North-East Poland) samples were taken from floors (coverings, carpets, uncarpeted floors), upholstery chairs, arm-chairs, blinds, desks, book-shelves and books. In the case of research laboratories, dust samples were obtained from floors in the Department of Biology and Parasitology of the Silesian Medical Academy in Katowice, and from upholstered chairs and wooden furnitures in the Institute of Systematic and Evolution of Animals of the Polish Academy of Sciences in Cracow. In offices, social rooms, archives and other workplaces (surface area) of the Coal-Mine in Katowice, the dust samples were taken from carpeted floors, uncarpeted floors, documents, upholstery and wooden furnitures. In drug-stores, the samples were collected from floors and upholstered chairs or armchairs. The remaining 14 samples were taken by vacuuming floors of a bakery in Jaworzno (5 samples), from documents in the Record Office in Lublin (4 samples) and from upholstered chairs, documents and wooden furnitures in the Police Department in Ciechanów (5 samples).

Dust sampling methods. All samples were collected with portable vacuum cleaners, on a specially constructed dust trap filter attached to the end of the hose. A new filter was used for each sample, and each sample was kept separately. A surface area of $1m^2$ at each sampling site was vacuumed. Next, samples of dust were weighed in a 150 ml beaker and analysed for mites as described by ARLIAN et al. (1983), with some modifications. The samples were prepared by soaking in 75% ethanol for 4 hours, and then suspended in a saturated NaCl solution and a few drops of soap, stirred with a magnetic stirrer ATM, type MM5, and held in floatation for 24 hours. After this time, supernatants were filtered through a filter paper. Sediments were again suspended in NaCl solution – the procedure was repeated at least 3 times. Filters with the material retained were placed in Petri dishes onto which was poured a saturated NaCl solution. Liquid surface and surface of the filter paper were carefully examined for mites under a binocular stereomicroscope, starting 1-2 hours after pouring. All mites were mounted in Hoyer's medium on microscope slides. Damaged mites were assumed

dead at the time of sampling, whereas intact mites were determined as alive at this time (COLLOFF 1992). Mites that were alive at the time of sampling could easily be distinguished as intact (undamaged) and because of their plump and/or white appearance.

Mite density was calculated as the number of specimens per 1 gram of dust. Because of difficulties with standardization of mite collection, the calculation of mite numbers of each taxon per gram of house dust was recommended as the best method for determining mite allergen exposure (PLATTS-MILLS et al. 1992). Mite abundance was also calculated as the number of specimens per sample.

When the samples were taken, air temperature and relative humidity in each dwelling were measured out and noted. Relative humidity was monitored with a hair hygrometer and Digital Humidity/Temperature Meter TES 1360 (TES Electrical Electronic Corp.).

Statistical analysis. The statistical analysis was performed using CSS-Statistica for Windows version 7.1. Statistical significance was declared at a p value of less than 0.05. Results were analysed using the Kolmogorov-Smirnov test, the χ^2 test, Student's t-tests, Pearson's product-moment correlation test and the Spearman rank correlation test.

III. RESULTS

Mites were found in 845 of 1,758 samples examined (48.1%). The mites occurred most frequently and numerously in dwellings, libraries and hospitals. A total of 15,662 mite specimens were collected, of which 96.2% was found in dwellings. Mean numbers of mites per 1 sample were approximately 18.4, 11.7, 1.8, 1.3, 1.1, 0.6, 0.1 and 0.1 for the bakery, all dwellings, libraries, coal-mine offices and social rooms, hospitals, institutes, drug-stores and other public places, respectively.

Mite fauna in dwellings

Overall results. Of a total of 1,289 samples examined, 708 (54.9%) were positive for mites. A total of 15,068 mites were isolated, including 12,381 of the family Pyroglyphidae (82.2%). The species composition of domestic acarofauna in dust samples from dwellings is listed in Table 1 and shows that 16 species of astigmatic mites were identified, between which 5 species were from the family Pyroglyphidae (house dust mites). Most of the pyroglyphid mites found in dwellings belong to the genus *Dermatophagoides* (12,097 specimens; 80.3% of a total mite population and 97.7% of all pyroglyphids). Among them, *Dermatophagoides farinae* was predominant (approx. 40.1% of the total count), followed by *D. pteronyssinus* (39.8 %) and *Euroglyphus maynei* (1.8 %). Another pyroglyphid mites *Hirstia chelidonis* and *Gymnoglyphus longior* occurred in very small numbers (approx. 0.05 and 0.01% of the total count, respectively). *D. farinae* was also the most frequent species and was found in 437 samples (33.9 % of the total count and 61.7% of samples positive for mites), while 373 samples (28.9%) contained specimens of *D. pteronyssinus* (Table 1).

Among the non-pyroglyphid domestic mites there were mainly members of the families Chortoglyphidae – *Chortoglyphus arcuatus* (TROUPEAU, 1879), Glycyphagidae – *Gohieria fusca* (OUDEMANS, 1902), *Lepidoglyphus destructor* (SCHRANK, 1781) and *Glycyphagus domesticus* (DE GEER, 1778), Acaridae – *Tyrophagus putrescentiae* (SCHRANK, 1781) and *Acarus siro* complex, Cheyletidae and Heterostigmata (Table 1).

Generally, *Ch. arcuatus* was the most abundant species per sample (38.3). Mean numbers of the remaining abundant mite species per sample were approximately 16.1, 13.8, 11.0, 6.3, 5.5, 5.3 and 1.6 for *D. pteronyssinus*, *D. farinae*, *E. maynei*, *G. domesticus*, *L. destructor*, *G. fusca* and *T. putrescentiae*, respectively.

Diversity and composition of mite species in years 1981-1986. Most abundant and most frequent were members of the family Pyroglyphidae, especially two species,

Table I

Species list, dominance and frequency of mites found in the examined house dust samples from dwellings in Poland[1]

Mite taxa	Dominance		Frequency		
	N	%	N	%[2]	%[3]
Dermatohagoides farinae	6037	40.07	437	33.90	61.72
D. pteronyssinus	5994	39.78	373	28.94	52.68
Dermatophagoides sp.	66	0.44	31	2.40	4.38
Euroglyphus maynei	274	1.82	25	1.94	3.53
Gymnoglyphus longior	2	0.01	2	0.15	0.28
Hirstia chelidonis	8	0.05	6	0.47	0.85
Acarus siro complex	19	0.13	17	1.32	2.40
Tyrophagus putrescentiae	64	0.42	39	3.03	5.51
T. neiswanderi	2	0.01	1	0.08	0.14
Tyrolichus casei	4	0.03	1	0.08	0.14
Caloglyphus sp.	2	0.01	2	0.15	0.28
Rhizoglyphus robini	1	0.01	1	0.08	0.14
Thyreophagus sp.	1	0.01	1	0.08	0.14
Acaridae – unidentified	6	0.04	4	0.31	0.56
Lepidoglyphus destructor	94	0.62	17	1.32	2.40
L. fustifer	1	0.01	1	0.08	0.14
Glycyphagus domesticus	44	0.29	7	0.54	0.99
G. privatus	4	0.03	2	0.15	0.28
Gohieria fusca	274	1.82	52	4.03	7.34
Glycyphagidae – unidentified	5	0.03	3	0.23	0.42
Chortoglyphus arcuatus	1802	11.96	47	3.65	6.64
Saproglyphidae	4	0.03	3	0.23	0.42
Anoetidae	3	0.02	3	0.23	0.42
Heterostigmata	65	0.43	23	1.78	3.25
Cheyletidae	190	1.26	88	6.83	12.43
Bdellidae	2	0.01	2	0.15	0.28
Other Actinedida	4	0.03	4	0.31	0.56
Oribatida	35	0.23	21	1.63	2.97
Mesostigmata	61	0.40	40	3.10	5.65
Total mites	**15068**	**100.0**	**708**	**54.93**	**100.00**

N = number of specimens; n = number of samples positive;
[1] based on own previous surveys (years 1981-2005; SOLARZ 1998, 2004, 2006, 2009) and recent, unpublished results (years 2006-2008);
[2] in relation to the total of samples examined (n = 1289);
[3] in relation to samples positive for mites (n = 708).

D. pteronyssinus and *D. farinae* (Fig. 1). The first species was the numerically dominant (45.1% of the total count) (Fig. 1). The second occurred in higher concentrations per 1 gram of dust. The pyroglyphid mites constituted 89.2% of a total count of mites obtained and they were found in 44.1% of all samples from dwellings. Approximately 44.1% of the examined samples contained at least one species of the family Pyroglyphidae, but only 19.3% of the samples contained exclusively one species of this family. Of all of 122 samples positive for mites, 51 (41.8%) were inhabited by *D. pteronyssinus* and *D. farinae*, and only 7 samples (5.7%) by both of these species and E. *maynei*. All of the samples with *E. maynei* and a single sample with *G. longior* were also coinhabited by *D. pteronyssinus* and *D. farinae*. Fourty six samples (37.7% of mite positive samples) were inhabited by a single species from the genus *Dermatophagoides*, with 22 samples (18.0%) containing only *D. pteronyssinus* and 24 samples (19.7%) containing only *D. farinae* (apart from the other, non-pyroglyphid mites). Among 51 samples coinhabited by both *D. pteronyssinus* and *D. farinae*, in 17 (33.3%) samples *D. farinae* was found as the dominant, whereas only in 14 (27.5%) samples – *D. pteronyssinus*. In the remaining 20 (39.2%) samples both of these mite species occurred in equal or similar numbers. From 30 samples (24.6% of the samples with mites) only mites of the genus *Dermatophagoides* were isolated; in 17 samples (13.9%) it was *D. pteronyssinus* and in 13 (10.7%) – *D. farinae*. Approximately 44.3% of all samples positive for mites contained only the pyroglyphid dust mite species, and 41.8% were coinhabited also by other the non-pyroglyphid mite species. Only 13.9% of samples contained exclusively mites from other groups. Apart the pyroglyphid mites, the significant element of the dust acarofauna in the region of Upper Silesia were members of families Cheyletidae (Actinedida) (especially *Cheyletus* spp.), Tarsonemidae (Heterostigmata), Acaridae (Astigmata) (especially *Tyrophagus putrescentiae* and *Acarus siro*) and Glycyphagidae (Astigmata) (mainly *Gohieria fusca*). Among the 122 samples positive for mites, 43 (35.2%) were inhabited by a single mite species, 41 (33.6%) were coinhabited by 2 mite species, 21 (17.2%) – by 3 species, 9 (7.4%) – by 4 species, 5 (4.1%) – by 5 species. Moreover, three single samples (2.5%) with complexes of 6 (0.8%), 7 (0.8%) and 8 species (0.8%) were collected. In the samples with single mite species most frequently occurred *D. pteronyssinus* (17 samples, 39.5%) and *D. farinae* (13 samples, 30.2%). Within the samples coinhabited by 2 species of mites, 16 combinations of the species composition were stated, and most frequently occurred the mixed populations of both dominants, *D. pteronyssinus* and *D. farinae* (22 samples, 53.7% of samples with 2 species of mites).

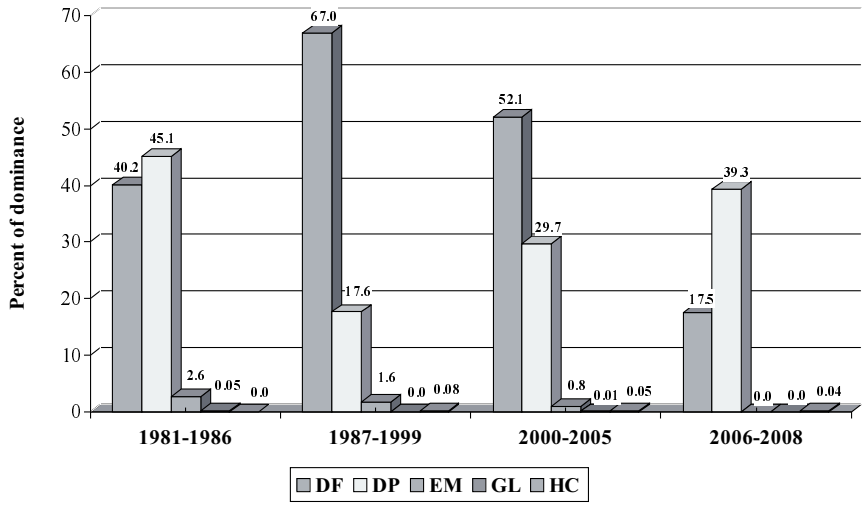

Fig. 1. Changes in the species composition of house dust mite fauna from dwellings (flats and houses) in Poland. Explanations: DF – *Dermatophagoides farinae*; DP – *Dermatophagoides pteronyssinus*; EM – *Euroglyphus maynei*; GL – *Gymnoglyphus longior*; HC – *Hirstia chelidonis*.

Among samples infested by 3 mite species 33.3% constituted the samples with *D. pteronyssinus*, *D. farinae* and *Cheyletus* sp. (7 samples) and 19.05% with both of dermatophagoid mites and with 1 species of gamasid mites. Moreover 10 combinations of 3 mite species represented by single samples were found. The samples with 4 species (9 combinations) most frequently were coinhabited by pyroglyphids (*D. farinae*, *D. pteronyssinus* and *E. maynei*) with 1 species of tarsonemid, cheyletid, glycyphagid or gamasid mites, whereas the samples with 5 species – by *D. pteronyssinus*, *D. farinae*, *T. putrescentiae*, *Cheyletus* sp. and an unidentified gamasid mite. Only remaining 19 samples were coinhabited exclusively by non-pyroglyphid mites showing 10 combinations of species composition, including 5 combinations with 1 species (*T. putrescentiae*, *G. fusca*, unidentified Tarsonemida and Gamasida), 4 combinations of 2 species (2 unidentified species of tarsonemid mites, *T. putrescentiae* and unidentified tarsonemid mite, *T. putrescentiae* and *A. siro* complex, unidentified Mesostigmata and Oribatida) and 1 combination of 4 species (*A. siro*, *R. robini*, *G. fusca*, Gamasina).

Diversity and composition of mite species collected in years 1987-1999. A total of 14 species of astigmatic mites were identified, between which 4 species were from the family Pyroglyphidae (house dust mites). Among them, *Dermatophagoides farinae* was predominant (approx. 67% of the total count), followed by *D. pteronyssinus* (17.6 %) and *Euroglyphus maynei* (1.6 %). *Hirstia chelidonis* occurred in very small numbers (approx. 0.1% of the total count). Among pyroglyphids, *D. farinae* was predominant in Świętochłowice (96.7%), Iwonicz-Zdrój (96.6%), Chorzów (94.8%), Katowice (91.8%), Sosnowiec (89.4%), Bytom (50.9%), whereas *D. pteronyssinus* was dominant in Łódź (92.9%), Wodzislaw (80.9%), Cracow (45.6%) and Bielsko-Biala (24.8%). Also on the total area of Upper Silesia, *D. farinae* was the dominant species with 2,218 specimens (constituting about 88.2% of the total mite population) and mean number per 1 sample (mite positive) 19.6, and was found in 97 samples (36.6 % of the total count and 85.8% of mite positive samples. Generally, *D. farinae* was also the most abundant species both per 1 sample (mite positive) (15.8) and per 1 gram of dust in all of indoor places examined. *D. farinae* was significantly more frequent in upholstered furniture than in beds or bedding, and floors ($\chi^2 = 9.23$, $p < 0.005$ and $\chi^2 = 59.17$, $p \leq 0.00001$, respectively). Moreover, it was significantly more frequent in beds or other sleeping accommodations than on floors ($\chi^2 = 24.44$, $p \leq 0.00001$). *D. pteronyssinus,* was collected more frequently from bed dust samples than from floors ($\chi^2 = 10.10$, $p < 0.005$). It was also more frequent in beds than in dust from upholstered furniture and finally on floors, but both differences were not statistically significant (χ^2; $p = 0.054$ and $p = 0.19$, respectively).

Pyroglyphid mites were found in 149 samples (44.5% of all samples and 94.3% of samples with mites) while only 9 samples (2.7%) contained exclusively non-pyroglyphid mites. Among the non-pyroglyphids there were mainly members of the families Chortoglyphidae (*Ch. arcuatus*), Glycyphagidae (*G. domesticus*, *G. privatus*, *Gohieria fusca*, *L. destructor*, *L. fustifer*), Acaridae (*T. putrescentiae*, *T. neiswanderi*, *Acarus siro* complex and *Tyrolichus casei*), Cheyletidae and Tarsonemidae. *D. farinae* was also the most frequent species and was found in 126 samples (37.6 % of the total count and 79.7% of samples positive for mites). Thus, approximately 45% of the samples analysed from dwellings, contained at least 1 species of the family Pyroglyphidae, and 33.1% of the samples contained exclusively one species from this family (taking into account only the pyroglyphid mites). Of all 158 samples positive for mites, only 29 (8.7% of all samples examined) were inhabited by *D. pteronyssinus* and *D. farinae*, only 5 samples (1.5%) by both of these species and *E. maynei*, and 2 (0.6%) samples by *D. farinae* and *H. chelidonis*. Moreover, single samples were found with *D. farinae* and *E. maynei*, and with *D. pteronyssinus* and *E. maynei*. A total of 111 samples (33.1% of all samples examined and 70.25% of the mite positive samples) were inhabited by a single species from this family, with 88 samples (26.3% and 55.7%, respectively) containing only *D. farinae*, 22 samples (6.6% and 13.9%, respectively) containing only *D. pteronyssinus* and 1 sample (0.3% and 0.6%) containing only *H. chelidonis* (Table 15). Among 29 samples coinhabited by both *D. pteronyssinus* and *D. farinae*, in 15 samples (4.5% and 9.5%) *D. farinae* was found as the

dominant, whereas in 10 samples – *D. pteronyssinus* was dominant (3.0% and 6.3%). In the remaining 4 samples both of these mite species occurred in equal or similar numbers (1.2% and 2.5%).

From 59 samples from beds (and couches), 22 samples from floors (and carpets), 21 samples from upholstery furniture, and from 3 samples from other places examined, only mites of the family Pyroglyphidae were isolated (without other mites) (generally 105 samples; 31.6% of all samples examined, 66.5% of the mite positive samples and 70.5% of samples positive for pyroglyphid mites). To summarize, approximately 66.5% of all samples positive for mites contained only the pyroglyphid dust mite species, and 27.8% were coinhabited also by other the non-pyroglyphid mite species. Only 5.7% of samples mite positive contained exclusively mites from other groups.

Among the 158 samples positive for mites, 49 samples from beds (32.7% of all samples from beds), 24 samples from floors and carpets (16.6% of these samples) and 20 samples from upholstery furniture (58.8% of these samples), were inhabited by a single mite species. In general, 31 (approx. 9.3% of all samples examined) were coinhabited by 2 mite species, 22 (6.6%) – by 3 species, 7 (2.1%) – by 4 species, 1 (0.3%) – by 5 species, and 2 (0.6%) – by 6 species. The combinations of 4, 5 and 6 species were collected only from the bed dust samples.

In the samples with single mite species (n = 93) there most frequently occurred *D. farinae* (73 samples; 78.5% of samples with 1 species). Within the samples coinhabited by 2 species of mites, 21 combinations were noted, and there most frequently occurred the mixed populations of both dominants, *D. pteronyssinus* and *D. farinae* (11 samples; 35.5% of samples with 2 species of mites). Among samples infested by 3 mite species, approximately 54.5% constituted samples with *D. pteronyssinus*, *D. farinae*, and some other species.

Diversity and composition of mite species collected in years 2000-2005. A total of 3,714 mites were isolated, including 3,212 of the family Pyroglyphidae (86.5%). Only 14.3 % of the mites collected were alive. The percentages of live mites in populations of pyroglyphid mites and in the total domestic mite population were 10.0% and 13.9%, respectively. No mites were found in 177 samples (52.8%). *D. farinae* was the predominant species in the examined dwellings (52.1% of the total catch), followed by *D. pteronyssinus* (29.7%) (Fig. 1). The former species was predominant in Katowice, Sosnowiec, Chorzów, Bytom, Gliwice, and generally in Upper Silesia, whereas the latter dominated in Łódź, Cracow and its vicinity. *D. farinae* was the most abundant species per 1 g of dust in all main types of indoor places examined (beds, upholstery furniture, carpeted floors). *D. farinae* was more abundant (per 1 g of dust) in samples from couches and sofas, whereas *D. pteronyssinus* in bed mattresses. Single-family houses (suburban settlement) were dominated by the chortoglyphid mite (*Ch. arcuatus*) and by *D. pteronyssinus*, whereas flats (urban and industrial area) by *D. farinae*; the main habitats for the occurrence of both pyroglyphid species (especially *D. pteronyssinus*) are sleeping accommodations, whereas *Ch. arcuatus* prefers carpets. It should be stressed that the domination of *D. farinae* in dwellings examined in years 1986-2005 was a characteristic tendency in many urban localities in Poland, whereas single-family houses of agricultural and/or suburban settlements were dominated by *D. pteronyssinus*.

More recently (2006-2008) *D. pteronyssinus* was found as the dominant in total samples examined (Fig. 1), especially in samples from four Upper Silesian towns (Katowice, Sosnowiec, Chorzów and Siemianowice Śląskie (it constituted 60.3% of all mites collected), and in samples from Staszów and vicinity (41.9% of all mites) and from Częstochowa and vicinity (88.3%).

Mite densities. Influence of indoor air temperature and relative humidity. Mean densities of mites in beds, upholstery furniture and floor dust are compared in Table 2. The number of total mites per 1 gram of dust varied in dwellings from different localities (Table 3). The mean number of mites per 1 gram of dust was highest in dust from beds, followed by upholstered furniture, and the lowest in dust samples from floors (Table 2). Numbers of total mite populations or particular pyroglyphid mite species were varied from one town to another, from one dwelling to another in the same town, and from one locus to another within the same dwelling. In general *D. farinae* was most abundant per 1 gram of dust among mites collected from dwellings (Tables 2 and 3). Generally, it should be stressed that significant relationships were found between

Table II

Abundance (per gram of dust) and dominance (percent of the total mite populations) of house dust mites (Pyroglyphidae) and total domestic mites in the examined dwellings

Places examined / Mites	Beds Mean ± SD Total mites [Live mites] (Percent of dominance)	Floor s Mean ± SD Total mites [Live mites] (Percent of dominance)	Upholstery furnitures Mean ± SD Total mites [Live mites] (Percent of dominance)
Dermatophagoides farinae	209.5 ± 920.7 [15.4 ± 76.6] (*71.72*)	11.1 ± 49.4 [2.2 ± 15.8] (*16.84*)	67.8 ± 195.6 [8.8 ± 24.5] (*91.95*)
Dermatophagoides pteronyssinus	69.9 ± 368.6 [11.8 ± 87.7] (*19.60*)	9.1 ± 65.5 [2.2 ± 19.1] (*7.51*)	4.5 ± 22.8 [NF] (*2.68*)
House dust mites (total)	281.6 ± 1009.4 [27.3 ± 117.8] (*93.54*)	18.3 ± 79.8 [4.5 ± 24.6] (*24.61*)	72.4 ± 33.5 [8.8 ± 4.2] (*95.30*)
Domestic mites (total)	299.3 ± 1033.6 [31.4 ± 120.3] (*99.46*)	130.3 ± 1245.0 [28.6 ± 249.1] (*97.41*)	73.2 ± 195.2 [9.3 ± 4.2] (*99.33*)
Relative humidity (%RH)	54.9 ± 19.5	56.3 ± 19.4	57.6 ± 24.6
Temperature (C)	21.2 ± 2.3	20.7 ± 2.8	21.8 ± 1.3

the numbers of mites per gram of dust (for both dominant species, *D. pteronyssinus* and *D. farinae*) and the levels of temperature and RH values (χ^2 test; $p < 0.0001$). Significant differences in the pyroglyphid mite concentrations were found between samples from floors and both samples of bed dust (*t*-test, $p < 0.001$) and samples from upholstery furnitures (*t*-test, $p < 0.05$), whereas the difference between samples from beds and upholstery furnitures was not significant (*t*-test, $p = 0.38$).

Mite fauna in hospitals

Hospitals examined in years 1981-1986. Total number of mites isolated from hospital dust samples and number of the samples positive for mites was distinctly lower than in dwellings. Forty mites were collected only from 26 samples (21.3% of a total of samples from hospitals) of dust from floor (n = 15 samples) and patient beds (n = 11 samples). Similarly as in dwellings, the most abundant mites were members of the family Pyroglyphidae, which formed 57.5% of total mite fauna from hospitals. The dominant species was *D. pteronyssinus* and constituted 42.5% of a total count (Fig. 2, Table 4). It was also most frequent and occurred in 15 samples (12.3% of a total of samples from hospitals) and in all of hospitals examined. Among specimens of *D. pteronyssinus* most abundant were tritonymphs and males; totally, 6 tritonymphs (35.3%), 5 males (29.4%), 3 females (17.6%), 2 protonymphs (11.8%) and 1 larva (5.9%) were isolated. Among pyroglyphid mites, besides *D. pteronyssinus*, specimens of *D. farinae* were found (1 protonymph,

Table III

Abundance (per gram of dust) of mites found in dust samples from dwellings of selected localities examined in Poland

Localities examined	Mean ± SD: Total mites [Live mites]		
	Dermatophagoides farinae	*D. pteronyssinus*	Total domestic mites
Łódź and vicinity (n = 9)	1.95 ± 3.94 [0.41 ± 0.82]	60.16 ± 175.47 [4.22 ± 11.24]	62.91 ± 179.69 [4.45 ± 11.17]
Kraków and vicinity (n = 24)	32.15 ± 74.64 [5.31 ± 15.20]	18.67 ± 82.17 [0.32 ± 1.57]	55.05 ± 156.82 [6.87 ± 16.29]
Bielsko-Biała (n = 28)	178.57 ± 611.09 [11.90 ± 36.52]	340.09 ± 807.79 [64.71 ± 198.16]	1159 ± 2905.98 [207.65 ± 582.65]
Sosnowiec (n = 115)	42.93 ± 184.40 [10.10 ± 59.64]	0.41 ± 2.99 [0.08 ± 0.85]	43.75 ± 184.79 [11.11 ± 59.95]
Katowice (n = 84)	273.71 ± 1162.57 [21.21 ± 100.49]	6.52 ± 38.18 [0.19 ± 1.00]	287.26 ± 1204.40 [24.83 ± 102.19]
Chorzów (n = 10)	87.48 ± 105.40 [18.60 ± 26.84]	3.36 ± 9.38 [1.00 ± 3.16]	97.54 ± 116.10 [21.62 ± 29.35]
Bytom (n = 6)	2.69 ± 5.67 [0.66 ± 1.02]	7.63 ± 9.75 [2.00 ± 4.00]	12.97 ± 13.38 [2.82 ± 3.92]
Wodzisław (n = 9)	17.04 ± 44.11 [NF]	73.70 ± 134.99 [14.81 ± 44.44]	91.85 ± 177.44 [14.81 ± 44.44]
Jaworzno/Chrzanów (n = 26)	NF	0.46 ± 2.16 [0.04 ± 0.20]	0.50 ± 2.16 [0.04 ± 0.20]

n – number of samples examined;
NF – not found.

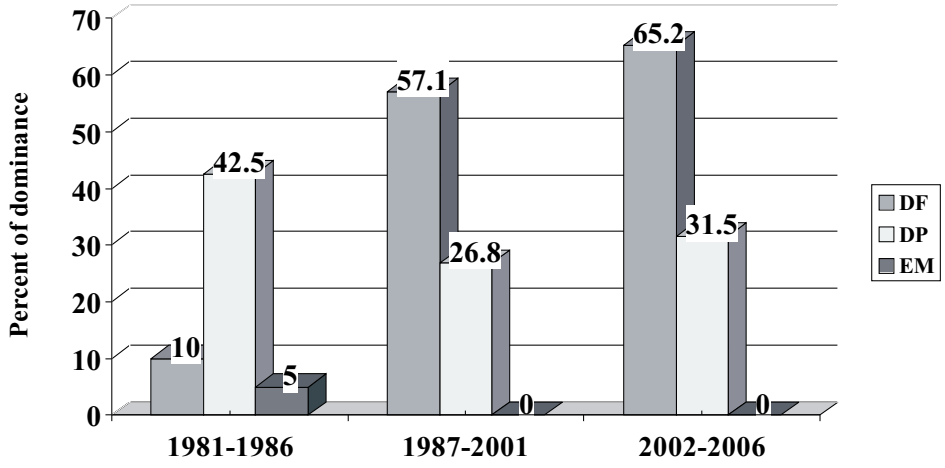

Fig. 2. Changes in the species composition of house dust mite fauna from hospitals of the Upper Silesia (Poland). Explanations: DF – *Dermatophagoides farinae*; DP – *Dermatophagoides pteronyssinus*; EM – *Euroglyphus maynei*.

Table IV

Species list, dominance and frequency of mites found in the examined house dust samples from hospitals in Poland (years 1981-1986)[1]

Mite taxa	Dominance		Frequency		
	N	%	n	%[2]	%[3]
Dermatohagoides pteronyssinus	17	42.5	15	12.3	57.7
Dermatophagoides farinae	4	10.0	4	3.3	15.4
Euroglyphus maynei	2	5.0	2	1.6	7.7
Acarus siro complex	1	2.5	1	0.8	3.8
Tyrophagus putrescentiae	2	5.0	2	1.6	7.7
Tyrophagus perniciosus	2	5.0	1	0.8	3.8
Caloglyphus berlesei	1	2.5	1	0.8	3.8
Gohieria fusca	1	2.5	1	0.8	3.8
Suidasia pontifica	2	5.0	2	1.6	7.7
Otodectes cynotis	1	2.5	1	0.8	3.8
Tarsonemidae	2	5.0	1	0.8	3.8
Cheyletidae	1	2.5	1	0.8	3.8
Mesostigmata	4	10.0	3	2.5	1154
Total mites	**40**	**100.0**	**26**	**21.3**	**100.00**

N = number of specimens; n = number of samples positive;
[1] based on own previous surveys (SOLARZ, 1998);
[2] in relation to the total of samples examined (n = 122);
[3] in relation to samples positive for mites (n = 26).

1 tritonymph, 2 homeomorphic males) in 2 samples and *E. maynei* (only 2 females) in 2 dust samples. Pyroglyphid mites occurred in 19 samples (15.6% of samples from hositals and 73.1% of the samples positive for mites). In samples from beds these mites were found solely, with exception of one sample of mattress dust, which was coinhabited also by *S. pontifica*. Samples of floor dust contained, apart from pyroglyphids, also mites from other groups, which were, however, not numerous.

Mean number of mite specimens per 1 gram of dust from hospitals was 30.0 ± 29.8 and ranged from 0.0 to 100.0. It was higher in dust from beds than in dust from floors (Table 5).

Mean numbers of mites per 1 gram in particular hospitals are compared in Table 6. It appears that they occurred in highest densities in hospitals located in Katowice, namely in The Mielęcki Clinical Hospital, Central Mining Hospital (Katowice-Ochojec) and in The First Clinic of Internal Diseases (Table 6).

Mite fauna in hospitals examined in years 1987-2001. All of the hospitals proved to be positive for mites (Table 7). Total number of mites isolated from hospital dust samples and number of the samples positive for mites was distinctly lower than in dwellings. Fifty six mites were collected only from 27 samples (27.3% of a total of samples from hospitals) of dust from floor (n = 8 samples) and patients' beds (n = 19 samples). Similarly to that of dwellings, the most abun-

Table V

Abundance of mites (expressed as mean number of mites per 1 gram of dust) in 122 dust samples from hospitals in Upper Silesia (Poland) examined in years 1981-1986[1]

	MEAN ± SD		
	Patient beds	Floors	Total samples
Total mites collected	37.8 ± 31.8	23.8 ± 25.9	30.0 ± 29.8

[1] based on own previous surveys (SOLARZ 1998)

Table VI

Abundance of domestic mites (expressed as mean number of mites per 1 gram of dust) in dust samples from particular hospitals examined in years 1981-1986 in Upper Silesia (Poland)[1]

Hospitals / Mites	Mean ± SD (Range[2])			
	Dermatophagoides pteronyssinus	*Dermatophagoides farinae*	*Euroglyphus maynei*	Total mites[3]
Children Public Hospital in Sosnowiec	1.0[4]	0.0[4]	0.0[4]	3.5 ± 1.5 (2.0-5.0)
Municipal Hospital N° 5 in Sosnowiec	1.0[4]	0.0[4]	0.0[4]	1.0[4]
Central Clinical Hospital of Silesian Medical Academy in Katowice	8.3[4]	0.0[4]	20.0[4]	20.54 ± 10.2 (8.3-33.3)
Mielęcki Clinical Hospital in Katowice	24.82 ± 15.53 (10.0-50.0)	50.0[4]	0.0[4]	40.89 ± 34.83 (10.0-100.0)
First Clinic of Internal Diseases in Katowice	23.75 ± 10.82 (10.0-40.0)	0.0[4]	0.0[4]	35.0 ± 20.61 (10.0-60.0)
Specialistic Hospital in Katowice	20.0[4]	0.0[3]	0.0[4]	20.0[4]
Central Mining Hospital in Katowice-Ochojec	34.4 ± 12.3 (20.0-50.0)	44.17 ± 35.85 (6.67-100.0)	6.7[4]	40.4 ± 34.8 (13.3-100.0)
Municipal Hospital in Katowice-Szopienice	1.0[4]	0.0[3]	0.0[4]	4.0[4]

[1]based on own previous surveys (Solarz 1998);
[2]in relation to samples positive for mites;
[3]including also other (non-pyroglyphid) mites – *Acarus siro, Tyrophagus putrescentiae, T. perniciosus, Caloglyphus berlesei, Gohieria fusca, Suidasia pontifica, Otodectes cynotis,* tarsonemid mites, cheyletid mite, gamasid mites;
[4] single sample positive for the particular mite species

Table VII

Abundance of domestic mites (expressed as mean number of mites per 1 gram of dust) in dust samples from particular hospitals examined in years 1987-2001 in Upper Silesia (Poland)[1]

Hospitals	Mean ± SD [Maximum] (Percent of dominance/Percent of frequency)					
	Dermatophagoides farinae	*D. pteronyssinus*	Total Pyroglyphidae[2]	Total domestic mites[3]	Live Pyroglyphidae[2]	Total Mites
Municipal Hospital N° 1 in Wodzisław	NF	NF	NF	1.2 ± 15.6 [12.5] (100/10.0)	NF	1.2 ± 15.6 [12.5] (100/10.0)
Separate Public Central Clinical Hospital of Silesian Medical Academy in Katowice	5.2 ± 22.3 [100] (40.0/10.0)	3.1 ± 11.2 [50.0] (60.0/15.0)	8.3 ± 24.3 [100.0] (100/20.0)	8.3 ± 24.3 [100.0] (100/20.0)	NF	8.3 ± 24.3 [100.0] (100/20.0)
District Railway Hospital in Katowice	11.8 ± 30.4 [100] (70.6/30.0)	1.3 ± 3.3 [12.5] (23.5/15.0)	13.7 ± 30.3 [100.0] (100/40.0)	13.7 ± 30.3 [100.0]	3.6 ± 13.6 [60.0]	13.7 ± 30.3 [100.0]
Upper Silesiam Medical Centre in Katowice-Ochojec	5.0 ± 15.8 [50] (25.0/10.0)	1.4 ± 3.9 [12.5] (25.0/20.0)	10.4 ± 18.8 [50.0] (100/40.0)	10.4 ± 18.8 [50.0]	NF	10.4 ± 18.8 [50.0]
Municipal Hospital in Chorzów	5.7 ± 26.8 [160.0] (64.0/10.3)	1.3 ± 5.1 [30.0] (24.0/10.3)	7.0 ± 27.0 [160.0] (88.0/17.9)	7.6 ± 27.0 [160.0] (96.0/23.1)	0.9 ± 3.6 [20.0]	7.7 ± 27.0 [160.0] (100/25.6)

[1] based on own previous surveys (Solarz 2001b);
[2] including unidentified mites of the genus *Dermatophagoides*;
[3] including *Tyrophagus putrescentiae* (Acaridida: Acaridae) and *Calvolia* sp. (Acaridida: Saproglyphidae);
NF = not found

dant mites were members of the family Pyroglyphidae, which formed 92.86% of total mite count from hospitals. The dominant species was *D. farinae* and constituted 57.1% of a total count (Table 8, Fig. 2). It was also most frequent and occurred in 13 samples (13.1% of a total of samples from hospitals) and in 4 of 5 hospitals examined. Among specimens of *D. farinae*, the most abundant were heteromorphic males and females; in total, 4 protonymphs (12.5%), 4 tritonymphs (12.5%), 12 heteromorphic males (37.5%), 1 homeomorphic male (3.13%), and 11 females (34.37%) were isolated. Among pyroglyphid mites, besides *D. farinae*, 15 *D. pteronyssinus* were found (2 protonymphs, 4 tritonymph, 5 males and 4 females) in 12 samples; 5 unidentified specimens of *Dermatophagoides* were in 2 dust samples. Pyroglyphid mites occurred in 23 samples (15.6% of samples from hospitals and 73.1% of the samples positive for mites). In samples from floors, only the pyroglyphid were found; in total 16 specimens (30.8% of all pyroglyphids found in the examined hospitals). Samples of bed dust contained, apart from pyroglyphids, also mites from other groups. These mites were found in samples without pyroglyphids. Generally, *D. farinae* was more frequent in samples from floors than from patients' beds, whereas *D. pteronyssinus* was collected more frequently from beds than from floors, but both differences were not significant (χ^2; $p = 0.31$ and $p = 0.51$, respec-

Table VIII

Abundance and prevalence of house dust mites in dust samples from hospitals examined in Poland (during years 1987-2001), in relation to mean values of relative humidity and temperature[1]

	Mean ± SD [Maximum] (Relative dominance[2]/Relative frequency[3])		
Mites (N = 56)	Patient beds (n = 69)	Floors (n = 30)	Total samples (n = 99)
Dermatophagoides farinae	6.4 ± 26.0 [160.0] (60.0/11.6)	5.8 ± 20.1 [100.0] (50.0/16.7)	6.2 ± 24.3 [160.0] (57.1/13.1)
D. pteronyssinus	2.0 ± 7.3 [50.0] (30.0/13.0)	0.4 ± 1.5 [7.1] (18.7/10.0)	1.5 ± 6.2 [50.0] (26.8/12.1)
Total Pyroglyphidae[4]	8.4 ± 26.6 [160.0] (90.0/21.7)	8.0 ± 21.2 [100.0] (100/26.7)	8.3 ± 25.0 [160.0] (92.9/23.2)
Live Pyroglyphidae[4]	1.4 ± 7.7 [60.0]	0.4 ± 2.3 [12.5]	1.1 ± 6.5 [60.0]
Total domestic mites[5]	8.9 ± 26.5 [160.0] (97.5/94.7)	8.0 ± 21.2 [100.0] (100/26.7)	8.6 ± 24.9 [160.0] (98.2/26.3)
Total mites[6]	9.0 ± 26.5 [160.0]	8.0 ± 21.2 [100.0]	8.7 ± 24.9 [160.0]
Relative humidity	51.5 ± 13.5 [83.0]	43.6 ± 9.3 [65.0]	49.1 ± 12.8 [83.0]
Temperature	21.3 ± 2.8 [26.0]	22.7 ± 1.7 [26.0]	21.7 ± 2.6 [26.0]

[1]based on own previous surveys (SOLARZ 2001b);
[2]Percent of the total population;
[3]Percent of the total samples examined;
[4]Including unidentified mites of the genus *Dermatophagoides*;
[5] Including also other (non-pyroglyphid) astigmatid domestic mites isolated;
[6]All mites found (including oribatids);
N = number of mite specimens;
n = number of samples examined

tively). The abundance of pyroglyphid species (expressed as mean number of mites per 1 gram of dust) found in the examined hospitals, in relation to the total count of mites collected and in relation to both places vacuumed, is presented in Table 8. Total mean number of mite specimens per 1 gram of dust from hospitals was 8.7 ± 24.9 and ranged from 0.0-160.0 (Table 8). This was only slightly higher in dust from beds (9.0) than in dust from floors (8.0) (Table 8). The mean numbers of mites per 1 gram in particular hospitals are compared in Table 7. Mites occurred in highest densities in hospitals located in Katowice, namely in the District Railway Hospital, The Upper Silesian Medical Centre (Katowice-Ochojec) and in the Public Central Clinical Hospital of the Silesian Medical Academy (Table 7).

Levels of relative humidity in the examined hospitals were significantly correlated with the numbers of *D. farinae* females (r = 0.25), total domestic mites (r = 0.24) and total mites (r = 0.25) per gram of dust from beds (Pearson's correlation test, $p < 0.05$), whereas the correlations between RH and total pyroglyphid mites, total and all stages of *D. pteronyssinus*, and other stages of *D. farinae*, per gram of bed dust, were non significant ($p > 0.05$). The numbers of house dust mites (Pyroglyphidae), domestic mites and total mites per gram of dust, between samples from patients' beds and samples from floors, were not significantly different (*t*-test, $p > 0.1$ for all cases).

Acarofauna in hospitals examined in years 2002-2006. All of the hospitals proved to be positive for mites (Table 9). Mites were collected from 39 samples (65% of a total of samples from hospitals). A total of 203 mites were isolated. The most abundant mites were members of the family Pyroglyphidae, which formed 99.01% of total mite count from hospitals. The dominant species was *D. farinae* and constituted 65.2% of a total count (Fig. 2). It was also most frequent and occurred in 34 samples (56.7% of a total of samples from hospitals and 82.9% of the samples positive for mites) and in all hospitals examined. Among pyroglyphid mites, besides *D. farinae*, 64 specimens of *D. pteronyssinus* were found (31.5%) (Fig. 2). This pyroglyphid species occurred in 20 samples (33.3% of samples from hospitals and 48.8% of the samples positive for mites). Moreover, single unidentified mites of orders Mesostigmata and Oribatida were found.

Table IX

Abundance of domestic mites (expressed as mean number of mites per 1 gram of dust) in dust samples from particular hospitals examined in years 2002-2006 in Upper Silesia (Poland)

Hospitals	Mean ± SD [Median] (Range) Live mites			
	Dermatophagoides farinae	*D. pteronyssinus*	Total Pyroglyphidae	Total Mites[1]
Hospital of the Ministry of Interior and Administration in Katowice	20.2 ± 25.8 [13.5] (0.0-100.0) *8.1 ± 12.5 [4.7] (0.0-50.0)*	10.5 ± 16.4 [1.1] (0.0-50.0) *8.3 ± 13.6 [1.1] (0.0-42.9)*	23.2 ± 27.7 [15.2] (0.0-114.3) *15.9 ± 22.5 [8.5] (0.0-75.0)*	30.8 ± 39.1 [20.3] (0.0-150.0) *15.9 ± 22.5 [8.5] (0.0-75.0)*
District Railway Hospital in Katowice	22.9 ± 36.0 [1.7] (0.0-140.0) *5.8 ± 12.6 [0.0] (0.0-40.0)*	12.0 ± 15.6 [0.0] (0.0-44.0) *7.7 ± 11.6 [0.0] (0.0-40.0)*	34.8 ± 46.0 [15.3] (0.0-180.0) *13.5 ± 22.3 [0.0] (0.0-80.0)*	34.8 ± 46.0 [15.3] (0.0-180.0) *13.5 ± 22.3 [0.0] (0.0-80.0)*
Upper SilesianCentre of Child and Mother Health in Katowice	16.1 ± 26.5 [2.2] (0.0-100) *2.0 ± 6.0 [0.0] (0.0-25)*	0.6 ± 2.8 [0.0] (0.0-12.5) *NF*	14.8 ± 26.5 [0.0] (0.0-98.0) *0.8 ± 2.5 [0.0] (0.0-10.0)*	16.7 ± 26.7 [5.1] (0.0-100.0) *0.8 ± 2.5 [0.0] (0.0-10.0)*

[1]including unidentified Gamasina and Oribatida; NF = not found

The age structure of pooled populations of *D. farinae* and *D. pteronyssinus* differed. In the total population of D. *farinae*, a dominance of female protonymphs was found (tritonymphs constituted 10%, females 47%, males 43%). In pooled populations of *D. pteronyssinus*, tritonymphs constituted only 3%, females 44% and males 53%. The most frequent stage in populations of the two pyroglyphid species were both adult forms, both in relation to the total samples examined and to the samples positive for mites. Differences of frequency between tritonymphs and females or males of both species were statistically significant (χ^2 $p < 0.00001$, in all cases). In the case of *D. farinae* slightly more frequent were females but this difference was statistically not significant ($\chi^2 = 0.05$; $p = 0.78$).

Mean number of mite specimens per 1 gram of dust from hospitals was 27.4 ± 38.3 and ranged from 1.0 to 180.0 (Table 10). It was only slightly higher in dust from beds than in dust from floors (Table 10). Mean numbers of mites per 1 gram in particular hospitals are compared in Table 9. Mites occurred in highest densities in two hospitals located in Katowice, namely in the District Railway Hospital and the Hospital of the Ministry of Interior and Administration (Table 9).

Table X

Abundance of domestic mite species (mean number of mites/1 gram of dust) in dust samples from hospitals examined in years 2002-2006, in relation to mean values of relative humidity and temperature

	Mean ± SD/Median/Range		
Mites (N = 203)	Patient beds (n = 30)	Floors (n = 30)	Total samples (n = 60)
Dermatophagoides farinae	18.7 ± 26.1/6.1/0-100	20.8 ± 32.8/8.1/0-140	19.8 ± 29.4/6.1/0-140
Total mites (Live mites)	(7.5 ± 12.5/0.0/0-50)	(3.2 ± 8.7/0.0/0-40)	(2.0 ± 5.9/0.0/0-25)
D. pteronyssinus	9.7 ± 15.3/0.0/0-50.0	5.6 ± 12.2/0.0/0-42.9	7.7 ± 13.9/0.0/0-50
Total mites (Live mites)	(6.0 ± 10.3/0.0/0-43.0)	(4.7 ± 11.5/0.0/0-42.9)	(5.4 ± 10.8/0.0/0-42.9)
House dust mites (in general) [1]	22.1 ± 31.4/5.1/0-114	26.1 ± 38.7/13.8/0-180	24.3 ± 35.0/9.5/0-180
Total mites (Live mites)	(13.1 ± 21.3/0.0/0-75)	(7.1 ± 16.7/0.0/0-80)	(10.1 ± 19.3/0.0/0-80)
Acari (in general) [2]	28.7 ± 38.4/8.5/0-150	26.5 ± 38.5/12.1/0-180	27.4 ± 38.3/11.0/0-180
Total mites (Live mites)	(13.1 ± 21.3/0.0/0-75)	(7.1 ± 16.7/0.0/0-80)	(10.1 ± 19.2/0.0/0-80)
Relative humidity	59.0 ± 3.6/59.1/53.9-65.0	59.1 ± 3.0/59.1/59.3-65.0	54.1 ± 1.0/54.1/53.9-57.9
Temperature	22.6 ± 0.9/22.9/20.6-24.1	22.7 ± 0.9/22.9/20.6-24.1	23.2 ± 0.9/23.5/21.6-24.1

[1] Pyroglyphidae;
[2] all mites found (including oribatids and gamasids);
N = number of mite specimens;
n = number of samples examined.

Mite fauna in libraries examined in 1981-1986

Fifty percent of samples from libraries were positive. *D. pteronyssinus* was the dominant species, constituting 63.2% of the mites collected, and was found in 35.7% of the samples from libraries (Figs 3-4). This mite was tenfold highest in number per gram of dust, as *D. farinae* (Table 11). The highest records per 1 gram of dust were isolated from samples of dust from book-shelves and upholstered chairs (Table 12). It should be stressed that after dwellings the highest mite densities were noted in libraries. Therefore there is a potential risk of an occupational exposure to dust mite allergens among librarians.

Mite fauna in libraries examined in years 1987-2001

All of libraries proved to be positive for mites. A total of 106 specimens of these arthropods were isolated. Overall, mites were found in 21 samples (37.5 %) out of 56 examined. Dust mites

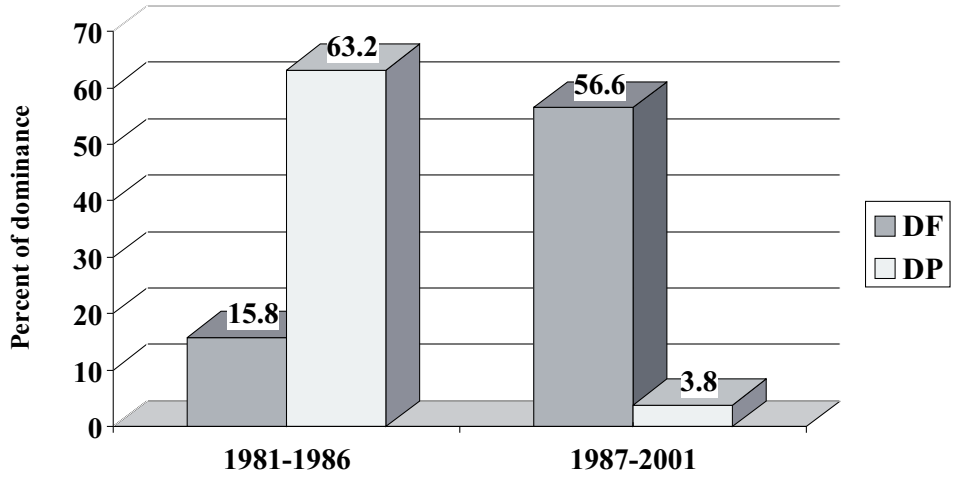

Fig. 3. Changes in the species composition of house dust mite fauna from libraries of the Upper Silesia (Poland). Explanations: DF – *Dermatophagoides farinae*; DP – *Dermatophagoides pteronyssinus*.

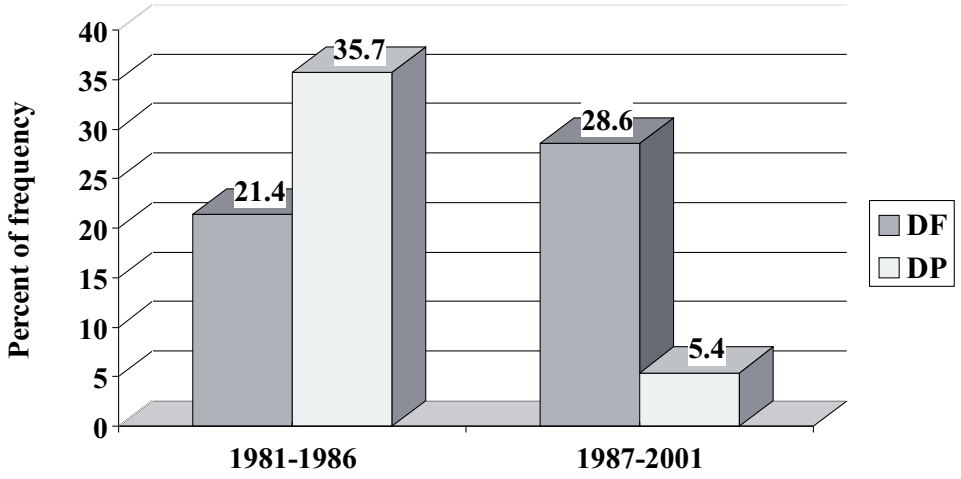

Fig. 4. Changes in the occurrence of pyroglyphid dust mite species in dust samples from the examined libraries of Upper Silesia (Poland). Explanations: DF – *Dermatophagoides farinae*; DP – *Dermatophagoides pteronyssinus*.

from the family Pyroglyphidae constituted 60.4% of all mites collected. The abundance of mites isolated from particular places in libraries (per 1 gram of dust from all samples examined) is compared in Table 13. The highest number of mites (37.7% of the total) was collected from samples from book-shelves and desks. Also, the highest numbers of mites per 1 gram of dust was found in samples of dust from book-shelves/desks and upholstered chairs (Table 13). *D. farinae* was the most dominant, constituting 56.6% of mites collected, and was found in 28.6% of the samples from libraries (Figs 3-4). This mite was also tenfold higher (per gram of dust) than *D. pteronyssinus* (Table 13). The latter species was found only in samples from book-shelves and from upholstered furnitures, where it was significantly more frequent ($\chi^2 = 4.42$; $p < 0.05$). *D. farinae* was isolated from

Table XI

Abundance of domestic mites (expressed as mean number of mites per 1 gram of dust) in 14 dust samples from libraries in Upper Silesia (Poland) examined in years 1981-1986[1]

Mites	Mean ± SD
Dermatophagoides pteronyssinus (N = 12)	203.5 ± 175.1
Dermatophagoides farinae (N = 3)	20.3 ± 21.3
Total mites[2] (N = 19)	154.5 5 ± 175.6

[1] based on own previous surveys (SOLARZ 1998);
[2] including other mites collected – *Tyrophagus palmarum,* other acarid mites unidentified and oribatid mites unidentified;
N = number of mite specimens.

Table XII

Abundance of mites (expressed as mean number of mites per 1 gram of dust) in 14 dust samples from libraries in Upper Silesia (Poland) examined in years 1981-1986 [1]

	Mean ± SD				
	Book-shelves and books	Carpeted floors	Desks	Upholstered chairs	Total samples (n = 14)
Total mites collected	325.0 ± 77.0	6.0[2]	7.7 ± 6.7	205.0 ± 195.0	154.5 ± 175.6

[1] based on own previous surveys (SOLARZ, 1998);
[2] single positive sample only;
n = number of samples examined.

samples from all places examined in the libraries, and was significantly more frequent in samples from book-shelves/desks than in samples from books, total floors (carpeted and uncarpeted) and upholstered or arm-chairs ($\chi^2 = 17.6$, $p \leq 0.00001$; $\chi^2 = 28.13$, $p \leq 0.00001$; $\chi^2 = 15.13$, $p = 0.0001$, respectively). Moreover, it was significantly more frequent in dust from carpeted floors than from total floors, books and upholstered or arm-chairs ($\chi^2 = 22.8$, $p \leq 0.00001$; $\chi^2 = 13.13$, $p < 0.0005$; $\chi^2 = 11.17$, $p < 0.001$, respectively), whereas the differences between book-shelves/desks and carpeted floors, or between books, total floors and upholstered or arm-chairs were non significant (χ^2; $p > 0.1$). There were non significant differences between mite prevalence of libraries and RH, and temperature ($p > 0.1$).

Mites from coal-mine social rooms and offices

Of 43 samples examined, only 5 (11.6%) were positive for mites. A total of 55 mites were isolated, all known as domestic mites, including 54 specimens of *D. farinae* and 1 of *A. siro* (Acaridae). All mites were found in offices, in samples from upholstered chairs (3 samples) and from carpets

Table XIII

Abundance of domestic mites (expressed as mean number of mites per 1 gram of dust) in dust samples from libraries in Upper Silesia (Poland) examined in years 1987-2001[1]

Places examined Mites (N = 106)	Mean SD ± (Maximum)					
	Books	Book-shelves	Carpeted floors	Total floors[2]	Upholstered chairs	Total samples (n = 56)
D. farinae	6.3 ± 14.1 (40)	65.5 ± 115.7 (400)	43.1 ± 55.2 (138.5)	14.8 ± 35.2 (138.5)	12.1 ± 21.2 (50)	27.2 ± 66.7 (400)
D. pteronyssinus	NF	3.8 ± 13.9 (50)	NF	NF	6.8 ± 16.2 (50)	2.5 ± 10.4 (50)
Pyroglyphidae – total	6.3 ± 14.1 (40)	73.2 ± 121.4 (400)	43.1 55.2 (138.5)	14.8 ± 35.2 (138.5)	18.9 ± 27.9 (75.0)	30.7 ± 70.5 (400)
Live (intact) mites	NF	3.8 ± 13.9 (50)	11.8 ± 13.5 (30.8)	3.2 ± 8.5 (30.7)	4.5 ± 11.5 (37.5)	3.4 ± 10.3 (50)
Domestic mites[3] – total	6.3 ± 14.1 (40)	124.5 ± 201.9 (666.7)	43.1 ± 55.2 (138.5)	18.9 ± 37.1 (138.5)	44.4 ± 82.7 (280)	50.7 ± 118.5 (666.7)
Live domestic mites	NF	3.8 ± 13.9 (50)	11.8 ± 13.5 (30.8)	6.1 ± 13.6 (50.0)	30.0 ± 83.7 (280)	10.1 ± 40.8 (280)
Total mites collected[4]	6.3 ± 14.1 (40)	292.5 ± 762.8 (2800)	49.8 ± 59.9 (138.5)	20.9 ± 40.4 (138.5)	44.4 ± 82.7 (280)	95.1 ± 398.3 (2800)
Total live mites	NF	167.9 ± 590.7 (2133.3)	18.5 ± 24.1 (60)	8.1 ± 18.0 (60)	30.0 ± 83.7 (280)	53.5 ± 303.0 (2133.3)

[1] based on own previous surveys (Solarz 2001b);
[2] including samples from carpets and samples from uncarpeted floors;
[3] including also other domestic mites collected – *Tyrophagus palmarum, T. putrescentiae, Glycyphagus privatus* and *Chortoglyphus arcuatus*;
[4] including mites of the genus *Bryobia* (Tetranychidae) found numerously in 2 libraries;
NF = not found;
N = number of mite specimens;
n = number of samples examined.

(2 samples). Generally, mite densities in the coal-mine offices and social rooms were lower than in dwellings and libraries, but comparable with those in the hospitals (Table 14).

Mite fauna in research institutes and laboratories examined in years 1981-2001

In samples of dust from institutes only non-pyroglyphid mites were found; 16.1% of these samples were mite positive. Considering allergenic domestic mites, only single specimens of *A. siro*, *T. putrescentiae* and *T. longior* were found in samples from floors in the Department of Biology and Parasitology of the Silesian Medical Academy in Katowice, whereas all samples from upholstered chairs and wooden furniture in the Institute of Systematics and Evolution of Animals of the Polish Academy of Sciences in Cracow were mite negative. The number of mites per gram of dust in all samples which were mite positive was lower than 100 (the threshold limit value of the risk of exposure to house dust mites).

Table XIV

Abundance of domestic mites (expressed as mean number of mites per 1 gram of dust) in dust samples from examined offices and social rooms of the coal-mine in Katowice (Upper Silesia, South Poland)

Mites (N = 55, n = 43)	Mean ± SD (Percent of dominance[1]/Percent of frequency[2])	Median	Range
Dermatophagoides farinae[3]	23.5 ± 141.0 (98.2/11.6)	0.0	0.0 – 925.0
Live *D. farinae*	1.6 ± 7.9	0.0	0.0 – 50.0
Total domestic mites[4]	24.1 ± 144.8 (100/11.6)	0.0	0.0 – 950.0
Live domestic mites	1.6 ± 7.9	0.0	0.0 – 50.0

Explanations:
[1] percent of total population;
[2] percent of total samples examined;
[3] sole species of the family Pyroglyphidae;
[4] including also other (non-pyroglyphid) domestic mites collected – *Acarus siro* (Acaridae);
N = number of mites collected;
n = number of samples examined.

Drug-stores

Of 30 samples examined, only 2 (6.7%) were positive for mites. Only 3 mite specimens were found, all from the family Pyroglyphidae: *Dermatophagoides farinae*, *D. pteronyssinus* and *Hirstia chelidonis*. The positive samples were collected from a floor and from an upholstered chair.

Other public utilities and work places

Considering the other work places or public utilities examined, the pyroglyphid mite *D. farinae* (1.3% of the total) was found only in the Police Department in Ciechanów, in dust from upholstered chairs, whereas pyroglyphids were absent in the archive. The species composition of domestic acarofauna in dust samples from the bakery in Jaworzno is listed in Table 15 and shows that 4 species of astigmatic mites were identified, between which only 1 species was from the family Pyroglyphidae – *D. pteronyssinus*. Most of the astigmatid mites found in the bakery belong to families Glycyphagidae and Acaridae. Among them, *Gohieria fusca* was predominant (approx. 40.2% of the total count), followed by *Acarus siro* complex (35.9%).

IV. DISCUSSION

D w e l l i n g s. These results corresponded well with the literature where 32-100% of homes and dwellings or dust samples analysed were positive for both species pyroglyphid mites (*D. pteronyssinus* and *D. farinae*) or other domestic mites (ARLIAN et al. 1978; VAN BRONSWIJK 1981; FAIN et al. 1990; HALLAS 1991; SOLARZ 2004, 2006, 2009). Ratios of numbers of the particular pyroglyphid dust mite species, especially between *D. pteronyssinus* and *D. farinae*, are different in sepa-

Table XV

Species list, dominance and frequency of mites found in samples from the examined bakery in Jaworzno (Upper Silesia, Poland)

Mite taxa	Dominance		Frequency		
	N	%	n	%[1]	%[2]
D. pteronyssinus	12	13.0	2	40	50
Acarus siro complex	33	35.9	3	60	75
Lepidoglyphus destructor	5	5.4	1	20	25
Gohieria fusca	37	40.2	1	20	25
Cheyletidae	3	3.3	1	20	25
Oribatida	2	2.2	1	20	25
Total mites	**92**	**100.0**	**4**	**80**	**100.00**

N = number of specimens;
n = number of samples positive;
[1] in relation to the total of samples examined (n = 5);
[2] in relation to samples positive for mites (n = 4).

rate regions of the world (FAIN et al. 1990; HART and WHITEHEAD 1990; MUMCUOGLU et al. 1999). Decisive factors influencing their occurrence and abundance are mainly relative humidity and temperature of both outdoor and indoor air (DUSBABEK 1995; KORSGAARD 1983a; ARLIAN 1989; ARLIAN et al. 1978, 1982, 1998a, b; DE BOER 1998; SOLARZ and SEŃCZUK 2003). It is commonly known that the optimal temperature is higher (between 25-30°C) and optimal humidity lower (50-75%RH) for *D. farinae* than for *D. pteronyssinus*. The former species appear to survive better in dryer habitats than the latter, whereas lower temperature (15-20°C) and higher humidity (75-80 %RH) favours *D. pteronyssinus* in mixed laboratory cultures (ARLIAN et al. 1998a). Mean values of relative humidity in the examined dwellings were generally below a critical equilibrium of humidity (CEH) for pyroglyphid house dust mites (especially for *D. pteronyssinus* and *E. maynei*) (ARLIAN 1989, 1992; ARLIAN et al. 1998a, b; COLLOFF 1991a, b). These data explain the dominance of *D. farinae* in the total of dwellings examined in years 1986-2005. As shown in the other previous surveys in Poland, *D. pteronyssinus* was found as the dominant species in Bydgoszcz, Warsaw, Poznań and vicinity, whereas *D. farinae* in Gdańsk and Gdynia (RACEWICZ 2001; SOLARZ 2001a, b). Moreover, in Warsaw *D. farinae* was even less numerous than *E. maynei* (SOLARZ 2001a) and Upper Silesia (HORAK 1987; HORAK et al. 1996). Summarizing, the domination of *D. farinae* in dwellings suggests to be a characteristic tendency at many localities in Poland in years 1987-2005 (Fig. 1). This tendency may also indicate that dwellings at these localities become more and more dry. On the other hand, the indoor air ambient humidity, which varies with the degree of ventilation of the dwellings, depends upon the building construction, and, therefore, energy-saving house insulation tends to increase indoor humidity and may lead to higher house dust mite densities (especially *D. pteronyssinus*) (KORSGAARD 1988, 1998a, b; HARVING et al. 1993; SUNDELL et al. 1995). These data explain the dominance of *D. pteronyssinus* in the dwellings examined in years 2006-2008 (Fig. 1). Although research has revealed how climatic conditions differently influence the biology of both species, insufficient data are available to fully explain differences in the occurrence and prevalence of both species between geographical areas and between dwellings within the same geographical area, as well as between particular places within the same dwelling (HARVING et al. 1993; ARLIAN et al. 1992, 1999b, c). In Europe, most abundant mite populations were usually collected

from bed mattresses (HALLAS & KORSGAARD 1997; HALLAS 1998; HORAK et al. 1996; SOLARZ 1997; TOVEY 1992).

H o s p i t a l s. It should be stressed that in hospitals house dust mites were less frequent and abundant than dwellings. The figures correspond with to data obtained in British and American hospitals (BLYTHE et al. 1975; RAO et al. 1975; BABE et al. 1995), where densities of mites were insignificant. Also in Poland, in Gdańsk and Gdynia (northern Poland), mites were seldom found in hospitals and were much less numerous than in private flats (mean numbers per gram of dust 1.03 and 13.07, respectively) (RACEWICZ 2001). However, considering individual species of pyroglyphid mites, only members of *D. pteronyssinus* were isolated from dust samples collected in hospitals in Gdańsk and Gdynia (RACEWICZ 2001), whereas *D. farinae* was more abundant in hospitals of the Upper Silesia region examined in years 1987-2006 (Fig. 2, Tables 8 and 10). On the other hand, in 8 hospitals located in Katowice and Sosnowiec, examined in years 1981-1986, the most abundant mites also were members of the family Pyroglyphidae, but the dominant species was *D. pteronyssinus*, which constituted 42.5% of a total count, whereas *D. farinae* and *E. maynei* formed only 10.0% and 5.0%, respectively (Fig. 2, Tab. 4). The density of mites (per gram of dust) was approximately twice as high in dust from beds than in dust from floors (Tab. 5).

In the area of Stockholm (Sweden), several mite species were found only in floor-dust samples from a hospital for long-term therapy, whereas all examined hospital beds were free from mites (TUROS 1979). Moreover, no *D. farinae* and/or *D. pteronyssinus* was found in 60 hospital dust samples from carpeted patients' rooms and hallways of a tertiary care hospital in the USA (in a temperate geographic region), that were obtained during a winter season; during the summer, the average mite density for all samples was low (BABE et al. 1995). Actual and previous results are also consistent with the data obtained by COLLOFF et al. (1991) in Western Australia, where mite concentrations were significantly lower in a sanatorium (13 mites per gram of dust) than in patients' homes (170 ones per gram of dust). On the other hand, in the Czech Republic the house dust mites were only twice as abundant in homes of eczematic children than in hospitals (VOBRÁZKOVÁ et al. 1986).

The factors responsible for the low mite density in hospitals are maintenance of low relative humidity and uncarpeted floors. It was also previously suggested that low humidity, use of low-pile carpets, and good housekeeping and laundering practices (frequent changing and washing of bed linen, cleaning of mattresses) were the main factors in preventing mite infestation in hospitals (RAO et al. 1975; BABE et al. 1995; RACEWICZ 2001).

L i b r a r i e s. Besides dwellings, the highest mite densities were noted in libraries. Therefore, there exists a potential risk of an occupational exposure to dust mite allergens among librarians. It is also noteworthy that in 2 libraries from Sosnowiec previously examined (1981-1986), the highest mite numbers per 1 gram of dust have also been isolated from samples of dust from book-shelves, but the dominant species was *D. pteronyssinus*, which occurred in numbers 6 times higher than *D. farinae* (or tenfold higher in relation to other positive samples).

O f f i c e s, i n s t i t u t e s a n d o t h e r w o r k p l a c e s o r p u b l i c u t i l i t i e s. Data presented in this paper confirmed the observations of several acarologists, small numbers of mites were found in hotel rooms and other social buildings or public places, such as schools, cinemas, nursery schools, student hostels, military barracks and naval ships, suggesting that the environment in these places is unsuitable for mite growth (KING et al. 1989; GREEN et al. 1992; RACEWICZ 2001). On the other hand, in Portland (USA) approximately one-half of the different offices examined were identified as having a dust mite population; the office upholstered chairs were the primary locations where dust mites thrived (JANKO et al. 1995). But the most important factor for occurrence and breeding of pyroglyphid dust mites is the presence of human beings, dead skin scales being the main source of food for these mites (HALLAS 1991; FAIN et al. 1990; VAN DER HOEVEN et al. 1992). Although beds are commonly known as the main indoor location of mite occurrence, they were, however – besides the dwellings – more abundant in libraries than in hospitals. Repeated routine cleaning practices, as well as maintenance of low relative humidity, could in part explain the low

abundance of mites in public buildings (GREEN et al. 1992; BABE et al. 1995; RACEWICZ 2001). In my opinion, some other biotic or abiotic factors, not yet clear, make book-shelves in libraries the most suitable environments for mite growth – more favourable than carpets and upholstered or arm-chairs. It is possible that older books (also book-shelves and desks) contain significant quantities of skin scales or dander from the readers or library workers, which serve as suitable food for the house dust mites.

V. FINAL REMARKS

In Poland, the qualitative and quantitative composition of the house dust mite fauna seems to differ regarding the site of collection and the time of collection. In the first period, years 1981-1986, we found *D. pteronyssinus* to be the dominant species, especially in hospitals and libraries. While between 1987 and 2005, *D. farinae* dominated the scenario. Interestingly, with the time, *D. pteronyssinus* appeared to become the most abundant and the most frequent species; properly recorded in the last period (2006-2008) when the higher numbers of *D. pteronyssinus* were reported (Fig 1). On the other hand, the incidence of other pyroglyphid, *E. maynei* showed a considerable decrease both in total numbers and density per gram of dust. Further studies are needed to clarify the relationship between indoor conditions (both biotic and abiotic factors) and the species composition of domestic acarofauna from dwellings and other public places in Poland.

A c k n o w l e d g e m e n t s. This study was possible thanks to the kind advice and great help of the late Professor Andrzej SZEPTYCKI, to whom this paper is dedicated. I express special thanks to Dr Jan BRUIN from Amsterdam for helpful discussion. Thanks are due also to Dr Maria Alejandra PEROTTI from Reading (UK) who reviewed the English manuscript.

REFERENCES

AALBERSE R. C. 1998. Allergens from mites: implications of cross-reactivity between invertebrate antigens. *Allergy*, **53**, Suppl. 48: 47-48.

ARLIAN L. G. 1989. Biology and ecology of house dust mites, *Dermatophagoides* spp. and *Euroglyphus* spp. I*mmunology and Allergy Clinics of North America*, **9**: 339-356.

ARLIAN L. G. 1991. House-dust-mite allergens: A review. *Experimental and Applied Acarology*, **10**: 167-186.

ARLIAN L. G. 1992. Water balance and humidity requirements of house dust mites. *Experimental and Applied Acarology*, **16**: 15-35.

ARLIAN L. G., PLATTS-MILLS T. A. E. 2001. The biology of dust mites and the remediation of mite allergens in allergic disease. *The Journal of Allergy and Clinical Immunology*, **107**: 406-413.

ARLIAN L.G., BERNSTEIN I. L., GALLAGHER J. S. 1982. The prevalence of house dust mites, *Dermatophagoides* spp., and associated environmental conditions in homes in Ohio. *The Journal of Allergy and Clinical Immunology*, **69**: 527-532.

ARLIAN L. G., BRANDT R. L., BERNSTEIN R. 1978. Occurrence of house dust mites, *Dermatophagoides* spp. (Acari: Pyroglyphidae) during the heating season. *Journal of Medical Entomology*, **15**: 35-42.

ARLIAN L. G., MORGAN M. S., GOELZ J. F. 1999a. Quantitation of dust mites and allergen in small dust samples. *The Journal of Allergy and Clinical Immunology*, **104**: 707-709.

ARLIAN L. G., MORGAN M. S., PETERSON K. T. 2008. House dust and storage mite extracts influence skin keratinocyte and fibroblast function. *International Archives of Allergy and Immunology*, **145**: 33-42.

ARLIAN L. G., NEAL J. S., BACON S. W. 1998b. Survival, fecundity, and development of *Dermatophagoides farinae* (Acari: Pyroglyphidae) at fluctuating relative humidity. *Journal of Medical Entomology*, **35**: 962-966.

ARLIAN L. G., NEAL J. S., VYSZENSKI-MOHER D. A. L. 1999b. Fluctuating hydrating and dehydrating relative humidities effects on the life cycle of *Dermatophagoides farinae* (Acari: Pyroglyphidae). J*ournal of Medical Entomology*, **36**: 457-461.

ARLIAN L. G., NEAL J. S., VYSZENSKI-MOHER D. A. L. 1999c. Reducing relative humidity to control the house dust mite *Dermatophagoides farinae*. *The Journal of Allergy and Clinical Immunology*, **104**: 852-856.

ARLIAN L. G., RAPP C. M., FERNANDEZ-CALDAS E. 1993a. Allergenicity of *Euroglyphus maynei* and its cross-reactivity with *Dermatophagoides* species. *The Journal of Allergy and Clinical Immunology*, **91**: 1051-1058.

ARLIAN L. G., VYSZENSKI-MOHER D. L., FERNANDEZ-CALDAS E. 1993b. Allergenicity of the mite, Blomia tropicalis. *The Journal of Allergy and Clinical Immunology*, **91**: 1042-1050.

ARLIAN L. G., WOODFORD P. J., BERNSTEIN I. L., GALLAGHER J. S. 1983. Seasonal population structure of house dust mites, *Dermatophagoides* spp. (Acari: Pyroglyphidae). *Journal of Medical Entomology*, **20**: 99-102.

ARLIAN L. G., CONFER P. D., RAPP C. M., VYSZENSKI-MOHER D. A. L., CHANG J. S. C. 1998a. Population dynamics of the house dust mites *Dermatophagoides farinae*, D. *pteronyssinus*, and *Euroglyphus maynei* (Acari: Pyroglyphidae) at specific relative humidities. *Journal of Medical Entomology*, **35**: 46-53.

ARLIAN L. G., BERNSTEIN D., BERNSTEIN I. L., FRIEDMAN S., GRANT A., LIEBER-MAN P., LOPEZ M., METZGER J., PLATTS-MILLS T., SCHATZ M., SPECTOR S., WASSERMAN S. I., ZEIGER R. S. 1992. Prevalence of dust mites in the homes of people with asthma living in eight different geographic areas of the United States. *The Journal of Allergy and Clinical Immunology*, **90**: 291-300.

BABE K. S., ARLIAN L. G., CONFER P. D., KIM R. 1995. House dust mite (Dermatopha-goides *farinae* and *Dermatophagoides pteronyssinus*) prevalence in the rooms and hallways of a tertiary care hospital. Clinical aspects of allergic disease. *The Journal of Allergy and Clinical Immunology*, **95**: 801-805.

BLYTHE M. E., AL UBAYDI F., WILLIAMS J. D., SMITH J. M. 1975. Study of dust mites in three Birmingham hospitals. *British Medical Journal*, **11**: 62-64.

BOER R., DE 1998. Reflections on the control of mites and mite allergens. *Allergy*, **53** (Suppl. 48): 41-46.

BRONSWIJK J. E. M. H. VAN. 1981. House dust biology (for allergists, acarologists and mycologists). N. I. B. Publishers, Zoelmond, 316 pp.

CHEW F. T., LIM S. H., GOH D. Y., LEE B. W. 1999. Sensitization to local dust-mite fauna in Singapore. *Allergy*, **54**: 1150-1159.

COLLOFF M. J. 1987. Mite fauna in dust from passenger trains in Glasgow. *Epidemiological Information Bulletin*, **98**: 127-130.

COLLOFF M. J. 1991a. Population studies on the house-dust mite, *Euroglyphus maynei* (COOREMAN, 1950) (Pyroglyphidae). (In:) R. H. SCHUSTER, P. W. MURPHY (eds) – The Acari: reproduction, development and life-history strategies. CHAPMAN and HALL, London. Pp: 497-505.

COLLOFF M. J. 1991b. A review of biology and allergenicity of house-dust mite *Euroglyphus maynei* (Acari: Pyroglyphidae). *Experimental and Applied Acarology*, **11**: 177-198.

COLLOFF M. J. 1992. Age structure and dynamics of house dust mite populations. *Experimental and Applied Acarology*, **16**: 49-74.

COLLOFF M. J. 1998a. Taxonomy and identification of dust mites. *Allergy*, **53**, Suppl. 48: 7-12.

COLLOFF M. J. 1998b. Distribution and abundance of dust mites within homes. *Allergy*, **53**, Suppl. 48: 24-27.

COLLOFF M. J., STEWART G. A., THOMPSON P. J. 1991. House dust acarofauna and Der p I equivalent in Australia: the relative importance of *Dermatophagoides pteronyssinus* and *Euroglyphus maynei*. *Clinical and Experimental Allergy*, **21**: 225-230.

COLLOFF M. J., AYRES J., CARSWELL F., HOWARTH P. H., MERRETT T. G., MITCHELL E. B., WALSHAW M. J., WARNER J. O., WARNER J. A., WOODCOCK A. A. 1992. The control of allergens of dust mites and domestic pets: a position paper. *Clinical and Experimental Allergy*, **22**, Suppl. 2: 1-28.

DAUTARTIENË A. 2002. House dust mites in Lithuania: their fauna, distribution and impact on humans. Abstract of Doctoral Thesis. Biomedical sciences, Vilnius University, biology (01B), Vilnius.

DUSBÁBEK F. 1995. Present state of research on house dust mites (Pyroglyphidae) in the Czech Republic. *Wiadomości Parazytologiczne*, **41**: 337-342.

DUTKIEWICZ J., JABŁOŃSKI L., OLENCHOCK S. A. 1988. Occupational biohazards. American *Journal of Industrial Medicine*, 1988: **14**: 605-623.

FAIN A., GUÉRIN B., HART B. J. 1990. Mites and allergic disease. Ed. B. GUÉRIN, Allerbio, Varennes en Argonne, 190 pp.

FELDMAN-MUHSAM B., MUMCUOGLU Y., OSTEROVICH T. 1985. A survey of house dust mites (Acari: Pyroglyphidae and Cheyletidae) in Israel. *Journal of Medical Entomology*, **22**: 663-669.

FRIEDMAN F. M., FRIEDMAN H. M., O'CONNOR G. T. 1992. Prevalence of dust-mite allergens in homes and workplaces of the Upper Connecticut River Valley of New England. *Allergy Proceedings*, **13**: 259-262.

GAMBOA P. M., JAUREGUI I., URRUTIA I., ANTEPARA I., GONZALEZ G., MUGICA V. 1996. Occupational asthma in a coal miner. *Thorax*, **51**: 867-868.

GREEN W. F., MARKS G. B., TOVEY E. R., TOELLE B. G., WOOLCOCK A. J. 1992. House dust mites and mite allergens in public places. *The Journal of Allergy and Clinical Immunology*, **89**: 1196-1197.

HALLAS T. E. 1991. The biology of mites. *Allergy*, **46**, Suppl. 11: 6-9.

HALLAS T. E. 1998. Pitfalls in evaluating mite exposure from house-dust samples. *Respiratory Medicine*, **92**: 1099-1101.

HALLAS T. E., IVERSEN M. 1996. Sources of exposure to storage mites in the farming environment. *Annals of Agricultural and Environmental Medicine*, **3**: 9-12.

HALLAS T. E., KORSGAARD J. 1997. Systematic variations in the appearance of house-dust mites (*Dermatophagoides* spp.), house mites (*Glycyphagus domesticus*) and of *Tarsonemus* sp. in dust samples from dwellings. *Revista Española de Alergologia e Immunologia Clinica*, **12**: 173-177.

HALLAS T. E., KORSGAARD J. 1998. Peak expiration flow variations may reflect house-dust-mite exposure and patient reactivity. *Allergy*, **53**, Suppl. 48: 303-305.

HART B. J. 1998. Life cycle and reproduction of house-dust mites: environmental factors influencing mite populations. *Allergy*, **53**, Suppl. 48: 13-17.

HART B. J., WHITEHEAD L. 1990. Ecology of house dust mites in Oxfordshire. Clinical and Experimental Allergy, **20**: 203-209.

HARVING H., KORSGAARD J., DAHL R. 1993. House-dust mites and associated environmental conditions in Danish homes. *Allergy*, **48**: 106-109.

HOEVEN W. A. D., VAN DER, DE BOER R., BRUIN J. 1992. The colonisation of new houses by house dust mites (Acari: Pyroglyphidae). *Experimental and Applied Acarology*, **16**: 75-84.

HORAK B. 1987. Preliminary study on the concentration and species composition of bacteria, fungi and mites in samples of house dust from Silesia (Poland). *Allergologia et Immuno-pathologia*, **15**: 161-166.

HORAK B., DUTKIEWICZ J., SOLARZ K. 1996. Microflora and acarofauna of bed dust from homes in Upper Silesia, Poland. *Annals of Allergy, Asthma, & Immunology*, **76**: 41-50.

HUGHES A. M. 1976. The mites of stored food and houses. H. M. S. O., London, 400 pp.

JANKO M., GOULD D. C., VANCE L., STENGEL C. C., FLACK J. 1995. Dust mite allergens in the office environment. *The American Industrial Hygiene Association Journal*, **56**: 1133-1140.

KING M. J., BETTS L. S., SONENSHINE D. E. 1989. House dust mites in naval ships, military barracks, and homes in the Hampton Roads area of Virginia. M*ilitary Medicine*, **154**: 467-473.

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

KORSGAARD J. 1983b. Mite asthma and residency: a case-control study on the impact of exposure to house dust mites in dwellings. *American Review of Respiratory Disease*, **128**: 231-253.

KORSGAARD J. 1988. Mite asthma and building construction in Denmark. *Allergologie*, **11**: 286-289.

KORSGAARD J. 1998a. Epidemiology of house-dust mites. *Allergy*, **53**, Suppl. 48: 36-40.

KORSGAARD J. 1998b. House-dust mites and asthma. A review on house-dust mites as a domestic risk factor for mite asthma. *Allergy*, **53**, Suppl. 48: 77-83.

MEHL R. 1998. Occurrence of mites in Norway and the rest of Scandinavia. *Allergy*, **53**, Suppl. 48: 28-35.

MUMCUOGLU K. Y., GAT Z., HOROWITZ T., MILLER J., BARTANA R., BENZVI A., NAPARSTEK Y. 1999. Abundance of house dust mites in relation to climate in contrasting agricultural settlements in Israel. *Medical and Veterinary Entomology*, **13**: 252-258.

NEAL J. S., ARLIAN L. G., MORGAN M. S. 2002. Relationship among house-dust mites, Der 1, Fel d 1, and Can f 1 on clothing and automobile seats with respect to densities in houses. *Annals of Allergy, Asthma, & Immunology*, **88**: 410-415.

OSHIMA S. 1964. Observations of floor mites collected in Yokohama. I. On the mites found in several schools in summer. *Japanese Journal of Sanitary Zoology*, **15**: 233-244.

PLATTS-MILLS T. A. E., WAYNE R. T., AALBERSE R. C., VERVLOET D., CHAPMAN M. D. 1992. Dust mite allergens and asthma: report of a Second International Workshop. *The Journal of Allergy and Clinical Immunology*, **89**: 1046-1060.

POPE A. M., PATTERSON R., BURGE H. 1993. Indoor allergens. Assessing and controlling adverse health effects. National Academy Press, Washington, 309 pp.

RACEWICZ M. 2001. House dust mites (Acari: Pyroglyphidae) in the cities of Gdańsk and Gdynia (Northern Poland). *Annals of Agricultural and Environmental Medicine*, **8**: 33-38.

RAO V. R. M., DEAN B. V., SEATON A., WILLIAMS D. A. 1975. A comparison of mite populations in mattress dust from hospital and from private houses in Cardiff, Wales. *Clinical Allergy*, **5**: 209-215.

REE H. I., JEON S. H., LEE I. Y., HONG C. S., LEE D. K. 1997. Fauna and geographical distribution of house dust mites in Korea. *The Korean Journal of Parasitology*, **35**: 9-17.

RIHS H-P., LIPPS P., MAY-TAUBE K., JÄGER D., SCHMIDT E. W., HEGEMANN J. H., BAUR X. 1994. Immunogenetic studies on HLA-DR in German coal miners with and without coal worker's pneumoconiosis. *Lung*, **172**: 347-354.

ROBINSON C., KALSHEKER N. A., SRINIVASAN N., KING C. M., GARROD D. R., THOMPSON P. J., STEWART G. A. 1997. On the potential significance of the enzymatic activity of mite allergens to immunogenicity. Clues to structure and function revealed by molecular characterization. Review. *Clinical and Experimental Allergy*, **27**: 10-21.

SAMŠIŇÁK K., VOBRÁZKOVÁ E. 1985. Mites from the city pavement. Zentralblatt für Bakteriologie Mikrobiologie und Hygiene Abt1 Originale, B, **181**: 132-138.

SAMŠIŇÁK K., VOBRÁZKOVÁ E., ŠPIČÁK V. 1978. Investigations on the fauna of beds in flats, children's sanatoria and old-age homes. *Folia parasitologica*, **25**: 157-163.

SOLARZ K. 1997. Seasonal dynamics of house dust mite populations in bed/mattress dust from two dwellings in Sosnowiec (Upper Silesia, Poland): an attempt to assess exposure. *Annals of Agricultural and Environmental Medicine*, **4**: 253-261.

SOLARZ K., 1998. The allergenic acarofauna of house dust from dwellings, hospitals, libraries and institutes in Upper Silesia (Poland). *Annals of Agricultural and Environmental Medicine*, **5**: 73-85.

SOLARZ K., 2001a. Risk of exposure to house dust pyroglyphid mites in Poland. *Annals of Agricultural and Environmental Medicine*, **8**:11-24.

SOLARZ K. 2001b. Pyroglyphidae (Acari: Astigmata) in Poland. Distribution, biology, population ecology and epidemiology. *Acta zoologica cracoviensia*, **44**: 435-528.

SOLARZ K. 2004. Distribution and ecology of allergenic mites in Poland. *Phytophaga*, **14**: 675-694.

SOLARZ K. 2006. Allergenic mites in habitats associated with man. *Biological Letters*, **43**: 299-306.

SOLARZ K., SEŃCZUK L. 2003. Allergenic acarofauna of synanthropic outdoor environments in a densely populated urban area in Katowice, Upper Silesia, Poland. *International Journal of Acarology*, **29**: 403-420.

SOLARZ K., SOLARZ D. 1996. The allergenic mites in coal-mine dust from coal mines in Upper Silesia (Poland). *Annals of Agricultural and Environmental Medicine*, **3**: 49-55.

SOLARZ K., SZILMAN P., SZILMAN E. 1997. Preliminary study on the occurrence and species composition of astigmatic mites (Acari: Astigmata) in samples of dust, debris and residues from farming environments in Poland. *Annals of Agricultural and Environmental Medicine*, **4**: 249-252.

SOLARZ K., SZILMAN P., SZILMAN E. 1999. Allergenic mites associated with bird nests in Poland (Astigmata: Pyroglyphidae, Acaridae, Glycyphagidae). (In:) J. BRUIN, L. P. S.VAN DER GEEST, M. W. SABELIS (eds) – Ecology and Evolution of the Acari. Kluwer Academic Publishers, Dordrecht, The Netherlands. Pp: 651-656.

SOLARZ K., SZILMAN P., SZILMAN E. 2004a. Occupational exposure to allergenic mites in a Polish Zoo. *Annals of Agricultural and Environmental Medicine*, **11**: 27-33.

SOLARZ K., SEŃCZUK L., MANIURKA H., CICHECKA E., PESZKE M. 2007. Comparisons of the allergenic mite prevalence in dwellings and certain outdoor environments of the Upper Silesia (Southwest Poland). *International Journal of Hygiene and Environmental Health*, **210**: 715-724.

SOLARZ K., SZILMAN P., SZILMAN E., KRZAK M., JAGŁA A. 2004b. Some allergenic species of astigmatid mites (Acari, Astigmata) from different synanthropic environments in southern Poland. *Acta zoologica cracoviensia*, **47**: 125-145.

SUGGARS A. L. 1987. House dust mites: a review. *Journal of Entomological Sciences*, Suppl **1**: 3-15.

SUNDELL J., WICKMAN M., PERSHAGEN G., NORDVALL S. L. 1995. Ventilation in homes infested by house-dust mites. *Allergy*, **50**: 106-112.

ŚPIEWAK R., BOŻEK A., SOLARZ K., MASŁOWSKI T., BREWCZYŃSKI P. Z. 1995. Das Prurigo-Asthma Syndrom infolge beruflicher Exposition gegen Mehlallergene. *Allergologie*, **18**: 102-106.

TOVEY E. R. 1992. Allergen exposure and control. *Experimental and Applied Acarology*, **16**: 181 202.

TUROS M. 1979. Mites in house dust in the Stockholm area. *Allergy*, **34**: 11-18.

VARGAS M. V., MAIRENA H. A. 1991. House dust mites from the metropolitan area of San José, Costa Rica. *International Journal of Acarology*, **17**: 141-144.

VOBRÁZKOVÁ E., SAMŠIŇÁK K., ŠPIČÁK V. 1979. Allergogenous mites (Acari: Pyroglyphidae) in private recreation houses. *Folia Parasitologica*, **26**: 343-349.

VOBRÁZKOVÁ E., SAMŠIŇÁK K., ŠPIČÁK V. 1985. The possibility of a sensitization to inhalatory allergens in nursery schools. *Zoologischer Anzeiger*, **215**: 195-200.

VOBRÁZKOVÁ E., KASIAKOVA A., SAMŠIŇÁK K. 1986. Analysis of dust samples from the clinical environmet of children with eczemas. *Angewandte Parasitologie*, **27**: 53-55.

WHARTON G. W. 1976. House dust mites: review article. *Journal of Medical Entomology*, **12**: 577-621.

WOUTERS E. F. M., JORNA T. H. J. M., WESTENEND M. 1994. Respiratory effects of coal dust exposure: Clinical effects and diagnosis. *Experimental Lung Research*, **20**: 385-394.

ZOCK J. P., BRUNEKREEF B. 1995. House dust mite allergen levels in dust from schools with smooth and carpeted classroom floors. *Clinical and Experimental Allergy*, **25**: 549-553.