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Pyroglyphidae (Acari: Astigmata) in Poland. Distribution, biology, population ecology and epidemiology

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Abstract. This paper gives a faunistic review of the pyroglyphid mites that have actually been recorded in Poland in dwellings, lofts and attics, hospitals, libraries, coal-mine offices, research institutes and other public places, in coal-mines, in farming environments (barns, cowsheds, byres, stables, poultry houses), and in natural environments such as birds' nests. Lofts, coal-mine offices, an archive and a police department were analysed for the first time for occurrence of house dust mites. Results are presented in tables and discussed with the literature data. A total of 25,295 mite specimens were isolated and identified, including 13,340 members of the family Pyroglyphidae (52.74%). Six species of pyroglyphid mites have been recorded: *Dermatophagoides pteronyssinus, D. farinae, D. evansi, Hirstia chelidonis, Euroglyphus maynei* and *Gymnoglyphus longior*. *D. farinae* was the predominant species in dwellings, followed by *D. pteronyssinus* and *E. maynei*. *H. chelidonis* was found in house dust samples, *E. maynei* in mice nest, *D. pteronyssinus* in coal-mine dust and debris, and *G. longior* in byres and barn debris. *H. chelidonis* was the predominant species in nests of *Hirundo rustica*, *Delichon urbica*, *Passer domesticus* and *Turdus* spp., whereas *D. evansi* was found numerously in nests of *Parus* sp. and *Sylvia* sp. For the first time in Poland, the sex, age structure, annual dynamics of populations of the pyroglyphid dust mite species, and fluctuations in levels of the mite allergens were investigated at three sites (couch, carpet and two upholstery arm-chairs) from the bedroon of the flat in Sosnowiec (Upper Silesia). Moreover, additional experiments were conducted to determine the dynamics of the laboratory population of the dust mite *Dermatophagoides farinae*.

Key words: Acari, house dust mites, allergenic mites, Poland, Upper Silesia, Pyroglyphidae, *Dermatophagoides, Euroglyphus, Gymnoglyphus, Hirstia*, coal-mine dust, nests of synanthropic birds, farming environments, rodents' nests, organic dust, allergy, atopy, mite allergens.

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Contents

I. INTRODUCTION

The family Pyroglyphidae CUNLIFFE, 1958 (Acari: Acaridida) presently consists of 47 species and 19 genera, whose species are associated with birds, mammals, or house dust and stored products (FAIN et al. 1990; VARGAS & SMILEY 1994; COLLOFF 1998a). Among members of the division Psoroptidia, only this family contains mainly nonparasitic taxa. The majority of these species are nidicolous, with bird associates outnumbering mammal associates. These mites feed on animal detritus and/or dander (skin scales) in the nests and have given rise to several more typically parasitic taxa (GAUD 1968; OCONNOR 1982; FAIN et al. 1990). But mites of this family are perhaps best known as the house dust mites, because of their occurrence in human dwellings.

Mites occurring in house dust, besides the ticks (Acari: Ixodida), are one of the most medically important group of mites (VOORHORST et al. 1964, 1969; WHARTON 1976; VAN BRONSWIJK 1981; ABE & ISHII 1987). The most abundant mites in house dust are members of the family Pyroglyphidae (WHARTON 1976; HORWIZ & BUSH 1997). The 3 mite species, most often and most numerously found in house dust throughout the world, are *Dermatophagoides pteronyssinus* (TROUESSART), *D. farinae* HUGHES and *Euroglyphus maynei* (COOREMAN) (ARLIAN 1991; ARLIAN et al. 1993a, b; HALLAS 1991; PLATTS-MILLS et al. 1992; POPE et al. 1993; MORGAN et al. 1997; ROBINSON et al. 1997). These 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 (VOORHORST et al. 1969; MOSBECH 1985; MOSBECH et al. 1991; ARLIAN 1991; SCHOU & LIND 1991; PLATTS-MILLS et al. 1992; TOVEY 1992; TOVEY & BALDO 1990; TOVEY et al. 1981, POPE et al. 1993). These diseases are atopic asthma, atopic dermatitis (eczema) and allergic rhinitis, keratoconjunctivitis or oculorhinitis (MUMCUOGLU et al. 1988; ARLIAN 1991; PLATTS-MILLS et al. 1992; COLLOFF et al. 1992; VAN BEVER et al. 1993; PAULI et al. 1993; KUBOTA et al. 1994; MARKS et al. 1995 a, b; ROSE et al. 1996; BOULET et al. 1997; CAMERON 1997). Recent studies show that the enzimatically active allergens are found in mite faeces; those faecal allergens include a cysteine proteinase, several serine proteinases, and glutathione S-transferase (ROBINSON et al. 1997; AALBERSE 1998; TSAI et al. 2000; TAKAHASHI et al. 2001). Research on mite allergenicity has focused recently on the seven dust mite species – *D. pteronyssinus, D. farinae, Dermatophagoides microceras* GRIFFITHS et CUNNINGTON, *D. siboney* DUSBABEK,CUERVO et DE LA CRUZ, *Sturnophagoides brasiliensis* FAIN, *E. maynei* and *Gymnoglyphus longior* (TROUESSART) (ARLIAN 1991; HILL et al. 1993; ROBINSON et al. 1997; FERRANDIZ et al. 1997; CHEW et al. 1999). To date, more than 14 proteins have been identified as allergens of *D. pteronyssinus* and/or *D. farinae* (AALBERSE 1998; KAWAMOTO et al. 2000; KUSUNOKI et al. 2000; MAJORI et al. 2000; SEWER et al. 2000; TSAI et al. 2000; BARNES et al. 2001).

Most often they are found in habitats intimately associated with man, such as beds, couches, sofas, other upholstery furnitures, clothing, floors and carpets (VAN BRONSWIJK 1981; SUGGARS 1987; FAIN et al. 1990; TOVEY 1992; HORAK et al. 1996).

The house dust mites have been reported from human dwellings and a wide variety of other habitats associated with man and his environment, both indoor and outdoor (e.g. in hospitals, libraries, schools, nursery schools, hotels, students' hotels, offices, military barracks, workplaces and other public places, in recreation facilities, farming environments, passenger trains, naval ships, ocean-going ships, birds' nests, city pavements, among others) (OSHIMA 1964; BLYTHE et al. 1975; RAO et al. 1975; TUROS 1979; VOBRÁZKOVÁ et al. 1979, 1985, 1986; WEGNER 1980; VAN BRONSWIJK 1981; SAMŠIŇÁK & VOBRÁZKOVÁ 1983, 1985; SAMŠIŇÁK 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; RACEWICZ 2001). The natural sources of allergenic mites in dwellings or stores are still not quiet 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). These mites are the major sources of indoor inhalant allergens faciliating both the sensitization of atopic subjects and asthmatic attacks in patients (ARLIAN 1991; COLLOFF et al. 1992; FAIN et al. 1990; PLATTS-MILLS et al. 1992).

Since storage mites have been found in house dust, the term domestic mites has been proposed, including the house dust mites (Pyroglyphidae) and the other allergenic mites (mainly storage mites) occurring in dwellings (PLATTS-MILLS et al. 1992).

The house dust mites now constitute the most dangerous pests of temperate climate countries, causing both significant loss of human life and immense waste of resources. In Poland, the knowledge of their occurrence in house dust is still poor and the number of faunistic surveys on dust acarofauna is anywhere from 10-20 (CHMIELEWSKI 1995; HORAK 1987; HORAK et al. 1996; SOLARZ 1998). Therefore, such surveys are indispensible in Poland, especially in the Upper Silesian region, where air vitiation may to have a stimulating influence on the sensitization of human beings with house dust allergens.

It is also commonly known that certain industrial dusts may cause chronic lung diseases in occupational populations, including coal workers (HUNPONU-WUSU & SOMORIN 1978; SOLARZ & SOLARZ 1996). It cannot be excluded that apart from coal dust itself, certain constituents of biological origin may also contribute to the pathogenic effect (DUTKIEWICZ et al. 1988).

Moreover, it should be stressed that a large part of the territory of Poland was not examined for the occurrence of allergenic mites in birds' nests, including the pyroglyphid and non-pyroglyphid mites of medical concern of the order Acaridida. The knowledge of their occurrence in the nests is still poor.

Since the proposal that allergen from the house dust mite *D. pteronyssinus* is almost identical to the main house dust allergen (VOORHORST et al., 1964, 1969) which is supposed to cause the house-dust atopy, interest in the abundance, species composition and diversity, population ecology, and frequency of pyroglyphid dust mites in the indoor environment has increased (ARLIAN et al. 1982; COLLOFF 1998b; HILL 1998). An understanding of the life cycle of house dust mites, their population age structure and seasonal dynamics, as well as environmental factors influencing mite populations, can 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. Age structure and annual dynamics of populations of the pyroglyphid mite species in dust from dwellings have not received a great deal of attention from acarologists, despite their important practical use for mite control and exposure assessment (HUGHES & MAUNSELL 1973; ARLIAN et al. 1978; FURUMIZO 1978; LANG & MULLA 1978; WICKMAN et al. 1991; COLLOFF 1992; POPE et al. 1993). Previous investigations have focused on seasonal fluctuations in ratios of adults and particular immature stages (DUSBÁBEK 1975; FURUMIZO 1978; LANG & MULLA 1978; WOODFORD et al. 1979; ARLIAN et al. 1983). Moreover, several studies on the relative proportion of larvae, protonymphs, tritonymphs, and adult males and females (age structure) in populations of *D. pteronyssinus, D. farinae* and *E. maynei* have been performed (VOORHORST et al. 1969; GRIDELET & LEBRUN 1973; DUSBÁBEK 1975, 1979; SOLARZ 2000b). COLLOFF (1992) for the first time included data on the proportion of eggs into the age structure of populations of these species. The population structure and dynamics of the house dust mites *D. farinae, D. pteronyssinus* and *E. maynei* has also been examined recently in laboratory conditions (ARLIAN et al. 1998a).

It is also commonly known that population age structure shows seasonal variation depending on indoor and outdoor environmental conditions, especially relative humidity and temperature (KORSGAARD 1983a, 1998a, b; DUSBÁBEK 1995). Seasonal fluctuations of the house dust mite density in different climatic zones or regions throughout the world differ significantly (VAN

BRONSWIJK 1981; KORSGAARD 1983a; FAIN et al. 1990; ARLIAN et al. 1992; MATSUOKA et al. 1995; HALLAS 1998).

For these reasons, additional studies in different countries and regions of the world are needed. 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 furnitures as the 3 main types of the indoor microhabitats of these mites (COLLOFF 1998b).

The Acarex test is a simple indirect measurement of house-dust-mite allergens, which measures the amount of guanine, a nitrogenous excretory product of mites. This test is semiquantitative, because it also detects guanine produced by any other domestic mite species and additionally cross-reacts with xanthine (HALLAS et al. 1993; HILL 1998). Nevertheless, comparisons between levels of guanine and measurements of mite allergens *Der p* 1 and *Der f* 1 by ELISA or RIA have shown significant positive correlations (HILL 1998).

Characteristics of the family Pyroglyphidae

1. Taxonomic position

Phylum: Arthropoda
Subphylum: Cheliceromorpha (= Chelicerata)
Class: Arachnida
Subclass: Acari
Superorder: Actinotrichida
Order: Acaridida (= Astigmata)
Division: Psoroptidia
Superfamily: Pyroglyphoidea

The superfamily Pyroglyphoidea includes three families: Pyroglyphidae, Turbinoptidae and Ptyssalgidae. The Turbinoptidae are parasites of birds and live in the nasal passages of their avian hosts. Members of Ptyssalgidae are found within the quills of hummingbirds (OCONNOR 1982; WOOLLEY 1988; EVANS 1992). The majority of the Pyroglyphidae are free-living in nests of birds (mainly Passeriformes), in house dust and stored plant products; only members of the genus *Paralgopsis* GAUD et MOUCHET are true parasites of birds (FAIN et al. 1990).

2. List of species

[Asterisks mark the species known from house dust samples]

Systematic knowledge of Pyroglyphidae has been generally summarized by FAIN (FAIN et al. 1990), FAIN & ATYEO (1990) and COLLOFF (1998a). The following systematics are based on these publications.

Family: Pyroglyphidae
  Subfamily: Pyroglyphinae
    Genus: *Pyroglyphus* CUNLIFFE, 1958
      Species: *Pyroglyphus morlani* CUNLIFFE, 1958
    Genus: *Hughesiella* FAIN, 1965, 1988
      Species: *Hughesiella africana* (HUGHES, 1954)*
        Hughesiella valerioi VARGAS et SMILEY, 1994*

Genus: *Bontiella* FAIN, 1965
Species: *Bontiella bouilloni* FAIN, 1965
Genus: *Euroglyphus* FAIN, 1965, 1988
Species: *Euroglyphus maynei* (COOREMAN, 1950)*
Genus: *Gymnoglyphus* FAIN, 1965, 1988
Species: *Gymnoglyphus longior* (TROUESSART, 1897)*
Gymnoglyphus osu (FAIN et JOHNSTON, 1973)
Genus: *Weelawadjia* FAIN et LOWRY, 1974
Species: *Weelawadjia australis* FAIN et LOWRY, 1974
Genus: *Campephilocoptes* FAIN, GAUD et PÉREZ, 1982
Species: *Campephilocoptes atyeoi* FAIN, GAUD et PÉREZ, 1982
Campephilocoptes paraguayensis FAIN, GAUD et PÉREZ, 1982
Genus: *Asiopyroglyphus* FAIN et ATYEO, 1990
Species: *Asiopyroglyphus thailandicus* FAIN et ATYEO, 1990
Subfamily: Dermatophagoidinae
Genus: *Dermatophagoides* BOGDANOV, 1864
Species: *Dermatophagoides pteronyssinus* (TROUESSART, 1897)*
Dermatophagoides farinae HUGHES, 1961*
Dermatophagoides microceras GRIFFITHS et CUNNINGTON, 1971*
Dermatophagoides evansi FAIN, HUGHES et JOHNSTON, 1967*
Dermatophagoides anisopoda (GAUD, 1968)
Dermatophagoides simplex FAIN et ROSA, 1982
Dermatophagoides sclerovestibulatus FAIN, 1975
Dermatophagoides aureliani FAIN, 1967
Dermatophagoides rwandae FAIN, 1967
Dermatophagoides neotropicalis FAIN et VAN BRONSWIJK, 1973*
Dermatophagoides siboney DUSBABEK, CUERVO et DE LA CRUZ, 1982*
Genus: *Sturnophagoides* FAIN, 1967
Species: *Sturnophagoides brasiliensis* FAIN, 1967*
Sturnophagoides petrochelidonis CUERVO et DUSBABEK, 1987
Sturnophagoides bakeri FAIN, 1967
Genus: *Malayoglyphus* FAIN, CUNNINGTON et SPIEKSMA, 1969
Species: *Malayoglyphus intermedius* FAIN, CUNNINGTON et SPIEKSMA, 1969*
Malayoglyphus carmelitus SPIEKSMA, 1973*
Genus: *Hirstia* HULL, 1931
Species: *Hirstia chelidonis* HULL, 1931*
Hirstia domicola FAIN, OSHIMA et VAN BRONSWIJK, 1974*
Subfamily: Guatemalichinae
Genus: *Guatemalichus* FAIN et WHARTON, 1970
Species: *Guatemalichus bananae* FAIN et WHARTON, 1970
Guatemalichus tachornis CRUZ, CUERVO et DUSBABEK, 1984
Genus: *Fainoglyphus* ATYEO et GAUD, 1977
Species: *Fainoglyphus magnasternus* ATYEO et GAUD, 1977
Genus: *Pottocola* FAIN, 1971

Subgenus: *Pottocola* FAIN, 1971
Species: *Pottocola* (*Pottocola*) *scutata* FAIN, 1971
Subgenus: *Capitonocoptes* FAIN et GAUD, 1984
Species: *Pottocola* (*Capitonocoptes*) *ventriscutata* FAIN et GAUD, 1984
Pottocola (*Capitonocoptes*) *longipilis* FAIN et GAUD, 1984
Pottocola (*Capitonocoptes*) *lybius* FAIN et GAUD, 1984
Subfamily: Onychalginae
Genus: *Kivuicola* FAIN, 1971
Species: *Kivuicola kivuana* FAIN, 1971, 1988b
Genus: *Onychalges* GAUD et MOUCHET, 1959
Species: *Onychalges longitarsus* (GAUD et MOUCHET, 1959)
Onychalges asaphospathus GAUD, 1968
Onychalges odonturus GAUD, 1968
Onychalges pachyspathus GAUD, 1968
Onychalges schizurus GAUD, 1968
Onychalges spinitarsis (FAIN et GAUD, 1984)
Onychalges nidicola FAIN et ROSA, 1982
Genus: *Paramealia* GAUD, 1968
Species: *Paramealia ovata* (GAUD et MOUCHET, 1959)
Subfamily: Paralgopsinae
Genus: *Paralgopsis* GAUD et MOUCHET, 1959
Species: *Paralgopsis paradoxus* (TROUESSART, 1899)
Paralgopsis ctenodontus GAUD, 1968

3. Morphology

Members of the division Psoroptidia typically demonstrate the following characteristics:
– lack setae from the idiosomal segment AD;
– have the progenital lips fused to the ventral surface of the body wall;
– show a reduction of the leg chaetotaxy: setae *pl* on tarsi I, and setae *v* on tibiae I and II, are absent;
– the deutonymphal stage does not occur in the life cycle.

The Pyroglyphidae are small mites, whitish in colour; the length of idiosoma of adults ranged from 168 µm (*M. intermedius*) to 585 µm (*O. longitarsus*). Idiosoma is generally oval in shape with parallel sides, and broadly rounded anterior and posterior margins. The degree of the cuticle sclerotization is variable; in some subfamilies or genera it is almost completely sclerotized, without true striations, whereas in others the cuticle is soft and striated, in which case the dorsal shields are more poorly developed. Morphology and biology of the pyroglyphids seems to indicate that the free-living forms are descended from permanently parasitic ancestors (OCONNOR 1982; WOOLLEY 1988). These mites morphologically show some features of parasitic Psoroptidia, particularly a regression of:
– legs IV (especially in males);
– dorsal shields (mainly the hysterosomal);
– copulatory suckers (vestigial or reduced, in the shape of small sclerotized rings);
– tarsal claws (only in the form of a small median axis).

On the other hand it has been suggested by FAIN (FAIN 1979; FAIN et al. 1990) that in the Pyroglyphidae the regression of the organs has preceeded the invasion of the host as if there were a preadaptation.

This regression involves also an idiosomal and leg chetotaxy. In 1990 GRIFFITHS et al. proposed a new system of the idiosomal chaetotaxy of astigmatid mites. Because of the reduction of chaetotaxy in Pyroglyphidae, the older chaetotaxic nomenclature (according to FAIN et al. 1990) is more useful for this family and is therefore applied in this study. Vertical setae are generally absent; thus, scapular setae (*sc e* and *sc i*) are the first pair, most anteriorly located. The absence of setae *v e* is the typical feature of the Pyroglyphidae; whereas setae *v i* occur only in the members of the genus *Paralgopsis* (subfamily Paralgopsinae) (FAIN et al. 1990). The external scapulars (*sc e*) are longer, more or less, as the internal setae (*sc i*). There are only 2 pairs of anal setae (*a e* and *a i*) in females.* On tarsi I and II 8 setae, on tibiae I and II only 1 seta.** Moreover, an apical migration of the solenidion ω*1* on tarsus I seems to be typical for the Pyroglyphoidea. Thus, the solenidia ω *1* and ω *3* are situated at the apex of this tarsus, close to each other. Famulus is a short spine, situated proximally to the solenidion ω*1*.

4. Biology

Among members of the division Psoroptidia, only the Pyroglyphidae family mainly contains nonparasitic taxa. However, some pyroglyphids (*Paralgopsis* sp.) live as external parasites of birds, apparently feeding on feather detritus (GAUD 1968; OCONNOR 1982; FAIN et al. 1990). Still others inhabit the space within the quills of feathers where these mites feed on the pith of the feather itself (GAUD 1968; OCONNOR 1982).

These mites respire through the cuticle. Their thin „skin" permits the exchange of oxygen and carbon dioxide, and water vapour easily evaporates from the surface of their body. As they feed from dry skin scales and other dust debris, they are vulnerable to desiccation and die when the relative humidity in the surrounding air is below 55% (or even 45%) (HALLAS 1991; KORSGAARD & IVERSEN 1991). Although it is common practice to measure ambient humidity, it is the humidity within their living places (surface of mattresses, bedding, sofas or couches, and carpets) that is relevant. As food is usually abundant (1 person sheds about 0.5-1.0 gram of skin scales or dander, which is enough to feed four thousand mites per month) and their temperature preferrence is equal to our preferred indoor temperature; air humidity becomes the most important environmental factor determining the density of a mite population (ARLIAN 1989; HALLAS 1991). Mite-body water loss contrains colonization and population growth, but pyroglyphid house dust mites are able to extract water vapour from unsaturated air by means of a hygroscopic salt solution in the so-called supracoxal glands (ARLIAN 1989, 1992; FAIN et al. 1990; COLLOFF et al. 1992). If the humidity falls below a critical level (Critical Equilibrium Humidity; CEH), the salts crystallize and block the entrance of the glands, thus slowing the rate of dehydration. It is the ability of house dust mites to survive at humidities well below saturation that accounts for their successful colonization of human dwellings worldwide.

Adult mites held at humidities below the CEH gradually dehydrate and die; males dehydrate faster and die sooner than females when held at similar dehydrating humidities (ARLIAN 1992). Laboratory studies by ARLIAN (1989, 1992) demonstrate that at between 40 – 50 % RH and temp. between 28-34 °C, the values of time required for 50 % of a test population of mites to die (LT_{50}) are between 2.07 – 3.24 days for females of *D. pteronyssinus* and only 1.82 – 3.43 days for males of this

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* Whereas in females of the Acaridae family there are 5-6 pairs of anal seatae.

** In the Acaridae family there are 13 and 12 tarsal setae on tarsi I and II, respectively, and 2 tibial setae on tibiae I and II.

species, while the values of LT_{50} for females and males of *D. farinae* held at the same conditions were 2.05-3.19 and 1.33-2.11, respectively (ARLIAN 1989, 1992). Even so, at these conditions some females and males are more resistant to dehydration and survive 6-10 days and 4-6 days for *D. farinae* and *D. pteronyssinus*, respectively. This has been confirmed by water balance studies, which indicate that the former species is more resistant to desiccation (ARLIAN 1989, 1992). Moreover, the feeding mites may have a slightly lower CEH than fasting mites (ARLIAN 1989).

The water content of dehydrating females of *D. farinae* has beem measured by ARLIAN & WHARTON (1974) just prior to death. The normal water content may be reduced at least 52% without any lethal effects. Whereas, *D. pteronyssinus* can survive at least a 17% loss in the body water content (ARLIAN & WHARTON 1974; ARLIAN 1992).

The process of water uptake is also temperature dependent. For example, *D. farinae* can maintain water balance and survive at humidities of about 55% RH at 15 °C (CEH = 55%; $a_v = 0.55$), 65% RH at 25 °C (CEH = 65%; $a_v = 0.65$), 70% RH at 30 °C (CEH = 70%; $a_v = 0.70$) and 75% RH at 35 °C (CEH = 75%; $a_v = 0.75$) (ARLIAN 1992). As mentioned above, *D. pteronyssinus* and also *E. maynei* are more susceptible to desiccation than *D. farinae*, and the CEHs for fasting mites of these species at 25 °C are 73% and 75% RH, respectively (ARLIAN 1989, 1992; COLLOFF 1991a, b). However, it should be stressed that feeding mites may have a slightly lower CEH (ARLIAN 1989). Mites held at humidities below their CEH feed sparingly and produce little faecal material, which is very important from the medical and allergological point of view (ARLIAN 1992). ARLIAN (1989, 1992) found that the feeding rate, and therefore water intake with the food by mites (both *D. farinae* and *D. pteronyssinus*) was directly influenced by air ambient relative humidity. A heavy accumulation of mite faecal pellets, proportional to the feeding rate, was observed on and around the food (culture medium) for mites feeding at or obove 75% RH. Moreover, water gained as a result of feeding amounted to only 4-16% of the total water gain at 75-85% RH. Water gained as a result of feeding for mites held below 75% RH amounted to less than 5% of the total water requirement to maintain water balance; therefore, in terms of maintaining this water balance, especially under dry conditions, the water gained during feeding is insignificant (ARLIAN 1992).

It was also demonstrated (ARLIAN et al. 1998b) that 84% of females *D. farinae* survived when exposed to a daily regime of 4 hours of moist air (75% RH) and 20 hours of dry air (0% RH), and produced approximately only 1/3rd of the number of eggs produced at constant 75% RH. A more recent study (ARLIAN et al. 1999a) has revealed that this species can complete its development and life cycle when given only short periods of moist air daily, but the rate of development is much slower than development at a constant 75% RH; therefore, reducing ambient humidity does reduce the rate of development of the mite populations and the accumulation of dust mite allergens.

Temperature is also an important factor influencing development of house dust mite populations in dwellings. Much simplified, it can be said that it is mostly temperature that decides how quickly mites can develop, whereas humidity determines the number of house dust mites able to live in a home (ARLIAN 1989, 1991, 1992; HALLAS 1991). The range of temperatures at which these mites can develop is between 15 and 35 °C. It has been also demonstrated (CHANG et al. 1998) that high temperatures (40-80 °C) has significant effects on the survival of *D. farinae*. At temperatures above 50 °C females of this species survived for less than 40 minutes, and at 60, 70 and 80 °C, 100% mortality occurred in less than 10 minutes. It seems that RH does not play a key role, but that temperature is the determining factor in mite survival when the temperature is higher than 50 °C. These results suggest that the technique of raising temperatures to above 40 °C for a short duration can be used to reduce living dust mite populations in dwellings and houses significantly (CHANG et al. 1998).

These mites are poikilothermic – they cannot regulate internal body temperature or metabolic rates – and egg production and population growth undergo a decline at low temperatures, while mortality rates and the duration of the life-cycle increase (MUMCUOGLU 1988; COLLOFF et al. 1992). Six developmental instars occur in the life cycle, as follows: egg, prelarva, larva, protonymph, tritonymph and both adult stages, male and female (WHARTON 1976; VAN BRONSWIJK

1981; ARLIAN 1989; FAIN et al. 1990). In the laboratory, at optimum conditions (75-80% RH and 20-30 °C), complete development of *D. pteronyssinus,* from egg to adult, takes 3-5 weeks (18-35 days) and is temperature dependent. The adults live for about 6 weeks, during which time the female produces 40-80 eggs (ARLIAN 1989; COLLOFF et al. 1992). More recent surveys (ARLIAN & DIPPOLD 1996; ARLIAN et al. 1998) reveal that there are significant differences between the reproductive biology of *D. pteronyssinus* and *D. farinae*. For example, females of both species exhibit significant differences in their longevity. Females of *D. farinae* lived much longer (100.4 ± 59.8 days, whereas females *D. pteronyssinus* only 31.2 days). However, the reproductive periods for both species are similar, and amount 31.3 ± 8.6 and 26.2 ± 10.7 days for *D. farinae and D. pteronyssinus*, respectively, with females producing 65.5 ± 17.4 and 68.4 ± 30.4 eggs, respectively (ARLIAN & DIPPOLD 1996). The post-egg producing period was very long for *D. farinae* (63.3 ± 64.6 days) and very short for *D. pteronyssinus* (only 1.8 ± 1.3 days). Moreover, under the same conditions (high protein and yeast diet, 23 °C, 75% RH) the former species developed no prolonged quiescent protonymphs (ARLIAN & DIPPOLD 1996) as it was early observed for *D. pteronyssinus* (ARLIAN et al. 1990).

Hypopus (resistant and phoretic deutonymphal stage) does not occur in the life cycle of the Pyroglyphidae. Its role plays a dessication-resistant quiescent protonymph, which is formed in *D. farinae* during dry periods of the year (ARLIAN et al. 1983; ARLIAN 1989, 1992). This life instar probably provides the major source of breeding mites for population growth when conditions become more favorable. These quiescent protonymphs have a significantly reduced metabolic rate compared to the active protonymphal stages (ARLIAN 1992). In natural environments, protonymphs may become quiescent stages when the ambient air humidity is below the CEH for the species. In temperate climates, indoor humidity may be less than 50% for several months during the heating season.

Review of faunistic studies on Pyroglyphidae in Poland

In Poland, knowledge of the occurrence of mites from the family Pyroglyphidae is still poor and number of faunistic publications is meager. For the first time in Poland, the finding of members of this family was published in 1972 by BOCZEK & DUTKIEWICZ. The former author found single specimens of *D. farinae* in sweepings from mills and warehouses (BOCZEK & DUTKIEWICZ 1972; BOCZEK 1980).

Further studies revealed the occurrence of members of the family Pyroglyphidae in dust samples, birds' nests, stored products, and in different farming environments in Poland.

1. House dust samples

The first samples of house dust in Poland were examined by ROMAŃSKI et al. (1977). The composition of the house-dust-mite fauna in dust samples from 50 houses in Bydgoszcz was studied. Among the mites found only *D. pteronyssinus* was from Pyroglyphidae. It was dominant and constituted 47.8% of the total mite population. Other significant mites were *Glycyphagus domesticus* (DE GEER, 1778) (28.4% of the total mite population) and *Lepidoglyphus destructor* (SCHRANK, 1781) (15.5%), both from the family Glycyphagidae (Acaridida). *D. farinae* was not found.

During surveys on the allergenic mites fauna in the dust of harbour buildings in Gdynia (WIĘCKO 1986), the pyroglyphid mites were also found, namely: *D. pteronyssinus*, *D. farinae* and *E. maynei*. The first species was most abundant among Pyroglyphidae (E. WIĘCKO, personal communication). A total of 38 species of mites were identified. The most abundant species were *Suidasia nesbitti* HUGHES, 1948 (43.7%) from Suidasiidae (Acaridida) and *Tyrophagus putrescentiae* (SCHRANK, 1781) (25%) from Acaridae (Acaridida).

In previous surveys (SOLARZ 1983, 1986) of house-dust-mite fauna in dust samples from dwellings and hospitals located in Sosnowiec and Katowice (Upper Silesia), the dominance of the Pyro-

glyphidae was demonstrated, as in Bydgoszcz. Approximately 63.5% of the total mite population belonged to this family. Most abundant were the following members of Pyroglyphidae – *D. pteronyssinus* (29% of the total mite population), *D. farinae* (25.5%) and *E. maynei* (6.0%). Unidentified *Dermatophagoides* spp. formed 3% of mites isolated from the samples examined (SOLARZ 1986).

As demonstrated by the more direct investigations of the house dust samples from dwellings (in Katowice, Sosnowiec, Mysłowice, Chorzów, Tarnowskie Góry, Bytom, Zabrze, Gliwice, Dąbrowa Górnicza and Ogrodzieniec), libraries (in Sosnowiec), institutes (in Katowice) and hospitals (in Katowice and Sosnowiec), the dominance of Pyroglyphidae was more significant than previously. About 89.2% of the total mite population from dwellings constituted the following members of this family – *D. pteronyssinus* (45.1%), *D. farinae* (40.2%), *E. maynei* (2.6%), *G. longior* (0.05%) and unidentified *Dermatophagoides* (1.24%). A total of 31 species of mites from 15 families were identified, of which 18 species belonged to Acaridida, 3 to Actinedida, 3 to Oribatida and 7 to Gamasida. The fauna of house dust mites was therefore rather differentiated in this region. This was particularly apparent in dwellings, where 49 combinations of species composition in collected mite populations were observed. A total of 402 samples were analysed: 238 samples from dwellings, 122 samples from hospitals, 14 from libraries and 28 from institutes. Mites were present in 51.3%, 50.0%, 21.3% and 17.9% of dust samples from dwellings, libraries, hospitals and institutes, respectively. Generally, they were found in 160 samples (39.8% of the total count). The majority of mites (96.0 %) were found in samples from the dwellings, especially in dust from upholstery furniture, couches, sofas and beds. Altogether, the pyroglyphid mites constitued 89.2%, 78.9% and 57.5% of a total population of mites collected from dwellings, libraries and hospitals, respectively, but were not found in institutes. In total, *D. pteronyssinus* was the most dominant, especially in libraries and hospitals, however in dwellings *D. farinae* was more abundant per 1 gram of dust than the former species. Another pyroglyphid mite, *E. maynei*, occurred in very small numbers (SOLARZ 1998, 2000a).

HORAK (1987) published the results of surveys on the species composition of microorganisms and mites in bed dust from dwellings situated in Katowice and Bytom (Upper Silesia). The mite fauna of the examined samples was dominated by two pyroglyphid species – *D. farinae* (62.7% of all specimens) and *D. pteronyssinus* (30.4%). Among the remaining part of the mite fauna which consisted of four species, only *E. maynei* (1.6%) was from Pyroglyphidae. The other mites were – *Gohieria fusca* (OUDEMANS, 1902) (2.1% of the total count), *Cheyletus eruditus* (SCHRANK, 1781) (1.5%), unidentified *Cheyletus* spp. (0.4%), *T. putrescentiae* (0.4%), other Acaridae (unidentified) (0.1%), Tarsonemidae (0.1%) and Gamasida (0.7%). Further studies also revealed the dominance of *D. farinae* (62.6% of all specimens), above *D. pteronyssinus* (23.0%) and *E. maynei* (7.6%) in examined flats of asthmatic and nonasthmatic subjects (HORAK et al. 1996). Thus, mites of the family Pyroglyphidae constituted about 93.2% of the total mite population. Together with non-pyroglyphid mites, 13 species were isolated belonging to 7 genera, 6 families, or higher taxa. The percentages of viable mites in the populations of *D. farinae*, *D. pteronyssinus*, *E. maynei*, and total pyroglyphid mites were 40.6%, 30.6%, 39.9%, and 38.1%, respectively. Among other, non-pyroglyphid mites, the viable count was higher, being 57.3% of the total. No significant differences were found between the counts of viable mites in the beds of asthmatic and nonasthmatic subjects.

Next, SAMOLIŃSKI et al. (1989) carried out the investigations on the occurrence of house dust mites in floor dust from 35 dwellings located in Warsaw. Among 1,820 specimens of mites obtained, the most abundant were members of the family Pyroglyphidae, namely: *Dermatophagoides* spp. (69.1% of collected mites) and *E. maynei* (18.2%). The most common mites were also Pyroglyphidae – *D. pteronyssinus* (43.7% of dwellings), *E. maynei* (18.5%) and *D. farinae* (19.4%). Other common mites were *Tyrophagus* sp. (14.6%) and *G. fusca* (10.4%).

The acarofauna of house dust in Poznań and on the territory of the Lednicki Landscape Park (localities of Dziekanowice and Rybitwy) was studied by DZIĘCIOŁOWSKI (1994). A total of 78 mite species were collected, among which 2 species of Pyroglyphidae were found – *D. pteronyssinus*

(43.5% of samples, 28.9% of the total count) and *D. farinae* (27.7% of samples, 18.0% of the total population). Eighty percent of specimens of the former species were found in Dziekanowice and Rybitwy, whereas 97% of the total population of the latter species was collected in dwellings in Poznań.

For the first time in Poland, seasonal dynamics and age structures of pyroglyphid dust mite populations were investigated in 3 beds from 2 dwellings in Sosnowiec (Upper Silesia) in 1984 and 1985 (SOLARZ 1997). Simultaneously, the relative humidity and temperature of ambient indoor air was recorded during the 2 years of the study. Generally, the increase of mite density was observed from April to November, and was related with the increase of indoor humidity. The mites were more abundant in the dwelling with central heating than in that with stove heating. *D. farinae* was the numerically dominant species (62.71% of the total mites), followed by *D. pteronyssinus* (28.81%). The analysis of the age population structure and its dynamics suggests the marked differences between particular pyroglyphid mite species and the beds examined. In total, *D. farinae* populations showed the dominance of immature stages, whereas in populations of *D. pteronyssinus* and *E. maynei,* the dominants were adult mites.

Mite fauna in the house dust of a basemat flat in Poznań was studied by CHMIELEWSKI (1995). The house dust samples were collected monthly, from November 1984 to December 1986, 1 sample per month. A total of 26 samples were examined, all of which were mite positive. Generally, 4,911 mites were isolated, among them over 15 mite species were specified. The most frequent and numerous were *D. pteronyssinus*, *G. domesticus* and *E. maynei* (the second species of the family Glycyphagidae). Moreover, within members of the family Pyroglyphidae, only *G. longior* was found, but in small numbers. The average mite density was 9.4 mites per 1 gram of dust and 186 mites per sample. The average numbers of the dominant species per 1 gram of dust were 2.7, 2.4 and 2.3, for *D. pteronyssinus*, *G. domesticus* and *E. maynei,* respectively.

In Lublin (southeastern Poland), dust samples from dwellings and nursery schools have also been examined by GIERYNG et al. (1995) for the occurrence of allergenic mites. From the analysed samples, adult mites of the genera *Dermatophagoides* and *Acarus* were been isolated. Moreover, a number of unidentified larval and nymphal stages were found. House dust mites were especially abundant in the samples collected in April, May, September, October and November.

Studies carried out by RACEWICZ (2001) in Gdańsk and Gdynia (in 1996-1998), were directed at the prevalence of allergenic mites in private flats and social buildings (as hotels, hospitals and students' hotels). A total of 277 samples were examined. About 37% of samples from dwellings and 16.8% samples from social institutions were mite positive. Altogether, 538 mite specimens were isolated; the majority of them (88.7%) consisted of 2 species from the family Pyroglyphidae – *D. farinae* and *D. pteronyssinus*. The former species was predominant and constituted 73.4% of the total count. Other mites (non-pyroglyphid) belonged to Acaridae, Cheyletidae and Parasitiformes. Mean number of mites per gram of dust and per 1 sample was low – 35 and 10 specimens, respectively (RACEWICZ 2001).

2. Dust from ocean-going ships

To supplement the above-mentioned data the results of examination of 228 dust samples from 35 ocean-going ships should be quoted (WEGNER 1980). On 5 of these ships, in dust from cabins, pantries and messrooms, two pyroglyphid mites were found – *D. pteronyssinus* (in cabins, pantries and messrooms) and *D. farinae* (in cabins). The former species was most abundant in cabins and made up 67% of the total mites collected, whereas the latter only 6.4%. These ships travelled to South America, the Near East and the Far East.

3. Stored products and farming environments

The first data were published in 1972 by BOCZEK & DUTKIEWICZ. The authors found single specimens of *D. farinae* in sweepings from mills and warehouses (BOCZEK & DUTKIEWICZ 1972; BOCZEK 1980). This mite was also found in stored dried herbs and flour (BOCZEK & CZAJKOWSKA 1973; CHMIELEWSKI 1975).

Numerous representatives of *E. maynei* and an individual nymph of *D. pteronyssinus* were occasionally found in stored herbs in Grudziądz by KARNKOWSKI (1990). Both species occurred in 2 different stores belonging to "Herbapol".

Samples of different materials (organic dust, litter, debris and residues) from farming environments (cowsheds, stables, barns, chaff-cutters, lofts, poultry houses and pigeon houses) were subjected to acarogical examination by SOLARZ et al. (1997). These samples were collected in Solarnia (near Lubliniec), vicinity of Kokotek (Częstochowa district), Łazy (near Książ Wielki; former Kielce district) and Lesko (former Krosno district). A total of 890 mites were isolated including 225 (25.3%) specimens from the order Acaridida (17 species), among them were the mite species considered as allergenic (e.g. *L. destructor* and *G. domesticus*). Among these astigmatic mites, several species of the family Glycyphagidae (*G. domesticus*, *Glycyphagus privatus*, *Ctenoglyphus plumiger* and *L. destructor*) were found to be numerically dominant. Two species belonging to the family Pyroglyphidae were found: *G. longior* and *H. chelidonis*. The pyroglyphid mites formed only 0.7 % of the total mite population.

4. Bird nests

Pyroglyphid mites were also found in birds' nests in Poland. Since 1959, the nests of synanthropic birds were investigated in Poland for an occurrence of allergenic both house-dust and storage mites, mainly by WASYLIK and CHMIELEWSKI (WASYLIK 1959, 1963, 1964, 1971, 1973; SANDNER and WASYLIK 1973; CHMIELEWSKI 1975, 1977, 1982a, b).

The pyroglyphid mites were found in birds' nests for the first time in Poland by CHMIELEWSKI (1975, 1977, 1982a, b). Three species of pyroglyphids, *D. pteronyssinus*, *H. chelidonis* and *G. longior*, were found in domestic sparrow's nests (*Passer domesticus*). A total of 75 nests were analysed from different regions of the country (Poznań, Wągrowiec, Środa, Skierniewice, Puławy, Poddębice, Sandomierz, Nowy Sącz, Wrocław, Białystok, Wolin and Gdańsk). The most frequently was found the mite *H. chelidonis* (86.7% of nests). *G. longior* and *D. pteronyssinus* were less frequent and less numerous – 21.3% and 8.0% of nests, respectively (CHMIELEWSKI 1975, 1977). The latter species was found in nests collected in Poznań, Poddębice, Sandomierz and Puławy (CHMIELEWSKI 1975, 1977). In Poland, *H. chelidonis* was also found in nests of *Passer montanus, Hirundo rustica, Delichon urbica* and *Sturnus vulgaris*, whereas *G. longior* – in nests of *H. rustica* (CHMIELEWSKI 1975, 1977, 1982b). As a result of a summarizing study on the composition of mite fauna inhabiting 130 domestic sparrow's nests, collected from 16 different sites in Poland in the period 1970-1978, a more frequent occurrence of *H. chelidonis* was detected – 91.5% of the nests examined (CHMIELEWSKI 1982b). Among the remainder, the most frequent astigmatic mites were *L. destructor* (23,9% of nests), *G. domesticus* (21,5%), *G. longior* (18,5%), *Tyrophagus longior* (GERVAIS, 1844) (12,3%) and *Acarus siro* L., 1758 (6,2%) (CHMIELEWSKI 1982b).

Moreover, among mite species belonging to the family Pyroglyphidae, the species *G. longior* was found in a domestic sparrow's nest in a barn located in Grabieniec near Turek (ANDRZEJEWSKA 1979). In nests of the domestic sparrow (Poznań vicinity) and in nests of the tree sparrow (*P. montanus*) (Warsaw vicinity) analysed by WASYLIK (1959, 1963, 1964, 1971, 1973) 16 species of astigmatic mites were stated. The majority of them were harmful species infesting stores. It was also suggested that the mites leave the nests of *P. montanus* in the summer and autumn (WASYLIK 1964). The dominating species among those leaving the nests are, in the summer *L. destructor,* and in the autumn *T. longior* (WASYLIK 1964). The remaining species (*A. siro, Tyrophagus perniciosus, T. si-*

milis, T. putrescentiae, Glycyphagus ornatus, G. privatus, G. domesticus, Thyreophagus entomophagus and *Rhizoglyphus* sp.) formed 1-22% of the total migrating population (WASYLIK 1964). Whereas, in nests of *P. domesticus* the author found 11 species of mites. The most frequently occurring were *L. destructor, A. siro, T. entomophagus* and *T. longior* (WASYLIK 1959). In nests of *P. montanus* analysed more recently (WASYLIK 1973; SANDNER & WASYLIK 1973) the most abundant species were *Acarus farris* (OUDEMANS, 1905), *T. longior, Tyrolichus casei* OUDEMANS, 1910, *L. destructor* and *Tyrophagus palmarum* OUDEMANS, 1924. The largest mite populations were found in the nests after 1-2 broods (WASYLIK 1971).

Further studies on an occurrence of allergenic mites in nests of birds were continued by SOLARZ et al. (1995, 1996, 1998, 1999). In total, this survey was carried out from January 1990 to March 1998. A total of 93 bird nests were examined for the occurrence of allergenic mites. Among astigmatic mites the most frequent and most abundant species were two pyroglyphids – *H. chelidonis* and *D. evansi*. The former species have been found to be numerically dominant, especially in nests of house martins and barn swallows. The second species was absent in the house martins nests. Mites *D. farinae* were found for the first time in Poland in association with birds (SOLARZ et al. 1996, 1999). *G. domesticus* (allergenic glycyphagid species) was the dominant in a total count of mites from nests of *P. domesticus*, although it has been found in only 2 of the domestic sparrows' nests analysed (SOLARZ et al. 1998). Other astigmatid species were distinctly less numerous and formed altogether 0.76% of all mites collected. In this count, among the members of the family Pyroglyphidae, *G. longior* has also been found. It occurred only in nests of domestic sparrows (SOLARZ et al. 1998).

To summarize, 6 valid species of pyroglyphid mites are presently known in Polish fauna, as follows:

(1) *D. pteronyssinus* – house dust in Upper Silesia, Bydgoszcz, Warsaw, Poznań and Lednicki Landscape Park (localities of Dziekanowice and Rybitwy), Gdańsk and Gdynia (HORAK 1987; HORAK et al. 1996; SAMOLIŃSKI et al. 1987; SOLARZ 1983, 1986, 1987, 1997, 1998, 2000a, b; DZIĘCIOŁOWSKI 1994; CHMIELEWSKI 1995; ŚPIEWAK et al. 1995; RACEWICZ 2001), dust of harbour buildings in Gdynia (WIĘCKO 1986), dust from social institutions in Gdańsk and Gdynia (RACEWICZ 2001), stored herbs in Grudziądz (KARNKOWSKI 1990), and nests of domestic sparrows (*P. domesticus)* in Poznań, Poddębice, Sandomierz and Puławy (CHMIELEWSKI 1975, 1977, 1982b).

(2) *D. farinae* – house dust in Upper Silesia, Warsaw, Poznań and vicinity (Lednicki Landscape Park: Dziekanowice and Rybitwy), Gdańsk and Gdynia (HORAK 1987; HORAK et al. 1996; SAMOLIŃSKI et al. 1989; SOLARZ 1983, 1985, 1986, 1987, 1997, 1998, 2000a, b; DZIĘCIOŁOWSKI 1994, RACEWICZ 2001), dust of harbour buildings in Gdynia (WIĘCKO 1986), dust from social institutions in Gdańsk and Gdynia (RACEWICZ 2001), stored dried herbs and flour, sweepings from mills and warehouses (BOCZEK & DUTKIEWICZ 1972; BOCZEK & CZAJKOWSKA 1973), in a brook-shelter of *Parus palustris* (Niepołomice near Cracow; SOLARZ et al. 1996, 1999).

(3) *D. evansi* – nests of *P. domesticus, H. rustica* and *Sylvia* sp. in Solarnia (near Lubliniec), and in a single sample of pine wood dust (Sominy near Somińskie Lake) (SOLARZ et al. 1995, 1996, 1998, 1999).

(4) *H. chelidonis – nests of P. domesticus, P. montanus, H. rustica, D. urbica, S. vulgaris, Turdus philomelos, Turdus* sp., *Parus caeruleus*, and *Sylvia* sp. (localities of Wolin, Gdańsk, Poznań, Wągrowiec, Środa, Skierniewice, Poddębice, Wrocław, Sandomierz, Puławy, Upper Silesia and probably all over the country) (CHMIELEWSKI 1975, 1977, 1982a, b; SOLARZ et al. 1996, 1998, 1999), a byre (cowshed) debris in Lesko (SOLARZ et al. 1997).

(5) *E. maynei – house dust in Upper Silesia, Warsaw and Poznań (*HORAK 1987; HORAK et al. 1996; SAMOLIŃSKI et al. 1989; SOLARZ 1985, 1986, 1987, 1997, 1998, 2000a, b; CHMIELEWSKI 1995), dust of harbour buildings in Gdynia (WIĘCKO 1986), stored herbs in Grudziądz (KARNKOWSKI 1990).

(6) *G. longior* – house dust in Poznań and Upper Silesia (CHMIELEWSKI 1995; SOLARZ 1998, 2000a), nests of *P. domesticus* and *H. rustica* (in Wolin, Poznań, Wągrowiec, Nowy Sącz, Sandomierz, Puławy, Grabieniec, Solarnia near Lubliniec) (ANDRZEJEWSKA 1979; CHMIELEWSKI 1975, 1977, 1982b; SOLARZ et al. 1996, 1998, 1999), debris from a byre in Lesko, barn litter in Solarnia near Lubliniec (SOLARZ et al. 1997).

Aims of the study

The aim of this investigation was to study:

– the occurrence, prevalence and species composition of the pyroglyphid mite fauna in house dust samples from beds, floors under the beds, carpets and linoleums in one-family houses, flats, lofts, hospitals, libraries, offices and other public utilities in Poland (especially in the region of Upper Silesia) in relation to other domestic mite taxa;

– levels of house dust infestation with mites and mite allergens in particular sites in the examined places;

– the main habitats of house dust mite occurrence and breeding in dwellings, hospitals and other public places;

– the influence of air temperature and humidity, and some other environmental factors or housing conditions on the abundance and frequency of domestic mites, especially of the family Pyroglyphidae;

– age structure and seasonal dynamics of populations of the pyroglyphid dust mite species in dwellings;

– annual fluctuations in the abundance of life stages of dust mite species – *D. farinae, D. pteronyssinus* and *E. maynei*;

– population dynamics and age structure of the laboratory populations of *D. farinae*;

– the possible occurrence of pyroglyphid house-dust mites in nests of synanthropic birds in southern Poland.

– the possibility of an occurrence of pyroglyphid mites in coal-mine dust and debris, with particular referrence to allergenic species as a potential risk factor of respiratory diseases among coal miners.

– the species composition of pyroglyphid allergenic mites in samples of organic dust, litter, debris, residues and other materials as the potential sources of the mite allergens in the farming environment.

– changes of the pyroglyphid mite fauna Poland – comparison of the results actually obtained with data of our previous surveys in Poland and/or in the Upper Silesian region.

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II. MATERIAL AND METHODS

Dust samples

The faunistic study was carried out from January 1989 to July 2001. A total of 617 dust samples were examined, including 335 samples from dwellings, 40 samples from lofts, 99 from hospitals, 56 from libraries, 31 from research laboratories, 43 from offices and social rooms of a coal-mine, and 13 from other public places (4 from a bakery in Jaworzno, 4 from an archive in Lublin and 5 from the Police Department in Ciechanów) [Tab. 1].

Table 1

Number of samples examined from beds, floors, upholstery furnitures, wooden furnitures and other places, and number of mites isolated

Sampling places	Total samples		Positive samples			Number of mites		
	Number of samples examined	Percent of the total of samples examined	Number of samples positive for mites	Percent of the total count of samples	Percent of the total mite positive samples	Number of mites isolated	Percent of the total count of mites	Mean number of mites per one sample
Dwellings	335	54.3	158	25.6	70.85	3714	91.6	11.1
Hospitals	99	16.0	27	4.4	12.1	56	1.4	0.6
Libraries	56	9.1	21	3.4	9.4	106	2.6	1.9
Coal-mine offices	43	7.0	5	0.8	2.25	55	1.3	1.3
Research institutes	31	5.0	5	0.8	2.25	19	0.5	0.6[2]
Other work places[1]	13	2.1	3	0.5	1.35	80	2.0	6.15
Lofts	40	6.5	4	0.6	1.8	23	0.6	0.6[2]
Total	617	100.0	223	36.1	100.0	4053	100.0	6.6

Key: [1] Archive (record office), police department and bakery; [2] Pyroglyphidae were not found.

1. Dwellings

Dust from dwellings was taken from wooden floors, carpets, linoleums, beds and other sleeping accomodations (as couches and sofas), upholstery and wooden furniture and some other places (pictures, shutters), in 109 houses or flats situated in Cracow and vicinity, Łódź, Katowice, Sosnowiec, Bytom, Zabrze, Chorzów, Gliwice, Mysłowice, Ruda Śląska, Wodzisław, Lubliniec vicinity, Pszczyna, Świętochłowice, Jaworzno, Chrzanów, Dąbrowa Górnicza, Bielsko-Biała, Szczyrk, Rabka, Kęty, Iwonicz-Zdrój, Skarżysko-Kamienna and Opole. A total of 335 samples were examined [Tab. 2].

In flats, the dust samples were collected from beds, upholstery and wooden furnitures, bedroom carpets, living room carpets, wooden floors and linoleums. In the one-family houses, dust was taken from beds, floors near the bed, carpets and linoleums.

Age, sex structures, and seasonal dynamics of pooled populations of the pyroglyphid dust mite species found in dwellings in Poland were also analysed. In this analysis of annual fluctuations in the numbers of developmental stages of pyroglyphid mites in the examined dwellings in Poland, the data from different houses and flats were pooled. Egg numbers are not included in this study, since eggs cannot be identified at – *Dermatophagoides* – species level (COLLOFF 1992).

Table 2

Number of samples examined from beds, floors, upholstery furnitures, wooden furnitures and other places, and number of mites isolated

Sampling sites	Total samples		Positive samples			Number of mites	
	Number of samples examined	Percent of total samples examined	Number of samples positive for mites	Percent of total count of samples from particular sampling sites	Percent of total mite positive samples	Number of mites isolated	Percent of total count of mites
Beds and couches	150	44.8	92	61.3	58.2	3158	85.0
Non-carpeted floors and carpets	145	43.3	38	26.2	24.1	386	10.4
Upholstery furnitures	34	10.1	25	73.5	15.8	149	4.0
Other indoor places[1]	6	1.8	3	50.0	1.9	21	0.6
Total	335	100.0	158	47.2	100.0	3714	100.0

Key: [1] wooden furnitures, pictures, shutters

2. Housing conditions influencing on an abundance of dust mites. Statistical and cluster analysis

An additional 39 samples from 7 single-family houses of Bielsko-Biała (subagricultural settlement) and 77 samples from 13 flats of several Upper Silesian towns (Katowice, Sosnowiec, Jaworzno, Mikołów, Ruda Śląska; urban and industrial agglomeration), were analysed for the effect of different housing conditions on the prevalence of house dust mites or other domestic mites. This supporting study was carried out from December 2000 to July 2001.

As previously stated (SOLARZ 2001), information on various parameters which could influence mite numbers were obtained by questioning the residents and analysed using the PEARSON's correlation test. These parameters (explanatory variables x) were: type of building, age of house, sampling method, type of heating, type of floor, type of bed, type of upholstery furniture, dwelling size (number of rooms), family size (number of inhabitants), inhabitants atopic or not, housewife (unemployed or employed), presence or absence of pets, cooking facility, cleaning frequency, kitchen (open or closed), relative humidity, temperature, weight of samples and date of sampling (month) [Tab. 3]. Whereas the criterion variables analysed (y) were: number of mites per gram of dust (total or live, in relation to the particular species of Pyroglyphidae, total house dust pyroglyphid mites and total domestic mites) and number of mite species (in relation to the total mites, pyroglyphid mites and non-pyroglyphid mites [Tab. 3]. The Acarex test was taken account as both the explanatory and the criterion variable. The criterion and explanatory variables (data matrix) adopted for the multiple regression analysis, the PEARSON's correlation test and the cluster analysis (WARD's method) of effects of housing conditions on the prevalence of domestic mites in the examined single-family houses are presented in detail in Tables 4 and 5, respectively.

3. Samples from hospitals, libraries, institutes, offices, social rooms and other workplaces and/or public places

The samples of dust from hospitals were vacuumed in 5 hospitals located in Katowice, Wodzisław and Chorzów, always from 2 sites – floor and patients' mattresses. In 8 libraries from Katowice, Sosnowiec and Dąbrowa Górnicza 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

Table 3

Criterion and explanatory variables adopted for the PEARSON's correlation test and multiple regression analysis of pyroglyphid mite prevalence in the examined flats in Upper Silesia (2000-2001)

Explanatory variables (*x*)	Criterion variables (*y*)
Type of building[1] [1-4] (*x1*)	Number of mites per gram of dust:
Age of house (in years) (*x2*)	*Dermatophagoides farinae (y1)*
Sampling method [2] [1-5] (*x3*)	*D. pteronyssinus (y2)*
Type of heating[3] (*x4*)	*Euroglyphus maynei (y3)*
Bedroom floor[4] (*x5*)	Pyroglyphidae (total) (*y4*)
Type of bedding[5] (*x6*)	Domestic mites (total) (*y5*)
Type of upholstery furniture[6] (*x7*)	Number of live mites per gram of dust:
Dwelling size [number of rooms] (*x8*)	*Dermatophagoides farinae (y6)*
Family size [number of inhabitants] (*x9*)	*D. pteronyssinus (y7)*
Inhabitants[7] (*x10*)	*Euroglyphus maynei (y8)*
Housewife[8] (*x11*)	Pyroglyphidae (total) (*y9*)
Pets[9] (*x12*)	Domestic mites (total) (*y10*)
Cooking facility[10] (*x13*)	Number of mite species:
Kitchen[11] (*x14*)	Total (*y11*)
Cleaning frequency [times per week] (*x15*)	Pyroglyphid mites (*y12*)
Relative humidity (%RH) (*x16*)	Non-pyroglyphid mites (*y13*)
Temperature (°C) (*x17*)	Acarex steps (*y14*)
Weight of samples (*x18*)	
Month (*x19*)	
Acarex test (*x20*)	

Key: [1]recreation house [1], block of flats [2], house [3], single-family house [4], old house [5]; [2]sweepings [1], car vacuum cleaner [2], domestic vacuum cleaner [3], Rainbow cleaner [4], Burkard Cyclone Surface Sampler [5]; [3]gas-stove [1], oil stove [2], central heating [3], electric [4] or coal-stove [5]; [4]carpet [3], plastic [1] or wooden [2]; [5]bed/mattress [1] or coach/sofa [2]; [6]chairs [1], arm-chairs [2], coach/sofa [3], complete sets of furniture [4]; [7]atopic [2] or not [1]; [8]employed [2] or unemployed [2]; [9]absent [1] or present [2]; [10]gas [1] or electric [2]; [11]open [2] or closed [1].

wooden furnitures in the Institute of Systematics and Evolution of Animals of the Polish Academy of Sciences in Cracow. In offices, social rooms, archives and other workplaces (surface area) of the "Wujek" Coal-Mine in Katowice, the dust samples were taken from carpeted floors, uncarpeted floors, documents, upholstery and wooden furnitures (42 samples). The remaining 13 samples were taken by vacuuming floors of a bakery in Jaworzno (n = 4), from documents in the Record Office in Lublin (n = 4) and from upholstered chairs, documents and wooden furnitures in the Police Department in Ciechanów (n = 5).

As in dwellings, information on various parameters which could influence mite numbers, was obtained by questioning the personnel and analysed using the PEARSON's correlation test. These parameters (explanatory variables *x*) were: age of building, type of building, sampling method, type of heating, type of floor (wooden, carpeted, linoleum), type of bed (in hospitals: linen or rubber), type

Table 4

Characteristics of examined houses in Bielsko-Biała (2000-2001) and variables adopted for statistical analysis of domestic mite prevalence (data matrix)

Characters (variables *x*)	House number 1 (n = 5)	House number 2 (n = 6)	House number 3 (n = 7)	House number 4 (n = 5)	House number 5 (n = 6)	House number 6 (n = 5)	House number 7 (n = 5)
Location (street) [1-4] (*x1*)	[1]	[1]	[1]	[2]	[2]	[3]	[4]
Age of house in years[1] (*x2*)	[2]	[2]	[2.5][8]	[2]	[3]	[2]	[3]
Family size [number of inhabitants] (*x3*)	[1]	[3]	[2]	[4]	[2]	[4]	[2]
House size [number of rooms] (*x4*)	[4]	[4]	[6]	[7]	[3]	[6]	[6]
Type of heating[2] (*x5*)	[3]	[3]	[5]	[3]	[3]	[3]	[3]
Housewife[3](*x6*)	[1]	[2]	[1]	[1]	[1]	[2]	[1]
Bedroom floor[4](*x7*)	[1]	[1]	[1]	[2]	[1]	[1]	[3]
Cooking facility[5] (*x8*)	[1]	[1]	[1]	[1]	[1]	[1]	[2]
Cleaning frequency [times per week] (*x9*)	[4]	[2]	[0.5]	[3]	[2]	[3]	[2]
Relative humidity (%RH)[6](x10)	65 [1]	75 [3]	75 [3]	76 [3]	76 [3]	75 [3]	81 [4]
Temperature (°C)[7] (*x11*)	20 [2]	19 [2]	16 [1]	22 [2]	15 [1]	14 [1]	14 [1]

Key: [1]<5 [1], 5-50 [2], 51-100 [3], >100 [4]; [2]gas-stove [1], oil-stove [2], central heating [3], electric [4] or coal-stove [5]; [3]unemployed [1] or employed [2]; [4]carpet [3], plastic [2] or wooden [1]; [5]gas [1] or electric [2]; [6]≈ 65 [1], ≈ 70 [2], ≈ 75 [3], 80 [4]; [7] ≈ 15 [1], ≈20 [2], ≈ 25 [3]; [8]old house (>100 years) connected with the new part (<5 years); n = number of samples examined.

rameters (explanatory variables *x*) were: age of building, type of building, sampling method, type of heating, type of floor (wooden, carpeted, linoleum), type of bed (in hospitals: linen or rubber), type of upholstery furniture, type of sampling place (e.g. libraries, archives and offices: book-shelves and/or other wooden furnitures, upholstered furniture, books, documents), relative humidity, temperature, weight of samples and date of sampling (month). Whereas the criterion variables analysed (*y*) were: number of mites per gram of dust (total or live, in relation to the particular species of Pyroglyphidae, total house dust pyroglyphid mites and total domestic mites) and number of mite species (in relation to the total mites, pyroglyphid mites and non-pyroglyphid mites). As in dwellings, the Acarex test was taken into account as both the explanatory and the criterion variable.

4. Dust sampling methods. General informations

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 (for 2 minutes) or brushed (in the case of sweepings). 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 MM 5, 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 deter-

Table 5

Prevalence of mites and levels of mite allergens (expressed as steps of the Acarex® test) in examined houses in Bielsko-Biała (2000-2001): criterion variables adopted for the PEARSON's correlation test [data matrix]

Mite prevalence	House number 1 (n = 5) (N = 97)	House number 2 (n = 6) (N = 59)	House number 3 (n = 7) (N = 381)	House number 4 (n = 5) (N = 81)	House number 5 (n = 6) (N = 9)	House number 6 (n = 5) (N = 35)	House number 7 (n = 5) (N = 11)
Mean number of mites per gram of dust (Percent of dominance/Percent of frequency)							
Total mites [*y1*][1]	646.7 [4]	822.2 [5]	6228.8 [9]	721.6 [4]	159.3 [2]	466.7 [3]	300.4 [3]
Domestic mites [*y2*][1]	646.7 [4]	803.2 [5]	6228.8 [9]	721.6 [4]	159.3 [2]	466.7 [3]	300.4 [3]
House dust mites [*y3*][1]	646.7 [4]	773.0 [4]	995.1 [5]	268.9 [3]	126.2 [2]	466.7 [3]	165.0 [2]
DP [*y4*][1]	NF [0]	639.7 [4] (78.0/66.7)	943.2 [5] (21.8/71.4)	112.5 [2] (14.8/50.0)	NF [0]	426.7 [3] (91.4/20.0)	165.0 [2] (63.6/50.0)
DF [*y5*][1]	646.7 [4] (100.0/20.0)	133.3 [2] (13.5/33.3)	39.0 [1] (0.8/14.3)	156.4 [2] (12.4/60.0)	126.2 [2] (77.8/66.7)	40.0 [1] (8.6/20.0)	NF [0]
ChA [*y6*][1]	NF [0]	NF [0]	5029.9 [9] (73.5/42.9)	373.3 [3] (69.1/20.0)	NF [0]	NF [0]	NF [0]
TP [*y7*][1]	NF [0]	20.6 [1] (3.4/33.3)	5.7 [1] (0.25/14.3)	NF [0]	33.0 [1] (22.2/33.3)	NF [0]	NF [0]
GF [*y8*][1]	NF [0]	NF [0]	198.0 [2] (3.4/42.9)	43.0 [1] (2.5/50.0)	NF [0]	NF [0]	NF [0]
GP [*y9*][1]	NF [0]	NF [0]	NF [0]	NF [0]	NF [0]	NF [0]	135.4 [2] (36.4/33.3)
LD [*y10*][1]	NF [0]	NF [0]	NF [0]	36.4 [1] (1.2/20.0)	NF [0]	NF [0]	NF [0]
Cheyletidae [*y11*][1]	NF [0]	9.5 [1] (1.7/16.7)	13.0 [1] (0.25/14.3)	NF [0]	NF [0]	NF [0]	NF [0]
Oribatida [*y12*][1]	NF [0]	19.0 [1] (3.4/16.7)	NF [0]	NF [0]	NF [0]	NF [0]	NF [0]
Mean number of live mites per gram of dust							
Total mites [*y13*][1]	NF [0]	495.2 [3]	650.0 [4]	89.7 [1]	43.9 [1]	213.3 [3]	140.4 [2]
Domestic mites [*y14*][1]	NF [0]	381.0 [3]	650.0 [4]	89.7 [1]	43.9 [1]	213.3 [3]	140.4 [2]
House dust mites [*y15*][1]	NF [0]	381.0 [3]	NF [0]	26.7 [1]	21.9 [1]	213.3 [3]	85.0 [1]
DP [*y16*][1]	NF [0]	381.0 [3]	NF [0]	NF [0]	NF [0]	200.0 [2]	85.0 [1]
DF [*y17*][1]	NF [0]	NF [0]	NF [0]	26.7 [1]	21.9 [1]	13.3 [1]	NF [0]
ChA [*y18*][1]	NF [0]	NF [0]	633.7 [4]	53.9 [1]	NF [0]	NF [0]	NF [0]
Number of mite species							
Total mites [*y19*]	[1]	[7]	[6]	[5]	[2]	[2]	[2]
Pyroglyphid mites [*y20*]	[1]	[2]	[2]	[2]	[1]	[2]	[1]
Nonpyroglyphids [*y21*]	NF [0]	[5]	[4]	[3]	[1]	[0]	[1]
Mean level of mite allergens (in Acarex test steps)							
[*y22*]	[1]	[1]	[1.75]	[0.75]	[0.75]	[0.5]	[0.25]

Key: [1] < 100 [1], 101-200 [2], 201-500 [3], 501-800 [4], 801-1000 [5], 1001-2000 [6], 2001-3000 [7], 3001-5000 [8], 5001-10 000 [9], > 10 000 [10]; n = number of samples examined; N = number of mites collected; NF = not found; DP = *Dermatophagoides pteronyssinus*; DF = *D. farinae*; ChA = *Chortoglyphus arcuatus*; TP = *Tyrophagus putrescentiae*; GF = *Gohieria fusca*; GP = *Glycyphagus privatus*; LD = *Lepidoglyphus destructor*.

Mite density was calculated as the number of specimens per 1 gram of dust. Because of difficulties with standarization 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). The weight of samples ranged from 0.05-1.8 gram. Mite abundance was also calculated as the number of specimens per 1 sample (= per 1 m^2).

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.).

The content of the mite allergens was measured by performing a semiquantitative guanine determination (Acarex test). According to the manufacturer's instructions the Acarex test results were expressed in 6 increasing classes as follows: – – – (= -3.0), – – (= - 2.0), – (= -1.0), + (= 1.0), ++ (= 2.0) and +++ (= 3.0), including also intermediate values. Moreover, the evaluation of guanine content, according to PAULI et al. (1993), may be performed as follows: for values from -1 to -3 the guanine content is <600 µg/gram of dust; for 1.0 guanine content is between 600 and 2,500 µg/gram of dust; for 2.0 it is between 2,500 – 10,000 µg/gram of dust, and for 3.0 – it is of at least 10,000 µg/gram of dust.

5. Samples from lofts

A total of 40 samples were taken by brushings from floors of 39 lofts of buildings located on the territory of Sosnowiec (n = 35), Katowice (n = 2) and Bytom (n = 3). The examined buildings in Sosnowiec were located on 35 different streets of the city.

6. A single flat study

Annual dynamics of house dust mites populations was analysed in one flat located in Sosnowiec (Upper Silesia, Poland) from December 1997-February 2000. The data were obtained on the basis of the analysis of 94 dust samples collected in the bedroom of this flat, from the 3 following places:

(1) Surface of the couch (used as a bed) with bed-clothes removed every morning (37 samples, from August 1997-January 2000).

(2) Surface of a long-hair carpet (new) (37 samples, from August 1997-January 2000).

(3) Surface of 2 upholstered arm-chairs (20 samples, from June 1998-January 2000).

Characteristics of the flat: centrally heated, new type of building, lived in for 10 years by two adults and one child; no signs of damp; no dogs or cats. A surface area of $1m^2$ at each sampling site was vacuumed (for 2 minutes) approximately once a month during the 2 years of investigations. Dust samples were collected with a portable vacuum cleaner Zelmer-Meteor Model # 1115.5 (Rzeszów, Poland; 700 W), on a specially constructed dust trap-filter attached to the end of the cleaner hose. When the samples were taken, air temperature and relative humidity were measured with Digital Humidity/Temperature Meter TES 1360 (TES Electrical Electronic Corp.), and noted. Values of the relative humidity and temperature were permanently recorded every day during the 2 years of the study by means of 2 thermo-hygrographs TŻ Model # 18 (Cracow, Poland; daily measurements), and also almost every week (most Saturdays) with a Digital Humidity/Temperature Meter TES 1360.

Four seasons were defined: January, February, and March as winter; April, May, and June as spring; July, August, and September as summer; October, November, and December as autumn.

Population dynamics of *D. farinae* under laboratory conditions

Mites used for the study were obtained from laboratory cultures maintained at 25°C and 75% RH, and raised on tropical fish food. Mites were selected randomly from the thriving pure cultures with the aid of a dissection stereomicroscope and confined in groups of approximately 10 in special ventilated rearing cages kept in glass desiccators. These cages were made from glass and had a rectangular shape (40 × 35 × 5 mm); a conical hole (rearing cell) of 7-13 mm diameter was drilled in

each cage. Filter paper was attached on one side of the cage (with the smaller opening) using hot wax as an adhesive; whereas the other side of the cage was covered with a microscopic slide coverslip, also attached by hot wax as previously described (SZLENDAK 1998). At the start of the experiment in February 2000, 3-5 cages, each containing approximately 10 mites, were placed separately in desiccators to make up 1 sample set. At specific times thereafter (1, 2 and 3 months), the set of caged mites from 1 dessicator was removed. Then, approximately 40-50 mg of culture material was randomly taken from each cage to determine population structure with the aid of a microscope.

During the laboratory experiment the mites were provided with food.

Organic dust and debris from farming environments

The study was carried out from 15 June 1992 to 24 September 2000. A total of 51 samples from certain farming environments, as cowsheds, stables, barns, chaff-cutters, lofts, poultry houses and pigeon houses, were analysed. All samples were collected into plastic bags of 1 litre capacity. These samples were taken in Majdan Górny (Lublin district), Łazy (near Książ Wielki), Solarnia (near Lubliniec), in Kokotek and vicinity and in Lesko (all localities in south-eastern Poland). The mites were extracted using the "BERLESE method" and preserved in 70% ethanol. For identification the mites were mounted in HOYER's medium on microscope slides.

Coal-mine dust and debris collected underground

The study was conducted from 17 June, 1991 to 31 January, 2001. A total of 230 samples were taken in 6 coal mines located in Katowice, Sosnowiec, Mysłowice and Czeladź (Upper Silesia). These samples were sweepings containing coal dust and, in some cases, pieces of wood and other debris. Mites were isolated by extraction with BERLESE funnels (samples of debris) or floatation method with NaCl saturated solution (dust samples). All mites were mounted on slides and determined with the aid of a compound microscope.

Nests of birds and nests of mammals

The study was carried out from January 1990-April 2000. A total of 69 birds' nests were examined for the occurrence of pyroglyphid mites, including: 9 nests of *Hirundo rustica,* 12 nests of *Passer domesticus*, 3 nests of *Delichon urbica,* 9 nests of *Sylvia* sp., 4 nests of *Turdus merula*, 1 of *T. philomelos* and 8 of *Turdus* spp. (unidentified), 3 nests of *Parus major,* 5 nests of *Parus* spp. (unident.), 2 nests of *Sturnus vulgaris,* 2 of *Phoenicurus ochruros*, and single nests of *Remiz pendulinus, Hippolais icterina, Tringa glareola* and *Acrocephalus schoenobaenus.* The majority of these nests were collected in Solarnia near Lubliniec, in Tychy and vicinity, Katowice, Ruda Śląska and Łaziska Górne (Upper Silesia, Poland). Moreover, 5 brood shelters of *Parus palustris* from Niepołomicka Forest and 2 pigeon houses (*Columba livia*) (Chorzów and Solarnia near Lubliniec) were investigated.

In addition to bird nests, 2 nests of *Rattus norvegicus* (Silesian ZOO in Chorzów; an allotment garden in Ruda Ślaska), 1 nest of *Ondatra zibethicus* (musk rat) (Mianocice, near Książ Wielki) and 1 nest of *Mus musculus* (poultry house, Zamość vicinity) were examined on the occurrence of pyroglyphid mites.

The mites were extracted using the „BERLESE method" and preserved in 70% ethanol. For identification the mites were mounted in HOYER's medium on microscope slides.

Statistical analysis

The statistical analysis was performed using CSS-Statistica for Windows version 4.5. 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 SPEARMAN rank correlation test, one-way analysis of variance (ANOVA), MANOVA, the LEVENE test of homogeneity of variances, FRIEDMAN ANOVA & KENDALL's Concordance test, the KRUSKAL WALLIS test and the WILCOXON matched pairs test.

The correlation coefficients were calculated by regression analysis and PEARSON's correlation test. Moreover, the multiple regression analysis was used to test for the difference between species and/or stages at 12 months (throughout one year). Student's t-test was used to test for significant differences in dust mite numbers among the examined places by sample date. The relationship between housing conditions and the prevalence of dust mites was examined by the PEARSON's product-moment correlation test, the multiple regression analysis and the cluster analysis (WARD's method).

III. RESULTS

A total of 25,295 mite specimens were isolated and identified, including 13,340 members of the family Pyroglyphidae (52.74%).

Dust samples

Overall results are presented in Table 1. Of a total of 617 samples examined, 223 (36.1%) were positive for mites. The mites occurred most frequently and numerously in dwellings, hospitals and libraries. A total of 4,053 mite specimens were collected, of which 91.6% was found in dwellings, whereas only 2.6% in libraries and 1.4% in hospitals [Tab. 1]. House dust mites from the family Pyroglyphidae were the dominants (3,383 specimens) and constituted 83.5% of a total count of mites obtained from dust samples. The majority of them was found in dwellings (94.94%), whereas in libraries only 1.89%, in coal-mine offices and social rooms 1.6%, and in hospitals – 1.54%. The remaining 0.03% of pyroglyphid mites was found in the Police Department.

Pyroglyphid mite fauna in dwellings

1. Overall results

The overall results obtained are presented in Table 2. The weight of samples ranged from 0.075 – 1.8 gram. Mites were found in 158 of 335 samples examined (47.2%). 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%).

Approximately 49.5% of samples showed positive levels of the mite allergens (Acarex test steps). Annual fluctuations of levels of mite allergens in pooled samples of dust from beds, floors and upholstery furnitures from the examined dwellings are presented in Table 6.

Mean relative humidities were 54.9%, 56.3% and 57.6% for samplings of bed dust, floor dust and dust from upholstery furnitures, alternatively. Mean temperatures were 21.1, 20.7 and 21.8°C, respectively.

Mean relative humidity, temperature and the Acarex step in dwellings which were mite positive, and in all dwellings examined in Poland are compared in Table 7. This difference was not statistically significant (χ^2 test; Yates corrected $\alpha = 0.66$).

Table 6

Annual fluctuations in the level of the dust-mite allergen in dust samples from beds, floors and upholstery furnitures in dwellings (samples from single flat in Sosnowiec and pooled samples from all dwellings actually examined in Poland).

Months	Mean levels of mite allergens ± SD (Minimum-Maximum) [Median]					
	Samples from the single flat in Sosnowiec (Upper Silesia)			Pooled samples from all dwellings actually examined in Poland		
	Couch	Carpet	Arm-chairs	Bed-dust samples	Floor-dust samples	Upholstery furnitures
January	-0.20 2.05 (-2.00 – 2.00) [-1.00]	-0.25 ± 2.02 (-2.00 – 1.50) [-0.25]	0.37 ± 2.18 (-2.50 – 1.50) [1.25]	-0.25 ± 1.99 (-2.50 – 2.50) [-0.25]	-1.32 ± 1.42 (-2.50 – 1.50) [-2.00]	0.30 ± 1.68 (-2.50 – 1.50) [1.00]
February	-0.50 ± 1.41 (-1.50 – 0.50) [-0.50]	-2.40 ± 0.22 (-2.50 – -2.00) [-2.50]	1.25 ± 0.35 (1.00 – 1.50) [1.25]	0.44 ± 1.79 (-2.00 – 2.00) [1.00]	-2.16 ± 0.59 (-3.00 – 0.00) [-2.25]	-0.70 ± 1.57 (-2.00 – 1.00) [-1.50]
March	1.00 ± 0.71 (0.50 – 1.50) [1.00]	0.17 ± 1.04 (-1.00 – 1.00) [0.50]	0.75 ± 0.35 (0.50 – 1.00) [0.75]	1.00 ± 1.90 (-2.00 – 3.00) [1.50]	0.00 ± 1.80 (-2.50 – 2.00) [1.00]	0.50[1]
April	0.88 ± 0.48 (0.50 – 1.50) [0.75]	-1.50 ± 0.71 (-2.00 – -1.00) [-1.50]	-0.25± 1.06 (-1.00 – 0.50) [-0.25]	1.25 ± 0.65 (0.50 – 2.00) [1.25]	-2.00 ± 2.17 (-3.00 – 2.00) [1.00]	-1.00[1]
May	0.00 ± 1.35 (-2.00 – 1.00) [0.50]	-1.67 ± 0.58 (-2.00 – -1.00) [-2.00]	-0.25 ± 1.06 (-1.00 – 0.50) [-0.25]	0.50 ± 0.52 (-2.00 – 1.00) [0.50]	-1.86 ± 0.38 (-2.00 – -1.00) [-2.00]	-0.75 ± 1.77 (-2.00 – 0.50) [-0.75]
June	0.75 ± 1.06 (0.00 – 1.50) [0.75]	-0.50 ± 1.29 (-2.00 – 1.00) [-0.50]	0.0 ± 1.35 (-2.00 – 1.00) [0.50]	1.17 ± 1.04 (0.00 – 2.00) [1.50]	1.00 ± 1.00 (0.00 – 2.00) [1.00]	0.83 ± 0.29 (0.50 – 1.00) [1.00]
July	1.00 ± 0.00 (1.00) [1.00]	-0.75 ± 1.50 (-2.00 – 1.00) [-1.00]	-1.25 ±1.50 (-2.00 – 1.00) [-2.00]	1.00 ± 0.00 (1.00) [1.00]	-0.75 ± 1.50 (-2.00 – 1.00) [-1.00]	-2.00 ± 0.00 (-2.00) [-2.00]
August	0.50 ± 1.73 (-2.00 – 2.00) [1.00]	-1.25 ± 1.50 (-2.00 – 1.00) [-2.00]	-0.75 ± 1.77 (-2.00 – 0.50) [-0.75]	0.25 ± 1.71 (-2.00 – 2.00) [0.50]	-1.60 ± 1.52 (-3.00 – 1.00) [-2.00]	-0.75 ± 1.77 (-2.00 – 0.05) [-0.75]
September	1.50 ± 1.41 (0.50 – 2.50) [1.50]	-0.25 ± 2.47 (-2.00 – 1.50) [-0.25]	0.50± 0.00 (0.50) [0.50]	0.14 ± 1.82 (-3.00 – 2.50) [0.50]	0.38 ± 1.60 (-2.00 – 1.50) [1.00]	1.25 ± 1.06 (0.50 – 2.00) [1.25]
October	0.25 ± 1.50 (-2.00 – 1.00) [1.00]	-0.50 ± 2.12 (-2.00 – 1.00) [-0.50]	0.75 ± 0.35 (0.50 – 1.00) [0.75]	0.83 ± 1.19 (-2.00 – 3.00) [1.00]	0.60 ± 0.76 (-2.00 – 2.00) [1.00]	1.00[1]
November	-0.38 ± 1.97 (-2.00 – 2.00) [-0.75]	-0.63 ± 1.60 (-2.00 – 1.00) [-0.75]	0.13 ± 1.44 (-2.00 – 1.00) [0.75]	0.42 ± 1.47 (-2.00 – 3.00) [0.50]	0.02 ± 1.30 (-2.50 – 1.00) [0.75]	0.75 ± 0.27 (0.50 – 1.00) [0.75]
December	0.00 ± 1.41 (-2.00 – 1.00) [1.00]	-2.38 ± 0.48 (-3.00 – -2.00) [-2.25]	0.00 ± 1.80 (-2.00 – 1.50) [0.50]	0.86 ± 1.29 (-2.00 – 2.00) [1.00]	-1.64 ± 1.55 (-3.00 – 1.00) [-2.00]	-0.17 ± 1.61 (-2.00 – 1.00) [0.50]

Key: [1]single analysis

Table 7

Differences in values of relative humidity, temperature and Acarex test between samples positive for mites and the total of samples examined from dwellings in Poland.

	Relative humidity (%RH)		Temperature (°C)	Allergen levels (Acarex steps)
Samples positive for house dust mites	Mean ± SD	57.3 ± 16.4	21.0 ± 2.4	0.4 ± 1.3
	Median	50.0	22.0	1.0
	Range	31.0 – 81.0	14.0 – 24.5	-2.5 – 3.0
	n	83	83	102
Total samples	Mean ± SD	54.1 ± 16.5	21.1 ± 2.4	-0.15 ± 1.6
	Median	48.0	21.1	0.5
	Range	31.0 – 81.0	14.0 – 24.5	-3.0 – 3.0
	n	177	177	264

Key: SD = standard deviation; n = number of measurements.

Mean relative humidity, temperature and the Acarex step in dwellings which were mite positive, and in all dwellings examined in Poland are compared in Table 7. This difference was not statistically significant (χ^2 test; YATES corrected $\alpha = 0.66$).

2. Species composition and diversity

The species composition of domestic acarofauna in dust samples from dwellings is listed in Table 8 and shows that 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 %). Another pyroglyphid mite *Hirstia chelidonis* occurred in very small numbers (approx. 0.1% of the total count). *H. chelidonis* was found for the first time in house dust samples in Poland. 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%), Wodzisław (80.9%), Cracow (45.6%) and Bielsko-Biała (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) [Tab. 9].

Generally, *D. farinae* was also the most abundant species both per 1 sample (mite positive) (15.8) [Tab. 8] and per 1 gram of dust in all of indoor places examined (Figs 1-3). *D. farinae* was significantly more frequent in upholstered furnitures than in beds or other sleeping accomodations, and than on 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 accomodations 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 furnitures and in the latter than on floors, but both differences were statistically not significant (χ^2; $p = 0.054$ and $p = 0.19$, respectively).

Table 8

Species list, dominance, abundance and frequency of mites found in the examined house dust samples

Mite taxa	Dominance[1]		Frequency[1]		Mean number of mites per 1 sample	
	N	%	n	%	1	2
Pyroglyphidae	**3212**	**86.48**	**149**	**44.48**	**9.59**	**20.33**
Dermatohagoides farinae	2488	66.99	126	37.61	7.43	15.75
D. pteronyssinus	653	17.58	57	17.01	1.95	4.13
Dermatophagoides sp.	7	0.19	5	1.49	0.02	0.04
Euroglyphus maynei	61	1.64	7	2.09	0.18	0.39
Hirstia chelidonis	3	0.08	3	0.89	0.009	0.02
Acaridae	**30**	**0.81**	**16**	**4.78**	**0.09**	**0.19**
Acarus siro	3	0.08	3	0.89	0.009	0.02
Tyrophagus putrescentiae	17	0.46	8	2.39	0.05	0.11
T. neiswanderi	2	0.05	1	0.30	0.006	0.01
Tyrolichus casei	4	0.11	1	0.30	0.01	0.02
Caloglyphus sp.	1	0.03	1	0.30	0.003	0.006
Thyreophagus sp.	1	0.03	1	0.30	0.003	0.006
Acaridae – hypopi unident.	2	0.05	2	0.60	0.006	0.01
Glycyphagidae	**69**	**1.86**	**11**	**3.28**	**0.21**	**0.44**
Lepidoglyphus destructor	10	0.27	2	0.60	2.98	0.06
L. fustifer	1	0.03	1	0.30	0.003	0.006
Glycyphagus domesticus	37	0.99	2	0.60	0.11	0.23
G. privatus	4	0.11	2	0.60	0.01	0.02
Gohieria fusca	17	0.46	7	2.09	0.05	0.11
Chortoglyphidae	**309**	**8.32**	**3**	**0.89**	**0.92**	**1.96**
Chortoglyphus arcuatus	309	8.32	3	0.89	0.92	1.96
TARSONEMIDA	**16**	**0.43**	**9**	**2.69**	**0.05**	**0.10**
Cheyletidae	**49**	**1.32**	**17**	**5.07**	**0.15**	**0.31**
Tetranychidae	**1**	**0.03**	**1**	**0.30**	**0.003**	**0.006**
Other ACTINEDIDA	2	0.05	2	0.60	0.006	0.01
ORIBATIDA	**13**	**0.35**	**5**	**1.49**	**0.04**	**0.08**
GAMASIDA	**13**	**0.35**	**9**	**2.69**	**0.04**	**0.08**
Live Pyroglyphidae	372	10.02	68	20.30	1.11	2.35
Live domestic mites	517	13.92	77	22.98	1.54	3.27
Live mites (total)	531	14.30	81	24.18	1.58	3.36
Total domestic mites	3688	99.30	157	46.87	11.01	23.34
Total mites	**3714**	**100.0**	**158**	**47.16**	**11.09**	**23.51**

Key: N = number of specimens; n = number of samples positive; 1 = in relation to the total of samples examined (n = 335); 2 = in relation to samples positive for mites (n = 158).

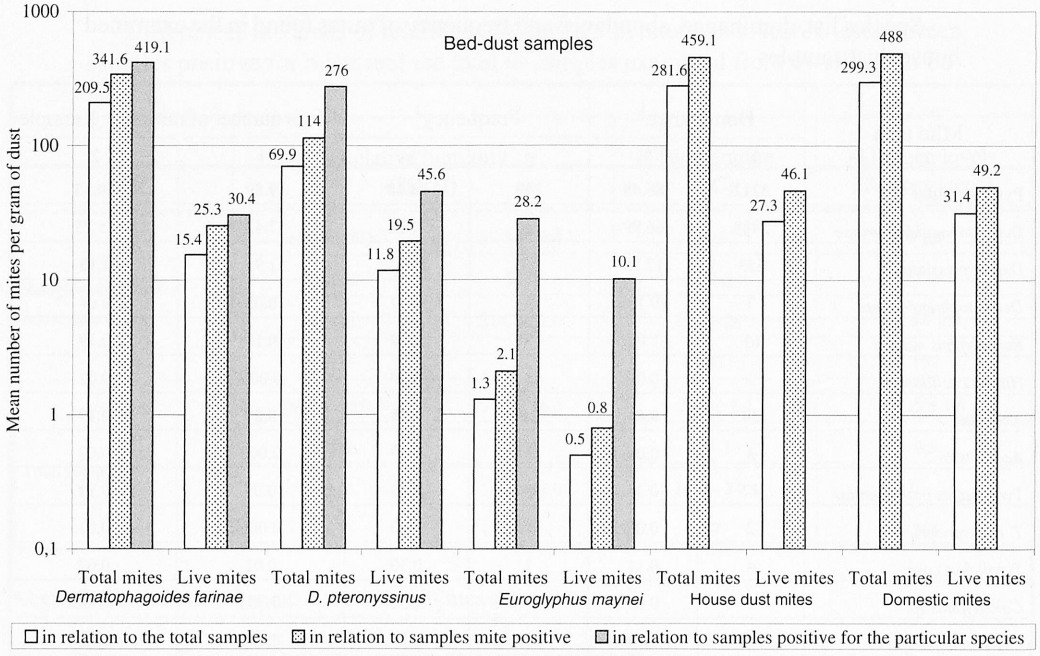

Fig. 1. Abundance of pyroglyphid house dust mites and domestic mites in samples of bed dust, and mean values of Acarex test, relative humidity and temperature in the examined dwellings in Poland.

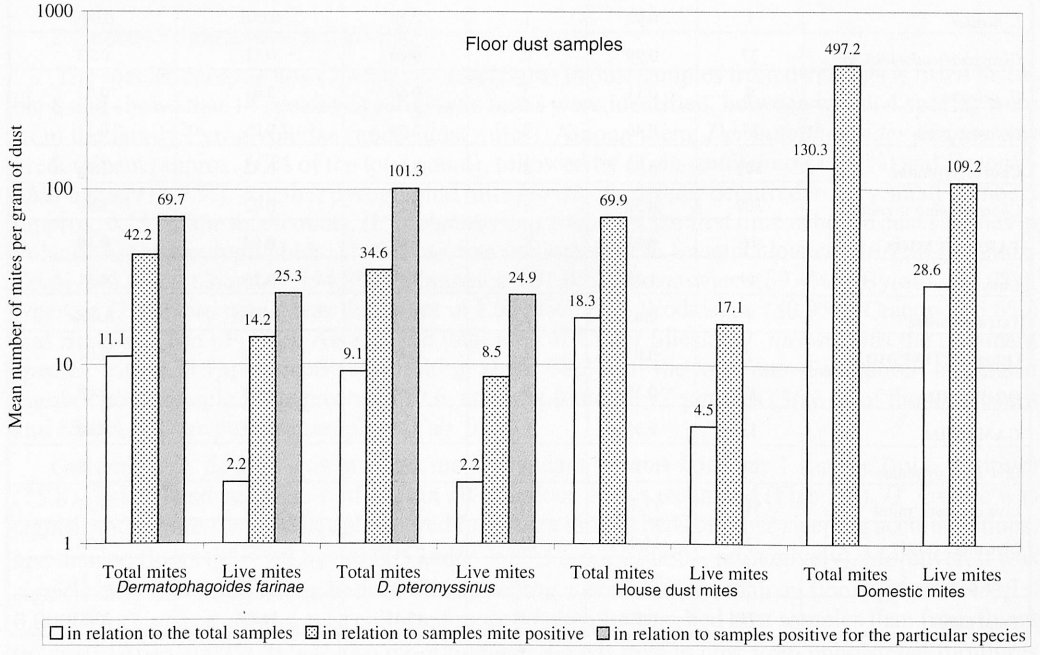

Fig. 2. Abundance of pyroglyphid house dust mites and domestic mites in samples of dust from floors, and mean values of Acarex test, relative humidity and temperature in the examined dwellings in Poland.

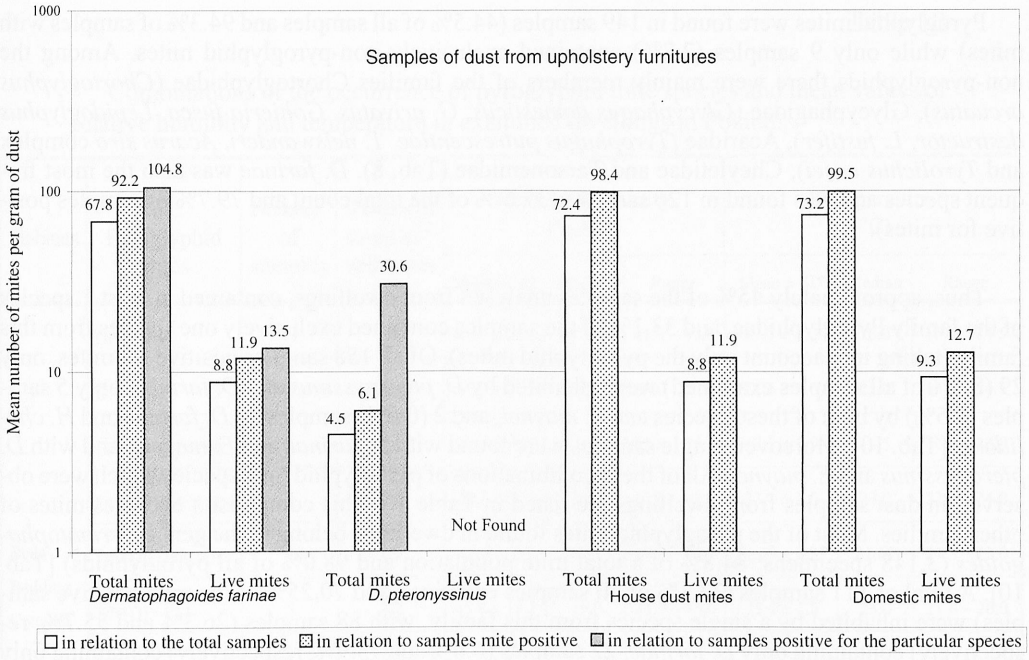

Fig. 3. Abundance of pyroglyphid house dust mites and domestic mites in samples of dust from upholstered furniture, and mean values of Acarex test, relative humidity and temperature in the examined dwellings in Poland.

Table 9

Species list, dominance, occurrence and mean number of pyroglyphid mites per 1 mite positive sample, in total dust samples from the examined localities in the Upper Silesia region, in relation to the other mite taxa

Mite taxa	Dominance		Occurrence			Mean number of mites per 1 sample positive for mites
	Number of mites	Percent of the total count	Number of samples	Percent of the total count	Percent of samples mite positive	
Dermatohagoides farinae	2218	88.16	97	36.60	85.84	19.63
D. pteronyssinus	100	3.97	35	13.21	30.97	0.88
Dermatophagoides sp.	5	0.20	3	1.13	2.65	0.05
Euroglyphus maynei	61	2.42	7	2.64	6.19	0.54
Hirstia chelidonis	3	0.12	3	1.13	2.65	0.03
Pyroglyphidae (total)	**2387**	**94.87**	**111**	**41.89**	**98.23**	**21.11**
Acaridae (total)	**25**	**0.99**	**11**	**4.15**	**9.73**	**0.22**
Glycyphagidae (total)	**47**	**1.87**	**4**	**1.51**	**3.54**	**0.42**
TARSONEMIDA	**13**	**0.52**	**5**	**1.89**	**4.42**	**0.23**
Cheyletidae	**27**	**1.07**	**11**	**4.15**	**9.73**	**0.24**
Other ACTINEDIDA	**2**	**0.08**	**2**	**0.75**	**1.77**	**0.02**
ORIBATIDA	**8**	**0.32**	**2**	**0.75**	**1.77**	**0.07**
GAMASIDA	**7**	**0.28**	**6**	**2.26**	**5.31**	**0.06**
TOTAL	**2516**	**100.0**	**113**	**42.64**	**100.0**	**22.25**

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 (*Chortoglyphus arcuatus*), Glycyphagidae (*Glycyphagus domesticus*, *G. privatus, Gohieria fusca, Lepidoglyphus destructor, L. fustifer*), Acaridae *(Tyrophagus putrescentiae, T. neiswanderi, Acarus siro* complex and *Tyrolichus casei*), Cheyletidae and Tarsonemidae (Tab. 8). *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* [Tab. 10]. Moreover, single samples were found with *D. farinae* and *E. maynei*, and with *D. pteronyssinus* and *E. maynei.* All of these combinations of pyroglyphid mite species which were observed in dust samples from dwellings are listed in Table 10. This comparison excludes mites of other families. Most of the pyroglyphid mites found in dwellings belong to the genus *Dermatophagoides* (3,148 specimens; 84.8% of a total mite population and 98.0% of all pyroglyphids) [Tab. 10]. 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* (apart from the other, non-pyroglyphid mites) [Tab. 10]. 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* (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%) (Tab. 10).

From 59 samples from beds (and couches), 22 samples from floors (and carpets), 21 samples from upholstery furnitures, 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 furnitures (58.8% of these samples), were inhabited by a single mite species. In general, 31 (aprox. 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 these samples). Within the samples coinhabited by 2 species of mites, 21 combinations of the species composition 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. All combinations of the mite species composition which were actually found in dwellings in Poland, are presented in Tables 11 and 12.

Table 10

Combinations of the occurrence of pyroglyphid mite species and mean values of relative humidity and temperature in examined dwellings in Poland.

Habitats	Pyroglyphid mites	Number[1] of samples	Percent of samples[2] with mites	Relative Humidity (% RH)			Temperature (°C)		
				Mean ± SD	Median	Range	Mean ± SD	Median	Range
Beds Bedding Couches	DP solely	13	8.2	65.7 ± 21.6	75.0	41.0 – 81.0	17.3 ± 4.2	16.0	16.0 – 24.5
	DF solely	47	29.8	54.7 ± 15.8	47.5	33.0 – 77.0	21.6 ± 2.0	22.0	15.0 – 24.5
	DP+DF (DP>DF)	8	5.1	72.5 ± 4.3	75.0	65.0 – 75.0	18.3 ± 2.9	18.5	14.0 – 22.0
	DP+DF (DP<DF)	9	5.7	39.5 ± 8.5	39.5	31.0 – 48.0	23.1 ± 1.0	23.0	22.0 – 24.0
	DP+DF (DP≅ DF)	3	1.9	42.5 ± 2.5	42.5	40.0 – 45.0	21.65 ± 0.35	21.65	21.3 – 22.0
	DP+DF+EM	5	3.2	45.8 ± 15.1	39.0	34.0 – 75.0	23.4 ± 1.5	23.0	21.8 – 26.0
	DF+EM	1	0.6	39.0	-	-	21.5	-	-
	DP+EM	1	0.6	45.0	-	-	22.0	-	-
	DF+HC	2	1.3	39.0 ± 1.0	39.0	38.0 – 40.0	21.5 ± 0.5	21.5	21.0 – 22.0
	HC solely	1	0.6	38.0	-	-	21.0	-	-
Floors Carpets	DP solely	9	5.7	74.3 ± 4.7	75.0	65.0 – 81.0	17.0 ± 1.8	17.0	14.0 – 19.0
	DF solely	19	12.0	57.9 ± 16.5	58.0	36.0 – 76.0	21.1 ± 2.2	22.0	15.0 – 23.2
	DP+DF (DP<DF)	3	1.9	38.0 ± 5.0	38.0	33.0 – 43.0	20.9 ± 0.4	20.9	20.5 – 21.3
	DP+DF (DP≅DF)	1	0.6	42.0	-	-	24.5	-	-
Upholstery Furniture	DF solely	19	12.0	51.4 ± 16.4	42.0	33.0 – 77.0	22.0 ± 1.1	22.0	20.5 – 24.5
	DP+DF (DP>DF)	2	1.3	69.6 ± 13.5	75.0	41.0 – 81.0	17.7 ± 2.6	18.0	14.0 – 22.0
	DP+DF (DP<DF)	3	1.9	41.3 ± 31.4	48.0	36.0 – 76.0	21.3 ± 0.9	22.0	20.0 – 22.0
Other places[3]	DF solely	3	1.9	72.0 ± 6.9	76.0	64.0 – 76.0	21.8 ± 0.3	22.0	21.5 – 22.0
Total		149	94.3	57.3 ± 16.4	50.0	31.0 – 81.0	21.0 ± 2.4	22.0	14.0 – 24.5

Key: [1]including also samples containing other non-pyroglyphid mite specimens; [2]percent of the total count of samples positive for mites from dwellings including also non-pyroglyphid mites (n=158); [3]single samples from pictures, shutters and book-shelves; DP = *Dermatophagoides pteronyssinus*; DF = *D. farinae*; EM = *Euroglyphus maynei*: HC = *Hirstia chelidonis*; = prevalence of the first species; = prevalence of the second species; ≅ = both species in almost equal numbers.

Table 11

Combinations of mite species composition in bed dust samples from examined dwellings in Poland.

n	N (%)	Combinations of mite species
1	48 (14.3)	Only Pyroglyphidae
	1 (0.3)	*Tyrophagus putrescentiae*
2	10 (3.0)	Only Pyroglyphidae
	2 (0.6)	*Dermatophagoides farinae* + Cheyletidae
	1 (0.3)	*D. farinae* + *T. putrescentiae*
	1 (0.3)	*D. farinae* + Gamasida
	1 (0.3)	*D. farinae* + Tarsonemida
	1 (0.3)	*D. farinae* + Oribatida
	1 (0.3)	*Dermatophagoides pteronyssinus* + *Gohieria fusca*
	1 (0.3)	*D. pteronyssinus* + *Glycyphagus privatus*
	1 (0.3)	*D. pteronyssinus* + *Lepidoglyphus fustifer*
	1 (0.3)	*D. pteronyssinus* + Actinedida (Tetranychidae)
3	2 (0.6)	*D. farinae* + *D. pteronyssinus* + *Acarus siro*
	2 (0.6)	*D. farinae* + *D. pteronyssinus* + Cheyletidae
	1 (0.3)	*D. farinae* + *D. pteronyssinus* + *T. putrescentiae*
	1 (0.3)	*D. farinae* + *D. pteronyssinus* + *Caloglyphus* sp. [1]
	1 (0.3)	*D. farinae* + *D. pteronyssinus* + Oribatida
	1 (0.3)	*D. farinae* + *Euroglyphus maynei* + other Actinedida[1]
	1 (0.3)	*D. farinae* + Cheyletidae + Gamasida
	1 (0.3)	*D. farinae* + Cheyletidae + hypopus Acaridae[1]
	1 (0.3)	*D. pteronyssinus* + *A. siro* + Cheyletidae
	1 (0.3)	*Hirstia chelidonis* + *Lepidoglyphus destructor* + *Glycyphagus domesticus*
	1 (0.3)	*D. farinae* + *D. pteronyssinus* + *E. maynei*
4	1 (0.3)	*D. farinae* + *D. pteronyssinus* + *E. maynei* + Cheyletidae
	1 (0.3)	*D. farinae* + *D. pteronyssinus* + *E. maynei* + Gamasida
	1 (0.3)	*D. farinae* + *D. pteronyssinus* + *G. fusca* + *Chortoglyphus arcuatus*
	1 (0.3)	*D. farinae* + *D. pteronyssinus* + Cheyletidae + Gamasida
	1 (0.3)	*D. farinae* + *D. pteronyssinus* + Cheyletidae + Tarsonemida
	1 (0.3)	*D. farinae* + *Tyrolichus casei* + Cheyletidae + Tarsonemida
	1 (0.3)	Tarsonemida + Oribatida + Gamasida + Actinedida[1]
5	1 (0.3)	*D. farinae* + *D. pteronyssinus* + *Tyrophagus neiswanderi* + hypopus Acaridae[1] + Gamasida
	1 (0.3)	*D. farinae* + *D. pteronyssinus* + *E. maynei* + 2 ´ Cheyletidae[2]
6	1 (0.3)	*D. farinae* + *D. pteronyssinus* + *E. maynei* + *G. privatus* + Cheyletidae + Tarsonemida

Key: n = number of species; N (%) = number of samples (percent of all samples examined); [1]unidentified; [2]two species from this family.

Table 12

Combinations of mite species composition in samples from floors and upholstery furnitures in examined dwellings in Poland

n	N (%)	Combinations of mite species	Places examined
1	21 (6.3)	Only Pyroglyphidae	Non-carpeted floors and carpets
	1 (0.3)	*Tyrophagus putrescentiae*	
	1 (0.3)	*Gohieria fusca*	
	1 (0.3)	Oribadida	
2	1 (0.3)	Only Pyroglyphidae (*Dermatophagoides farinae* + *D. pteronyssinus*)	
	2 (0.6)	*Dermatophagoides farinae* + *T. putrescentiae*	
	1 (0.3)	*D. farinae* + *G. fusca*	
	1 (0.3)	*Dermatophagoides pteronyssinus* + Oribatida	
	1 (0.3)	*T. putrescentiae* + Cheyletidae	
	1 (0.3)	Tarsonemida + Gamasida	
3	2 (0.6)	*D. farinae* + *D. pteronyssinus* + Cheyletidae	
	1 (0.3)	*D. farinae* + *D. pteronyssinus* + Tarsonemida	
	1 (0.3)	*D. farinae* + *Lepidoglyphus destructor* + *Gohieria fusca*	
	1 (0.3)	*D. farinae* + Tarsonemida + Oribatida	
	1 (0.3)	*D. pteronyssinus* + *G. fusca* + *Chortoglyphus arcuatus*	
	1 (0.3)	*T. putrescentiae* + *G. fusca* + *Ch. arcuatus*	
1	18 (5.4)	Only Pyroglyphidae	Upholstery furniture
	1 (0.3)	*Glycyphagus domesticus*	
2	3 (0.9)	*D. farinae* + *D. pteronyssinus*	
	1 (0.3)	*D. farinae* + *Thyreophagus* sp.[1]	
3	1 (0.3)	*D. farinae* + *D. pteronyssinus* + Cheyletidae	
	1 (0.3)	*D. farinae* + *D. pteronyssinus* + Gamasida	
1	3 (0.9%)	*D. farinae*	Other places[2]

Key: n = number of species; N (%) = number of samples (percent of all samples examined); [1]unidentified; [2]single samples from pictures, shutters and book-shelves.

3. Mite density

The total mean number of mites per gram of dust (in all samples examined) was 204.1 ± 1,079.8, while the greatest number of domestic mites per 1 gram of dust was 14,971.4. The number of pyroglyphid mites per 1 gram of dust varied in dwellings from 0.0-8,285.7. Numbers of total mite populations or particular pyroglyphid mite species were varied from one town to another [Tables 13 and 14], from one dwelling to another in the same town, and from one locus to another within the same dwelling, at various seasons of the year (Fig. 4).

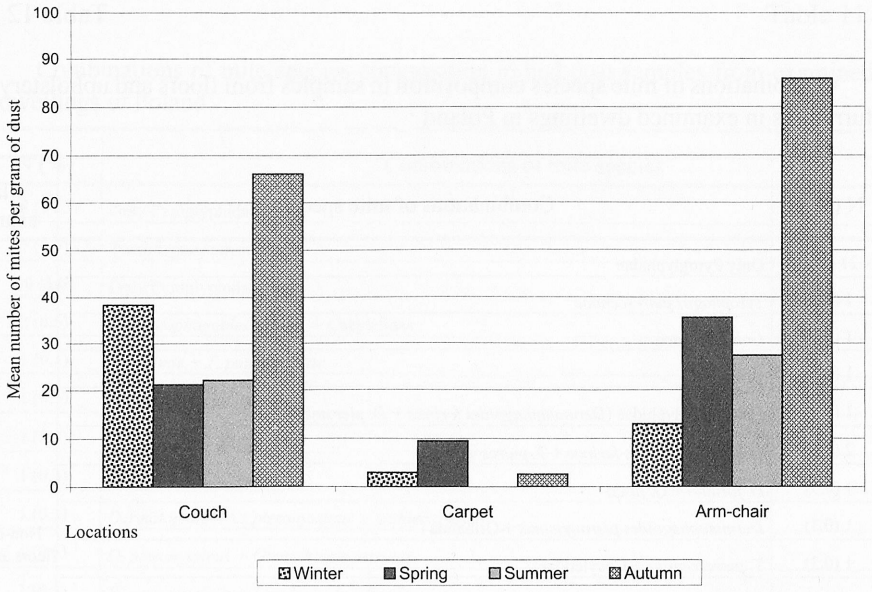

Fig. 4. Mean seasonal mite densities (per gram of dust) in dust samples from three sites in the examined flat in Sosnowiec. Four seasons were defined: January, February, and March as winter; April, May, and June as spring; July, August, and September as summer; October, November, and December as autumn.

Table 13

Mean numbers of mites per 1 gram of dust in samples from beds, floors and upholstery furnitures from examined dwellings at particular localities in Poland (1989-2000)

Sampling sites	Mean ± SD (Range)					
	Upper Silesia (total)	Bielsko-Biała and vicinity	Cracow and vicinity	Łódź and vicinity	Other localities	Total
Beds Couches Sofas	209.2 ± 977.7 (0.0 - 8342.9) [n=131]	2063.0 ± 1310.5 (100.1 - 3233.3) [n=7]	161.4± 291.7 (0.0 - 750.0) [n=6]	185.7 ± 308.6 (4.0 - 542.0) [n=3]	720.0 ± 1247.1 (0.0 - 2160.0) [n=3] [2]	299.3 ± 1033.6 (0.0 - 8342.9) [n=150]
Floors Carpets	5.2 ± 23.5 (0.0 - 166.7) [n=101]	858.1 ± 3241.0 (0.0 - 14971.4) [n=21]	24.7 ± 63.4 (0.0 - 233.3) [n=13]	1.5 ± 1.7 (0.0 - 3.4) [n=5]	4.1 ± 4.7 (0.0 – 12.5) [n=5] [3]	130.3 ± 1245.0 (0.0 – 14971.4) [n=145]
Upholstery furniture	79.4 ± 209.7 (0.0 – 1133.3) [n=29]	ND	8.3 ± 7.4 (0.0 - 14.3) [n=3]	1.7 [n=1]	160.0 [n=1] [4]	73.2 ± 195.2 (0.0 – 1133.3) [n=34]
Other places[1]	525.0 ± 798.0 (0.0-1900.0) [n=4]	ND	3.6 ± 3.6 (0.0-7.1) [n=2]	ND	ND	351.2 ± 762.9 (0.0-1900.0) [n=6]
Total	119.6 ± 697.2 (0.0 – 8342.9) [n=265]	1159.4 ± 2906.0 (0.0 – 14971.4) [n=28]	55.0 ± 156.8 (0.0 - 750.0) [n=24]	62.9 ± 179.7 (0.0 - 542.0) [n=9]	260.1 ± 673.5 (0.0 – 2160.0) [n=9]	203.8 ± 1079.8 (0.0 - 14971.4) [n=335]

Key: [1]wooden furniture, pictures and shutters; [2]single samples of bed dust from Skarżysko-Kamienna, Kęty and Iwonicz-Zdrój; [3]single samples of floor dust from Szczyrk (n=2), Iwonicz-Zdrój (n=2) and Rabka (n=1); [4]single sample from Iwonicz-Zdrój; n – number of samples; N D – not determined.

Table 14

Mean numbers of mites per 1 gram of dust in samples from beds, floors and upholstery furnitures from examined dwellings at particular localities in Upper Silesia (1989-2000)

Mean ± SD (Range)							
Sampling sites	Katowice	Sosnowiec	Chorzów	Bytom	Wodzisław	Chrzanów and Jaworzno	Other Upper Silesian localities
Beds Couches Sofas	509.8 ± 1632.1 (0.0 - 8342.9) [n=44]	41.2 ± 78.6 (0.0-375.0) [n=48]	97.5 ± 116.1 (0.0-310.0) [n=10]	13.0 ± 13.4 (0.0-35.0) [n=6]	138.7 ± 231.2 (0.0-533.3) [n=5]	3.0 ± 6.0 (0.0 - 12.0) [n=4]	73.0 ± 96.9 (0.0 – 280.0) [n=14] [2]
Floors Carpets	13.0 ± 40.4 (0.0-166.7) [n=30]	2.9 ± 10.8 (0.0-66.7) [n=45]	N D	N D	0.0 [n=3]	0.04 ± 0.2 (0.0-1.0) [n=22]	0.0 [n=1] [3]
Upholstery furniture	163.3 ± 394.4 (0.0 - 1133.3) [n=8]	43.1 ± 54.5 (0.0-200.0) [n=20]	N D	N D	133.3 [n=1]	ND	ND
Other places [1]	0.0 [n=2]	1050.0 ± 850.0 (200.0-1900.0) [n=2]	ND	ND	ND	ND	ND
Total	287.3 ± 1204.4 (0.0 – 8342.9) [n=84]	43.7 ± 184.8 (0.0 – 1900.0) [n=115]	97.5 ± 116.1 (0.0-310.0) [n=10]	13.0 ± 13.4 (0.0-35.0) [n=6]	91.8 ± 177.4 (0.0-533.3) [n=9]	0.5 ± 2.3 (0.0-12.0) [n=26]	73.0 ± 96.9 (0.0 – 280.0) [n=15]

Key: [1] wooden furniture, pictures and shutters; [2] samples of bed dust from Dąbrowa Górnicza (n=2), Gliwice (n=2), Zabrze (n=2), Mysłowice (n=2), Świętochłowice (n=2) and single samples from Ruda Śląska, Lubliniec vicinity, Pszczyna and Opole; [3] sample from Gliwice; n – number of samples; N D – not determined.

The results concerning an assessment of exposure to pyroglyphid house dust mites in dwellings in Poland were previously published as the part of the actual study (SOLARZ 2001).

4. Main places of mite breeding

About 85% of mites was found in beds, whereas only 10.4% and 4.0% in dust samples from floors and upholstery furniture, respectively [Tables 2 and 15]. The remaining 0.6% of mites was found in dust samples from the other indoor places (shutters and pictures) [Tables 2 and 15]. The beds showed also the highest number of mites per 1 sample [Tab. 15] and highest mean number of mites per 1 gram of dust [Figs 1-3]. Considering only pyroglyphid mites (so-called house dust mites), the beds also showed the highest mean number of mites per 1 sample and per 1 gram of dust [Tab. 15; Figs 1-3]. Of a total of 3,212 pyroglyphid mites collected, 2,954 (91.97%) were found in beds (or other sleeping accommodations), 142 in dust from upholstered furniture (4.42%), 95 (2.96%) in floor dust samples, and 21 (0.65%) in samples from shutters.

Table 15

Species list, dominance, occurrence and mean number of pyroglyphid mites per 1 mite positive sample, in examined dust samples (n = 335) from 109 dwellings at 27 localities in Poland (1989-2000)

Mites	Rate of dominance (Percent of the total count)					Rate of occurrence (Percent of total samples)					Mean number of mites per 1 sample (mite positive)				
	1	2	3	4	**5**	1	2	3	4	**5**	1	2	3	4	**5**
Pyroglyphidae	**93.54**	**24.61**	**95.30**	**100.0**	**86.48**	**60.00**	**20.07**	**70.59**	**50.00**	**44.48**	**31.47**	**2.50**	**5.68**	**7.00**	**19.96**
Dermatohagoides farinae	71.72	16.84	91.95	100.0	66.99	50.00	16.55	70.59	50.00	37.61	24.62	1.71	5.48	7.00	15.75
D. pteronyssinus	19.60	7.51	3.35	NF	17.58	26.00	8.97	14.71	NF	17.01	6.59	0.76	0.20	NF	4.05
Dermatophagoides sp.	0.19	0.26	NF	NF	0.19	2.00	0.69	2.94	NF	1.49	0.07	0.03	NF	NF	0.04
Euroglyphus maynei	1.93	NF	NF	NF	1.64	4.67	NF	NF	NF	2.09	0.66	NF	NF	NF	0.39
Hirstia chelidonis	0.10	NF	NF	NF	0.08	2.00	NF	NF	NF	0.89	0.03	NF	NF	NF	0.02
Live Pyroglyphidae	10.51	4.40	10.74	33.33	10.02	28.67	8.97	29.41	33.33	20.30	3.61	0.45	0.64	2.33	2.38
Live domestic mites	13.11	19.43	14.09	33.33	13.92	31.33	12.41	29.41	33.33	22.98	4.50	1.97	0.84	2.33	3.31
Live mites (total)	13.33	21.24	14.09	33.33	14.30	32.67	13.79	29.41	33.33	24.18	4.58	2.16	0.84	2.33	3.40
Total domestic mites	**99.46**	**97.41**	**99.33**	**100.0**	**99.30**	**61.33**	**25.52**	**73.53**	**50.00**	**46.87**	**33.45**	**9.89**	**5.92**	**7.00**	**22.92**
Total mites	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**61.33**	**26.21**	**73.53**	**50.00**	**47.16**	**33.67**	**10.13**	**5.96**	**7.00**	**23.12**
Number [N] of total:	**3158**	**386**	**149**	**21**	**3714**	**150**	**145**	**34**	**6**	**335**					
	Mites					**Samples**									

Key: 1 – in relation to samples from beds; 2 – in relation to samples from floors; 3 – in relation to samples from upholstery furnitures; 4 – in relation to samples from other places (wooden furnitures, pictures, shutters); **5** – in relation to total of samples examined.

Housing conditions influencing the abundance of dust mites. Statistical and cluster analysis

1. Single-family houses in the subagricultural settlement of Bielsko-Biała (South Poland)

Weights of the samples ranged between 0.01-0.5g. All of the examined houses proved to be positive for mites [Tables 5 and 16]. A total of 673 mite specimens were isolated, including 308 members of the family Pyroglyphidae (45.8%). The most frequent species were 2 pyroglyphids – *D. pteronyssinus* (38.50% of all samples examined) and *D. farinae* (30.8%), whilst the dominant species was *Chortoglyphus arcuatus* (Acaridida, Chortoglyphidae), which constituted 49.9% of the total population. The remaining part of acarofauna consisted of the following taxa: *G. fusca* (2.2% of the total count), *T. putrescentiae* (0.75%), *G. privatus* (0.6%), *L. destructor* (0.15%), Cheyletidae (0.3%) and Oribatida (0.3%). Densities of mites (per gram of dust) and guanine levels found in particular houses or places examined, and housing conditions recorded in the houses are presented in Tables 4, 5, 16 and 17. The main habitats for the occurrence of both pyroglyphid species (especially *D. pteronyssinus*) are beds, whereas for *Ch. arcuatus* – carpets [Tab. 17].

Table 16

Numbers (or mean numbers) of mites per 1 gram of dust from the particular places examined in single-family houses in Bielsko-Biała (2000-2001)

Mean ± SD. Total mites (Live mites)							
Houses Sites examined	House number 1 [n = 5]	House number 2 [n = 6]	House number 3 [n = 7]	House number 4 [n = 5]	House number 5 [n = 6]	House number 6 [n = 5]	House number 7 [n = 5]
Bed	3233.3 (NF) [n = 1]	2266.7 ± 666.7 (266.7) [n = 2]	2669.7 ± 397.0 (NF) [n = 2]	1331.4 ± 1335.3 (66.7 ± 66.7) [n = 2]	97.1 (NF) [n = 1]	2333.3 (1066.7) [n = 1]	653.8 ± 346.1 (253.8 ± 53.8) [n = 2]
Floor under Bed	NF [n = 1]	228.6 (228.6) [n = 1]	742.9 (NF) [n = 1]	400.0 (133.3) [n = 1]	183.3 ± 116.7 (NF) [n = 2]	NF [n = 1]	NF [n = 1]
Carpet	NF [n = 1]	57.1 (NF) [n = 1]	18639.6 ± 3668.1 (2254.9 716.5) [n = 2]	NF [n = 1]	48.5 ± 48.5 (NF) [n = 2]	NF [n = 1]	194.2 (194.2) [n = 1]
Linoleum	NF [n = 2]	57.1 (NF) [n = 2]	120.0 ± 120.0 (20.0 ± 20) [n = 2]	545.5 (181.8) [n = 1]	394.7 (263.2) [n = 1]	NF [n = 2]	NF [n = 1]
Total samples	646.7 ± 1446.0 (NF)	822.2 ± 1198.1 (82.5 ± 128.4)	6228.8 ± 8806.9 (650.0 ± 1171.9)	721.6 ± 997.1 (89.7 ± 84.2)	159.3 ± 152.9 (43.9 ± 107.4)	466.7 ± 1043.5 (213.3 ± 477.0)	300.4 ± 412.7 (140.4 ± 135.9)

Key: n = number of samples examined; NF = not found.

Numbers of samples showing concentrations of mites per gram of dust of 100 or higher, were 22 (56.4%) and 19 (48.7%) for total domestic mites and total house dust mites (Pyroglyphidae), respectively. Moreover, it should be stressed that in 21 of the samples examined (53.8%), results of the Acarex test were positive (guanine content was approximately between 600 and more than 10,000 g/gram of dust). Considering these additional samples, the greatest number of pyroglyphid mites per 1 gram of dust was 3,233.3 (house number 1, bed dust), whereas the greatest number of domestic mites per 1 gram of dust was 22,307.7 (house number 3, carpet dust).

The multiple regression analysis revealed associations between levels of mite allergens (Acarex test steps) and numbers of *D. pteronyssinus* and total Pyroglyphidae per gram of dust ($p < 0.005$ and $p < 0.05$, respectively), whereas for *D. farinae* and total domestic mites (including mainly *Ch. arcuatus*) the relationships were not significant ($p = 0.91$ and $p = 0.31$, respectively). The multiple regression analysis showed negative influence of cleaning frequency on the prevalence of *D. pteronyssinus*, higher temperatures on the occurrence of live *D. pteronyssinus*, and the highest relative humidities on the total house-dust-mite abundance [Tab. 18]. Moreover, the abundance of *D. pteronyssinus, D. farinae*, total Pyroglyphidae, and number of species of the pyroglyphid mites, were associated with beds as the most favourable type of furniture [Tables 3 and 18].

Table 17

Mean numbers of domestic mites per 1 gram of dust from particular places examined in houses from Bielsko-Biała in relation to mean values of temperature and relative humidity (2000-2001)

Mites	Mean ± SD: Total mites (Live mites) / Percent of dominance					Temperature (°C)	Relative humidity (%RH)
	Bed/Mattress [n = 11; N = 340]	Floor under bed [n = 8; N = 24]	Carpet [n = 9; N = 295]	Linoleum [n = 11; N = 14]	Total samples [n = 39; N = 673]		
DP	1088.1 ± 1117.4 / 46.8 (136.1 ± 303.4)	107.1 ± 260.0 / 62.5 (14.3 ± 40.4)	126.1 ± 250.7 / 2.3 (21.6 ± 64.7)	NF	358.0 ± 756.1 / 26.8 (46.3 ± 169.5)	17.1 ± 2.7 [M = 15]	76.3 ± 2.4 [M = 15]
DF	436.6 ± 940.3 / 34.7 (6.1 ± 20.1)	87.5 ± 164.2 / 25.0 (16.7 ± 47.1)	10.8 ± 32.4 / 0.3 (NF)	40.4 ± 91.8 / 21.4 (12.0 ± 39.7)	155.0 ± 522.2 / 19.0 (8.5 ± 31.1)	17.8 ± 3.0 [M = 12]	74.7 ± 3.0 [M = 12]
ChA	169.7 ± 562.8 / 16.5 (12.1 ± 40.2)	NF	3907.7 ± 7915.9 / 94.6 (488.4 ± 1023.7)	3.6 ± 12.1 / 7.1 (3.6 ± 12.1)	950.7 ± 3996.6 / 49.9 (120.6 ± 513.0)	17.5 ± 2.6 [M = 4]	75.2 ± 0.4 [M = 4]
GF	3.0 ± 10.05 / 0.3 (NF)	NF	136.3 ± 281.4 / 3.05 (12.7 ± 35.9)	31.1 ± 69.3 / 35.7 (NF)	41.1 ± 144.6 / 2.2 (2.9 ± 18.1)	18.4 ± 2.9 [M = 5]	75.4 ± 0.5 [M = 5]
LD	NF	NF	NF	16.5 ± 52.3 / 7.1 (16.5 ± 52.3)	4.7 ± 29.1 (4.7 ± 29.1) / 0.15	22.0 [M = 1]	76.0 [M = 1]
GP	61.5 ± 180.1 / 1.2 (25.2 ± 59.5)	NF	NF	NF	17.4 ± 96.5 / 0.6 (7.1 ± 33.6)	14.0 ± 0.0 [M = 2]	81.0 ± 0.0 [M = 2]
TP	6.1 ± 20.1 (NF)	8.3 ± 23.6 / 4.2 (NF)	NF	20.8 ± 41.7 / 21.4 (12.1 ± 38.3)	9.3 ± 27.0 / 0.75 (3.4 ± 21.1)	16.8 ± 1.8 [M = 5]	75.4 ± 0.5 [M = 5]
THDM	1533.0 ± 1264.0 (142.2 ± 322.5)	194.6 ± 270.4 (30.9 ± 57.5)	136.9 ± 246.6 (21.6 ± 64.7)	40.4 ± 91.8 (12.0 ± 39.7)	515.3 ± 932.5 (54.8 ± 180.0)	17.3 ± 2.9 [M = 22]	75.7 ± 3.0 [M = 22]
TDM[1]	1773.4 ± 1194.5[1] (161.3 ± 321.7)	203.0 ± 264.5 (30.9 ± 57.5)	4180.0 ± 8400.2 (522.7 ± 1047.3)	117.7 ± 192.8[1] (44.1 ± 90.8)	1539.7 ± 4228.9 (184.9 ± 546.7)	17.2 ± 2.8 [M = 25]	75.7 ± 2.9 [M = 25]
Total[1,2] mites	1773.4 ± 1194.5[2] (171.5 ± 317.3)	217.3 ± 262.1[2] (45.2 ± 87.5)	4180.0 ± 8400.2 (522.7 ± 1047.3)	117.7 ± 192.8[1] (44.1 ± 90.8)	1542.7 ± 4227.9 (193.0 ± 545.7)	17.2 ± 2.8 [M = 25]	75.7 ± 2.9 [M = 25]

Key: [1] including also *Cheyletidae*; [2] including also Oribatida; n = number of samples examined; N = number of mites collected; M = number of measurements or/and positive samples; NF = not found; DP = *Dermatophagoides pteronyssinus*; DF = *D. farinae*; ChA = *Chortoglyphus arcuatus*; GF = *Gohieria fusca*; LD = *Lepidoglyphus destructor*; GP = *Glycyphagus privatus*; TP = *Tyrophagus putrescentiae*; THDM = total house dust mites (pyroglyphids); TDM = total domestic mites.

The result of the cluster analysis (r – PEARSON's, WARD's method) suggested low associations between densities of *Ch. arcuatus,* total domestic mites, total mites, live domestic mites and total live mites (per gram of dust) and housing conditions analysed [Tables 4 and 5]. The criterion variables concernig the pyroglyphid house dust mites were classified into 2 groups. Numbers of *D. farinae* and *Ch. arcuatus* per gram of dust, and guanine levels were associated with the temperature, house-cleaning frequency and type of furniture (i.e. couches as sleeping accomodations, carpeted floors, upholstery furnitures). The second group consisted of the number of rooms, family size, age of house and relative humidity, the variables of which were associated with numbers of total and live *D. pteronyssinus,* live *D. farinae,* total and live Pyroglyphidae per gram of dust and number of mite species (total, pyroglyphid and non-pyroglyphid) (Fig. 5).

Table 18

Effects of housing conditions on the prevalence of house dust mites, domestic mites and levels of guanine in examined single-family houses in Poland (results of multiple regression analysis)

Criterion variables (y)	^2R	Explanatory variables (x^1) – Partial correlation coefficient						
		Relative humidity	Temperature	Age of house	House size	Family size	Cleanin frequency	Type of furniture
DP/ 1g[3]	0.67	-0.34	-0.18	-0.15	0.14	0.026	**-0.35***	**-0.49****
DF/ 1g[4]	0.5	-0.12	0.07	0.05	-0.07	-0.03	0.1	**-0.35***
HDM/1g[5]	0.67	**-0.45***	-0.10	-0.09	0.07	0.001	-0.23	**-0.61****
ChA/1g[6]	0.53	-0.23	0.01	0.04	0.17	0.01	-0.16	0.26
DM/1g[7]	0.53	-0.28	-0.003	0.02	0.18	0.006	-0.20	0.11
LHDM/1g[8]	0.47	-0.08	-0.30	-0.09	0.06	0.07	-0.03	-0.29
LDP/1g[9]	0.48	-0.11	**-0.35***	-0.16	0.11	0.01	-0.09	-0.28
LDF/1g[10]	0.38	0.13	0.17	0.30	-0.27	0.31	0.30	-0.16
Guanine levels[11]	0.19	-0.01	0.02	-0.02	0.06	-0.05	0.003	0.15
Number of species:								
Total	0.56	0.16	0.33	-0.001	-0.09	0.06	-0.15	-0.29
Pyroglyphidae	0.62	0.13	0.26	0.07	-0.17	0.14	-0.06	**-0.52****
Non-pyroglyphids	0.49	0.02	0.24	-0.03	0.06	-0.009	-0.21	0.04

Key: [1]as described in Table 4; ^2R = multiple regresion coefficient; [3]DP/1g = number of *Dermatophagoides pteronyssinus* per gram of dust; [4]DF/1g = number of *D. farinae* per gram of dust; [5]HDM/1g = number of total house dust mites (Pyroglyphidae) per gram of dust; [6]ChA/1g = number of *Chortoglyphus arcuatus* per gram of dust; [7]DM/1g = number of total domestic mites (including Acaridae, Glycyphagidae, Chortoglyphidae, Cheyletidae) per gram of dust; [8]LHDM/1g = number of live house dust mites per gram of dust; [9]LDP/1g = number of live *D. pteronyssinus* per gram of dust; [10]LDF/1g = number of live *D. farinae* per gram of dust; [11]expressed as Aarex test steps; * $p < 0.05$; ** $p < 0.01$.

Moreover, the PEARSON's correlation test has revealed the following significant relationships:

– negative correlation between abundance of *D. farinae* (per gram of dust) and relative humidity ($r = -0.35$; $p < 0.05$);

– type of heating (coal-stoves) was significantly correlated with numbers of *D. pteronyssinus* (r = 0.36), *Ch. arcuatus* (r = 0.48*), total domestic mites (r = 0.52**) and total mites (r = 0.55**) per gram of dust, and the number of species of pyroglyphid mites (r = 0.34) ($p < 0.05$, $*p < 0.01$, $**p \leq 0.001$);

– type of furniture (bed) was significantly correlated with numbers of *D. pteronyssinus* (r = 0.50) and total Pyroglyphidae (house dust mites) (r = 0.58*) per gram of dust, and the number of species of pyroglyphid mites (r = 0.50) ($p \leq 0.001$, $*p \leq 0.0001$);

– age of house was correlated with numbers of *G. fusca* (r = 0.41*); *Ch. arcuatus* (r = 0.39), total domestic mites (r = 0.41*) and total mites (r = 0.41*) per gram of dust ($p < 0.05$, $* p \leq 0.01$);

– cleaning frequency had significant effects on densities of *D. pteronyssinus* (r = -0.34), *G. fusca* (-0.38), *Ch. arcuatus* (r = -0.37), total domestic mites (r = -0.39) and total mites (r = -0.39) per gram of dust, and the number of species of pyroglyphid mites (r = -0.38) ($p < 0.05$);

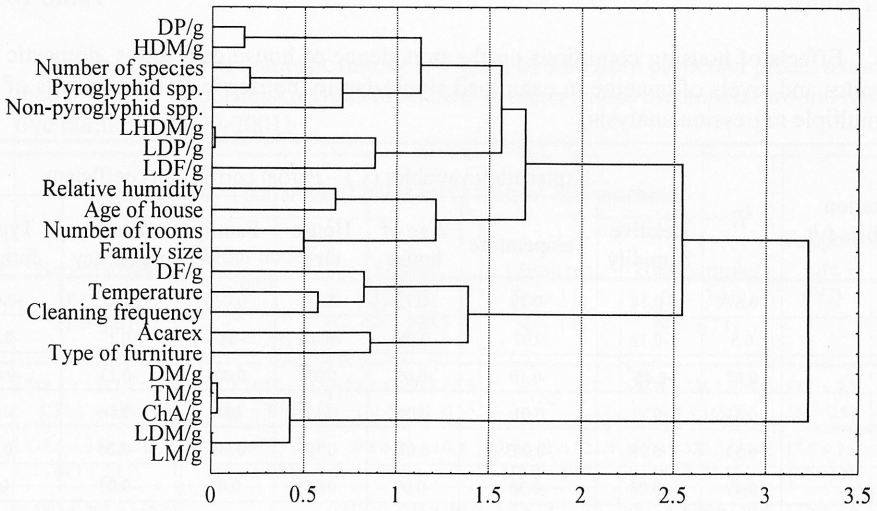

Fig. 5. Cluster analysis (1-PEARSON's r; WARD's method) of housing conditions analysed, and house dust mites (Pyroglyphidae) collected from single-family houses of Bielsko-Biała (subagricultural settlements; South Poland). Key: DP – *Dermatophagoides pteronyssinus*, LDP – live *D. pteronyssinus*, DF – *Dermatophagoides farinae*, LDF – live *D. farinae*, ChA – *Chortoglyphus arcuatus*, HDM – house dust mites (Pyroglyphidae), LHDM – live house dust mites, DM – domestic mites, LDM – live domestic mites, TM – total mites, LM – live mites (total), Pyroglyphid spp. – number of species of pyroglyphid mites, Non-pyroglyphid spp. – number of species of non-pyroglyphid mites, /g – per gram of dust.

– family size was negatively correlated with numbers of *T. putrescentiae* per gram of dust ($r = -0.37$; $p < 0.05$);

– Acarex test levels were correlated with month of sampling ($r = 0.94$, $p \leq 0.0001$) and were highest in October;

– positive correlation between type of floor (uncarpeted, linoleum) and numbers of *L. destructor* per gram of dust ($r = 0.42$; $p < 0.01$).

Effects of the other analysed conditions, such as levels of indoor temperature, weight of samples, housewife (working or not), type of bed, house size and family size, on the prevalence of mites, were not significant (PEARSON's correlation test, $p > 0.05$).

Considering individual life stages of the pyroglyphids, the following correlations were stated (PEARSON's test):

– beween RH and numbers of females ($r = -0.37$) and heteromorphic males ($r = -0.36$) of *D. farinae* per gram of dust (negative correlation; $p < 0.05$);

– between age of house and numbers of protonymphs of *D. pteronyssinus* per gram of dust (positive correlation; $r = 0.48$, $p < 0.005$);

– between type of heating and numbers of larvae ($r = 0.32$), protonymphs ($r = 0.58^{**}$) and males ($r = 0.44^{*}$) of *D. pteronyssinus* per gram of dust (positive correlations; $p < 0.05$, $^{*}p \leq 0.005$, $^{**}p \leq 0.0001$);

– between cleaning frequency and also numbers of larvae ($r = -0.32$), protonymphs ($r = -0.44^{*}$) and males ($r = -0.34$) of *D. pteronyssinus* per gram of dust (negative correlations; $p < 0.05$, $^{*}p \leq 0.005$);

– between beds as types of furniture and numbers of larvae ($r = 0.34$), tritonymphs ($r = 0.36$), females ($r = 0.51^{**}$) and males ($r = 0.42^{*}$) of *D. pteronyssinus* per gram of dust, and numbers of tritonymphs ($r = 0.32$) and heteromorphic males ($r = 0.35$) of *D. farinae* per gram of dust ($p \leq 0.05$, $^{*}p < 0.01$, $^{**}p \leq 0.001$).

2. Flats in the urban agglomeration of Upper Silesia (South Poland)

Weights of the samples ranged between 0.005-1.15g. Of a total of 77 samples examined, 30 (approx. 39%) were positive for mites. Moreover, 12 of the 13 examined flats proved to be positive for mites (92.31%). A total of 214 mite specimens were isolated, including 211 members of the family Pyroglyphidae (98.6%). Most frequent species were 2 pyroglyphids – *D. farinae* (33.8% of all samples examined) and *D. pteronyssinus* (14.3%). The former mite was predominant and constituted 89.25% of the total population. In addition, 3 females of *E. maynei* were collected (1.4%). The remaining part of acarofauna consisted of single specimens of *G. domesticus*, Cheyletidae and Tarsonemidae (1.41% of the total count) [Tab. 19].

Table 19

Abundance (mean numbers of mites per 1 gram of dust), dominance and frequency of house dust mites and domestic mites in samples from 13 flats examined in 2000-2001 (Upper Silesia, Poland).

Mites	Mean ± SD [Maximum] Total mites (Live mites)	Relative dominance [1]	Relative frequency [2]
Dermatophagoides farinae	12.21 ± 36.55 [260.87] (0.99 ± 3.92 [27.3])	89.25	33.77
D. pteronyssinus	2.93 ± 15.73[133.3] (0.15 ± 1.07 [9.1])	7.94	14.29
Euroglyphus maynei	2.16 ± 13.61 [100.0] (NF)	1.4	2.60
Total Pyroglyphidae	17.26 ± 43.99 [265.22] (1.14 ± 4.02 [27.3])	98.6	38.96
Total mites [3]	17.52 ± 44.26 [265.22] (1.17 ± 4.04 [27.3])	100.0	38.96

Key: [1] percent of all mites collected; [2] percent of all samples examined; NF = not found; [3] including single specimens of *Glycyphagus domesticus* (Acaridida: Glycyphagidae), Tarsonemidae and Cheyletidae.

Mean levels of the relative humidity and temperature in the examined flats were 43.3% (±7.7) and 21.5°C (± 1.8), alternatively. Mean content of guanine (in Acarex test steps) in the examined samples was –1.3 (± 1.5; median = -2).

Numbers of samples and flats showing concentrations of mites per gram of dust of 100 or higher, were 5 (6.5%) and 3 (23.1%), respectively. Moreover, it should be stressed, that only in 19 of the samples examined (24.7%; 10 samples from beds, 5 samples from upholstered furniture and 4 samples from carpets), results of the Acarex test were positive (guanine content was approximately between 600 and more than 10,000 µg/gram of dust). On the other hand, the number of flats positive for the Acarex test was 11 (84.61%). Considering these additional samples from flats, the greatest number both of pyroglyphid mites and of domestic mites per 1 gram of dust was 265.2.

The result of the cluster analysis (by median method) suggested low associations between densities of *D. farinae*, total pyroglyphid mites and total mites (per gram of dust) and housing conditions analysed. The housing conditions [Tab. 3] were also classified by the cluster analysis (r-PEARSON's, WARD's method and median method) into 2 groups. One group consisted of the temperature, closed kitchen, presence of pets, age of flat, cooking facility (gas), central heating and flat cleaning (vacuuming) frequency. These were considered to be the factors unfavourable for mites (dry factors). The second group consisted of the relative humidity, working housewife, type of furniture, number of rooms and family size, the characters of which were considered to be favourable (or humid) factors. The mites were also divided into 2 groups. *D. farinae* (live and total) formed 1 cluster of mites, which seemed to be better associated with the dry (unfavourable) factors. *D. pteronyssinus* (live and total) and *E. maynei* and formed the second cluster. These mites appeared to be better associated with the humid factors [Fig. 6a, b].

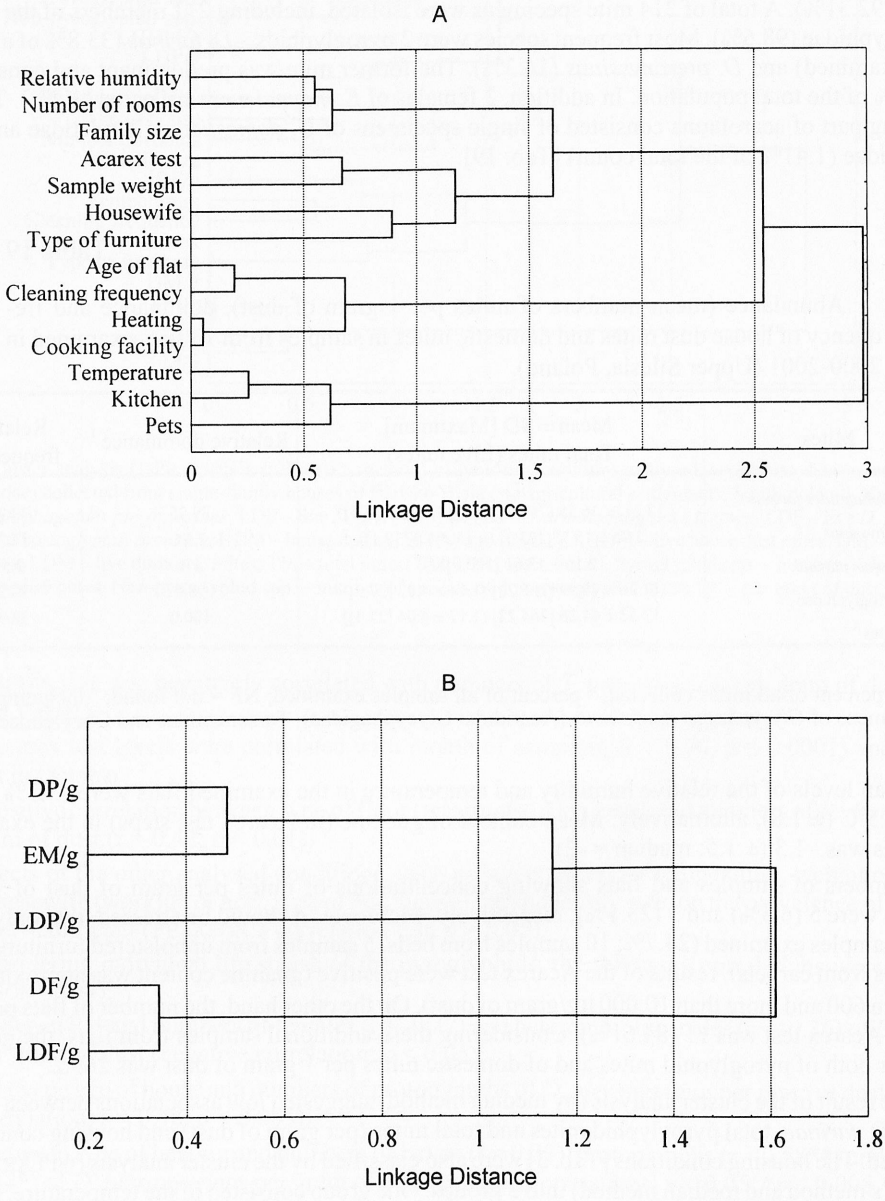

Fig. 6. Cluster analysis (1-PEARSON's r; WARD's method) of housing conditions analysed (A), and house dust mites (Pyroglyphidae) (B) collected from 13 flats examined (industrial area; Upper Silesia, Poland). Key: DP – *Dermatophagoides pteronyssinus*, EM – *Euroglyphus maynei*, LDP – live *D. pteronyssinus*, DF – *D. farinae*, LDF – live *D. farinae*, /g – per gram of dust.

Moreover, the PEARSON's correlation test has revealed the following significant relationships:

– positive correlation between abundance of total and live *D. farinae*, live Pyroglyphidae (per gram of dust) and cooking facility (gas) (r = 0.30 – 0.36; $p < 0.05$);

– positive correlation between weight of sample and guanine levels (Acarex test steps) (r = 0.33; $p < 0.05$);

– Acarex test was also significantly correlated with numbers of total *D. farinae* (r = 0.36), live *D. farinae* (r = 0.39*), live pyroglyphid mites (r = 0.37) and live domestic mites (r = 0.37) per gram of dust, and with the number of pyroglyphid mite species (r = 0.5**) ($p < 0.05$, $*p < 0.01$, $**p \leq 0.001$);

– family size (number of inhabitants) was significantly correlated with numbers of *E. maynei* per gram of dust (r = 0.34, $p < 0.05$);

Effects of the other analysed conditions on the prevalence of mites [Tab. 3], were nonsignificant (PEARSON's correlation test, $p > 0.05$).

Considering the individual life stages of the pyroglyphids, the following 2 correlations were found (PEARSON's test):

– positive correlation between abundance of females, tritonymphs and larvae of *D. farinae* (per gram of dust) and cooking facility (gas) (r = 0.34 – 0.37; $p < 0.05$);

– positive correlation between Acarex test and numbers of heteromorphic males and tritonymphs of *D. farinae* per gram of dust; r = 0.35, $p < 0.05$);

D. farinae was significantly more abundant (per gram of dust) than *D. pteronyssinus* and *E. maynei* (Student's *t*-test; t = 2.04 and 2.22, respectively; $p < 0.05$), whereas this difference between *D. pteronyssinus* and *E. maynei* was nonsignificant (t = 0.46, $p = 0.65$). No significant differences in abundance (number of mites per gram of dust) were also found between live *D. farinae* and live *D. pteronyssinus* (t = 1.78, $p = 0.08$), and between total and live *D. pteronyssinus* (t = 1.55, $p > 0.1$). Significant differences were found, however, between total and live *D. farinae* per gram of dust, and between total and live Pyroglyphidae per gram of dust (t = 2.89 and 3.4 ; $p = 0.005$ and 0.001, alternatively), while the difference between total Pyroglyphidae and the total mites collected was not significant (t = -1.18, $p = 0.24$).

Pyroglyphid mite fauna in hospitals

Weights of the samples ranged between 0.02-0.53 g. All of the hospitals proved to be positive for mites [Tab. 20]. Total number of mites isolated from hospital dust samples and number of the samples positive for mites was distinctly lower than in dwellings. Mites (56 ones) 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 abundant 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 57.14% of a total count. It was also most frequent and occurred in 13 samples (13.13% 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 were found of *D. pteronyssinus* (2 protonymphs, 4 tritonymph, 5 males and 4 females) in 12 samples, and 5 unidentified specimens *Dermatophagoides* 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, the pyroglyphid only mites 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, which were not numerous, however, and were found individually (in samples without pyroglyphids).

Table 20

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

Hospitals	Mean ± SD [Maximum] (Percent of dominance/Percent of frequency)					
	Dermatophagoides farinae	*D. pteronyssinus*	Total Pyroglyphidae[1]	Total domestic mites[2]	Live Pyroglyphidae[1]	Total Mites
Municipal Hospital No 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)
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 Silesian 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)

Key: [1]including unidentified mites of the genus *Dermatophagoides*; [2] including *Tyrophagus putrescentiae* (Acaridida: Acaridae) and *Calvolia* sp. (Acaridida: Saproglyphidae); NF = not found.

The abundance of pyroglyphid mite 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 21. 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 [Tab. 21]. This was only slightly higher in dust from beds (9.0) than in dust from floors (8.0) [Tab. 21].

The mean numbers of mites per 1 gram in particular hospitals are compared in Table 20. It appears that the 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 [Tab. 20].

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 [Tab. 21], but both differences were statistically not significant (χ^2; $p = 0.31$ and $p = 0.51$, respectively).

The lowest numbers of mites per gram of dust were found in November, September and June (1.88–5.0), whereas the highest was in samples collected in July, March and October (100.0–160.0). Samples without mites were collected mainly in heated seasons (winter months).

The number of mites per gram of dust was 100 or higher in only 3 samples of bed dust, but in 42 of the samples examined (42.4%) the Acarex test steps were positive (guanine content was approximately between 600 and 3,750 µg/gram of dust).

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 nonsignificant ($p > 0.05$). Levels of guanine in samples from beds were positively correlated with levels of temperature (PEARSON's correlation test; r = 0.3, $p < 0.01$). Moreover, type of mattress (linen) was correlated with numbers of *D. pteronyssinus* females (r = 0.41), total *D. pteronyssinus* (r = 0.31) and heteromorphic males of *D. farinae* (r = 0.35) per gram of

Table 21

Abundance of dust mite species (mean number of mites/1 gram of dust) in dust samples from hospitals examined[1], in relation to mean levels of guanine (Acarex test steps) and mean values of relative humidity and temperature. Data includes all samples examined, also those mite negative

Mites (N=56) / Places examined	Mean ± SD [Maximum] (Relative dominance[2]/Relative frequency[3])		
	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 house dust mites[4] (Pyroglyphidae)	1.40 ± 7.7 [60.0]	0.4 ± 2.3 [12.5]	1.1 ± 6.5 [60.0]
Total domestic (astigmatid) mites[4]	8.89 ± 26.5 [160.0]	8.0 ± 21.2 [100.0]	8.7 ± 24.9 [160.0]
Total mites[6]	9.0 ± 26.51 [160.0]	7.98 ± 21.16 [100.0]	8.66 ± 24.91 [160.0]
Guanine levels	-0.6 ± 1.3 [2.5]	-1.7 ± 1.3 [1.5]	-0.9 ± 1.4 [2.5]
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]

Key: [1]Municipal Hospital N° 1 in Wodzisław, Public Central Clinical Hospital of Silesian Medical Academy in Katowice-Ligota, District Railway Hospital in Katowice-Ligota, Upper Silesian Medical Centre in Katowice-Ochojec and Municipal Hospital in Chorzów; [2]percent of total population; [3]percent of total samples examined; [4]including unidentified mites of the genus *Dermatophagoides*; [5] including also other, non-pyroglyphid, astigmatid domestic mites isolated (= *Tyrophagus putrescentiae* and *Calvolia* sp.); [6]all mites found (including oribatids); N = number of mite species; n= number of samples examined.

dust from beds (PEARSON's correlation test, $p < 0.01$). The differences in 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 significant (*t*-test, $p > 0.1$ for all cases).

Considering exclusively samples from patients' beds in the Municipal Hospital in Chorzów, which were vacuumed monthly (from January 1999-January 2000), RH had significant and positive effects on densities of *D. pteronyssinus* (r = 0.38), total Pyroglyphidae (r = 0.42), total domestic mites (r = 0.42), total mites (r = 0.43), live Pyroglyphidae (r = 0.36), live domestic mites (r = 0.36) and total live mites (r = 0.36) per gram of dust, and numbers of mite species (r = 0.42), whereas the RH on mattress surfaces was correlated with numbers of *D. pteronyssinus* (r = 0.37), *D. farinae* (r = 0.36), total Pyroglyphidae (r = 0.43), total domestic mites (r = 0.43), total mites (r = 0.44), live *D. farinae* (r = 0.37), live total Pyroglyphidae (r = 0.37), live total domestic mites (r = 0.37) and total live mites (r = 0.37) per gram of dust, and numbers of mite species (r = 0.41) (PEARSON's test, $p < 0.05$ in all cases). In this hospital, a nonsignificant difference was found in numbers of mites per gram of dust, between *D. farinae* and *D. pteronyssinus* (Student's *t*-test, $p > 0.3$).

Taking into account the remaining 4 hospitals, where floors and patients' beds were vacuumed twice during 1999 (in March and in October/November), the higher temperature had significant negative effects on the numbers of *D. farinae* (r = -0.26), total pyroglyphid mites (r = -0.26) and total mites (r = - 0.26) per gram of dust, whereas the influence of temperature on the occurrence of *T.*

putrescentiae was positive (r = 0.25) (PEARSON's test; $p < 0.05$). Levels of an ambient air relative humidity in the examined hospitals were correlated (positively) only with Acarex test steps (levels of guanine and mite allergens) (PEARSON's test; r = 0.41, $p = 0.001$).

Mite fauna in libraries

Weights of the samples ranged between 0.05 and 1.0 g. All of libraries proved to be positive for mites. A total of 106 specimens of these arachnids were isolated. Generally, they were found in 21 samples (37.5 %) out of 56 examined. Dust mites from the family Pyroglyphidae constituted 60.4% of all mites collected.

The abundance of mites isolated from the particular places examined in libraries (per 1 gram of dust from all samples examined) is compared in Table 22. 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 upholstery chairs [Tab. 22]. On the other hand, considering Acarex test steps, the highest levels of guanine were recovered from carpeted floors and the lowest levels from book-shelves and desks [Tab. 22]. *D. farinae* was the most dominant, constituting 56.6% of mites collected, and was found in 28.6% of the samples from libraries. This mite occurred also in tenfold higher numbers per gram of dust than *D. pteronyssinus* [Tab. 22]. 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 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 ($\chi^2 = 22.8$, $p \leq 0.00001$; $\chi^2 = 13.33$, $p < 0.0005$; $\chi^2 = 11.17$, $p < 0.001$, respectively), whereas the differences between book-shelves/desks and carpeted floors, or between books, total floors and upholstered or arm-chairs were statistically nonsignificant (χ^2; $p > 0.1$).

Among the examined samples, 7 (12.5%) contained levels of guanine higher than 600 g/gram of dust, whereas 9 samples (16.1%) showed 100 or more mites per gram of dust (between 100 – 2,800); these samples were collected from book-shelves and desks (6 samples), carpeted floors (2 samples) and an upholstered chair (1 sample).

In the actually examined libraries, the significant positive correlation was found only between levels of relative humidity and numbers of *Ch. arcuatus* per gram of dust (r = 0.42) and the number of species of non-pyroglyphid mites (r = 0.42), and between weight of samples and – number of total mites per gram of dust (negative correlation; r = -0.37), number of species (total mites) (negative correlation; r = -0.37) and levels of guanine (Acarex test steps) (positive correlation; r = 0.54*) (PEARSON's test; $p < 0.05$, $*p < 0.01$). Other conditions analysed, such as temperature, age and/or type of building, type of furniture and number of workers, had nonsignificant effects on the mite prevalence ($p > 0.05$).

Analysing data of the previous surveys in libraries, effects of RH, temperature and weight of sample on the mite prevalence were not significant ($p > 0.1$).

Coal-mine social rooms and offices

Weights of the samples ranged between 0.04 and 0.57g. 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 (2 samples). But only in 1 sample of carpet dust was the number of mites per gram of dust higher than 100 (i.e. 950/1g); results of the

Table 22

Abundance of domestic mites (expressed as mean number of mites per 1 gram of dust) in dust samples from examined libraries in Upper Silesia (Poland) in relation to mean levels of guanine, relative humidity and temperature

Places examined / Mites (N = 106)	Mean ± SD [Maximum] (Relative dominance[1]/ Relative frequency [2])					
	Books (n = 8)	Book-shelves[3] (n = 13)	Carpeted floors (n = 6)	Total floors[4] (n = 22)	Upholstered chairs (n = 11)	Total samples (n = 56[5])
Dermatophagoides farinae	6.3 ± 14.1 [40.0] (33.3/25.0)	65.5 ± 115.7 [400.0] (40.0/53.8)	43.1 ± 55.2 [138.5] (93.1/50.0)	14.8 ± 35.2 [138.5] (85.3/18.2)	12.1 ± 21.2 [50.0] (41.4/27.3)	27.2 ± 66.7 [400.0] (56.6/28.6)
D. pteronyssinus	NF	3.8 ± 13.9 [50.0] (2.5/7.7)	NF	NF	6.8 ± 16.2 [50.0] (10.3/18.2)	2.5 ± 10.4 [50.0] (3.8/5.4)
Total Pyroglyphidae	6.3 ± 14.1 [40.0] (100/25.0)	73.2 ± 121.4 [400.0] (42.5/53.8)	43.1 ± 55.2 [138.5] (93.1/50.0)	14.8 ± 35.2 [138.5] (85.3/18.2)	18.9 ± 27.9 [75.0] (51.7/36.4)	30.7 ± 70.5 [400.0] (60.4/30.4)
Live Pyroglyphidae	NF	3.8 ± 13.9 [50.0]	11.8 ± 13.5 [30.8]	3.2 ± 8.5 [30.7]	4.5 ± 11.5 [37.5]	3.4 ± 10.3 [50.0]
Total domestic mites [6]	6.3 ± 14.1 [40.0] (100/25.0)	124.5 ± 201.9 [666.7] (57.5/61.5)	43.1 ± 55.2 [138.5] (93.1/50.0)	18.9 ± 37.1 [138.5] (94.1/27.3)	44.4 ± 82.7 [280.0] (100/45.5)	50.7 ± 118.5 [666.7] (82.1/37.5)
Live domestic mites	NF	3.8 ± 13.9 [50.0]	11.8 ± 13.5 [30.8]	6.1 ± 13.6 [50.0]	30.0 ± 83.7 [280.0]	10.1 ± 40.8 [280.0]
Total mites [7]	6.3 ± 14.1 [40.0]	292.5 ± 762.8 [2800.0]	49.8 ± 59.9 [138.5]	20.9 ± 40.4 [138.5]	44.4 ± 82.7 [280.0]	95.1 ± 398.3 [2800.0]
Total live mites	NF	167.9 ± 590.7 [2133.3]	18.5 ± 24.1 [60.0]	8.1 ± 18.0 [60.0]	30.0 ± 83.7 [280.0]	53.5 ± 303.0 [2133.3]
Guanine levels [8]	-1.8 ± 1.5 [1.0]	-2.0 ± 0.8 [0.5]	-1.1 ± 1.7 [1.0]	-1.3 ± 1.6 [1.0]	-1.7 ± 1.2 [1.0]	-1.8 ± 1.3 [1.0]
Relative humidity	55.7 ± 2.3 [59.0]	55.3 ± 2.2 [59.0]	55.2 ± 2.4 [59.0]	55.8 ± 2.4 [59.0]	55.9 ± 2.0 [59.0]	55.6 ± 2.1 [59.0]
Temperature	23.3 ± 0.7 [24.1]	23.2 ± 0.7 [24.1]	23.4 ± 0.4 [24.1]	23.3 ± 0.5 [24.1]	23.1 ± 0.7 [24.1]	23.2 ± 0.6 [24.1]

Key: [1] percent of total population; [2] percent of total samples examined; [3] and other wooden furnitures; [4] including also 2 samples from walls; [5] including 6 samples from carpets and 16 samples from uncarpeted floors; [6] including also other (non-pyroglyphid) domestic mites collected – *Tyrophagus palmarum*, *T. putrescentiae*, *Glycyphagus privatus* and *Chortoglyphus arcuatus*; [7] including mites of the genus *Bryobia* (Tetranychidae) found numerously in 2 libraries; [8] Acarex test steps; NF = not found; N = number of mite specimens; n = number of samples examined.

Acarex test were positive in only 8 of the samples examined (18.6%) (guanine content was approximately between 600 and 2,500 µg/gram of dust).

Correlations between mite numbers per gram of dust and levels of guanine, weights of samples, months of sampling and types of furniture were statistically not significant (PEARSON's test, SPEARMAN rank test; $p > 0.1$). Significant differences were found between stages of the Acarex test and numbers of live *D. farinae* and live total domestic mites (Student's *t*-test; $p < 0.05$).

Generally, mite densities in the coal-mine offices and social rooms actually examined were lower than in dwellings and libraries, but comparable with those in the hospitals [Tables 20-23].

Table 23

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, Poland) in relation to mean levels of guanine (Acarex test steps)

Mites (N = 55, n = 43)	Mean ± SD (Relative dominance[1]/Relative frequency[2])	Median	Minimum–Maximum
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
Guanine levels	-1.5 ± 1.6	-2.25	-3.0 – 1.5

Key: [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.

Mite fauna in research institutes and laboratories

Weights of the samples ranged between 0.39 and 0.42g. 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). Results of the Acarex test were always negative (mean -1.8 ± 0.58; range between -2.5 – -1.5).

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 the pyroglyphids were absent in the archive and in the bakery. Weights of the samples ranged between 0.10 and 1.0g. The abundance and occurrence of mites collected from the remaining work places or public utilities examined are presented in Table 24. The number of mites per gram of dust in all mite positive samples was lower than 100 (between 2-77). Only in 3 samples (23.1%) were the Acarex test steps positive; guanine content was approximately 600 – 10,000 µg/gram of dust (mean: -0.42 ± 1.41, median: 2.0, range: between -3.0 – 2.0).

A significant positive correlation was found only between levels of mite allergens (guanine, Acarex test steps) and numbers of total domestic mites per gram of dust (PEARSON's test; $r = 0.89$, $p = 0.001$), numbers of live domestic mites per gram of dust (SPEARMAN rank test; $R = 0.77$, $p < 0.005$), number of total mite species and number of species of non-pyroglyphid mites (PEARSON's test; $r = 0.94$, $p \leq 0.0001$ in both cases), and between the levels of guanine and the occurrence of acarids or glycyphagids (PEARSON's test; $r = 0.87$, $p < 0.005$ and $r = 0.97$, $p \leq 0.0001$, respectively).

Table 24

Mean numbers of mites per 1 gram of dust in samples from particular sites in other particular work places examined

Mean ± SD (Range) [Median]						
Sampling sites	*Dermatophagoides farinae*	Live *D. farinae*	Domestic mites[1]	Live domestic mites[1]	Total mites[1]	Acarex test steps
Archive (Record Office) in Lublin	NF	NF	NF	NF	NF	-2.0 ± 0.0 (-2.0 – -2.0) [-2.0]
Police Department in Ciechanów	2.0 ± 4.5 (0.0–10.0) [0.0]	2.0 ± 4.5 (0.0–10.0) [0.0]	2.0 ± 4.5 (0.0–10.0) [0.0]	2.0 ± 4.5 (0.0–10.0) [0.0]	2.0 ± 4.5 (0.0–10.0) [0.0]	0.1 ± 0.2 (0.0–0.5) [0.0]
Bakery in Jaworzno	NF	NF	19.7 ± 38.2 (0.0–77.0) [1.0]	19.7 ± 38.2 (0.0–77.0) [1.0]	19.7 ± 38.2 (0.0–77.0) [1.0]	0.75 ± 0.96 (0.0–2.0) [0.5]

Key: [1]including other, non-pyroglyphid domestic mites (*Gohieria fusca*, *Lepidoglyphus destructor*, *Acarus siro* and Cheyletidae), found in the bakery; NF – not found.

The influence of some biotic and/or abiotic factors examined, such as type of public place (= type of building), type of heating, presence or absence of pets, was insignificant ($p > 0.1$), with the exception of the occurrence of glycyphagids (*G. fusca*) which was correlated with the presence of pets (PEARSON's test; $r = 0.60$; $p < 0.05$).

L o f t s

Weights of the samples ranged between 3.5 and 19.72 g. Only 4 samples proved to be positive for mites (10%). Pyroglyphid mites were not found. Generally, 23 mite specimens were collected, including 3 of *G. domesticus* (allergenic species of the family Glycyphagidae). The remaining part of the acarofauna consisted of 16 of *Argas reflexus* (Ixodida, Ixididae), 2 of Gamasida (unidentified), and single specimens of the genera Oribatida and Actinedida (unidentified).

It should also be stressed that lofts in an urban area were actually examined for the first time for an occurrence of house dust mites.

Mites found underground in coal-mines

The weight of samples ranged from 0.08-95.0 grams.

Mites were isolated from 41 (approximately 18%) of the total of 231 samples examined [Tab. 25]. A total of 365 mite specimens belonging to the following 5 orders were isolated: Acaridida, Actinedida, Tarsonemida, Oribatida and Gamasida. Only allergenic mites from the order Acaridida (acaridid mites) were identified to the species level.

Considering the mites of the family Pyroglyphidae, only 1 protonymph of *D. pteronyssinus* was found in debris from the "Niwka-Modrzejów" Coal-Mine in Sosnowiec (01.03.97; the slant 2/II, 630 m depth; rest and food consumption area, with rotting stored wood) (0.27% of all mites collected).

Pyroglyphid mite fauna in farming environments

Mites were found in 49 of the 51 samples examined (aprox. 96.1%). A total of 5,260 mite specimens were isolated, including 98 mites from the family Pyroglyphidae (1.86% of the total count). The pyroglyphid mites were found in 7.84% of the total samples examined. Only 2 species of the family Pyroglyphidae were isolated – *G. longior* (1.81% of all mites collected) and *H. chelidonis*

Table 25

Pyroglyphid mites found in coal-mines (underground), in farming environments and nests of rodents

Mites	Coal-mines					Farming environments					Nests of small rodents				
	Dominance		Frequency		N/s	Dominance		Frequency		N/s	Dominance		Frequency		N/s
	N	(%)	n	(%)		N	(%)	n	(%)		N	(%)	n	(%)	
Pyroglyphidae	1	0.27	1	0.43	0.004	98	1.86	4	7.84	1.92	2	0.76	1	25.0	0.5
Dermatohagoides pteronyssinus	1	0.27	1	0.43	0.004	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
Hirstia chelidonis	NF	NF	NF	NF	NF	3	0.06	1	1.96	0.02	NF	NF	NF	NF	NF
Gymnoglyphus longior	NF	NF	NF	NF	NF	95	1.81	3	5.88	0.06	NF	NF	NF	NF	NF
Euroglyphus maynei	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	2	0.76	1	25.0	0.5
Total mites	366	100.0	41	17.75	1.58	5260	100.0	49	96.08	103.14	262	100.0	4	100.0	65.5

Key: N – number of mites collected; n – number of samples; N/s – number of mites per 1 sample; NF – not found.

(0.06%) [Tab. 25]. The former species was found in single samples from a poultry house, a cowshed and a barn, whereas the second only in cowshed debris. The dominance of *G. longior* in poultry houses was significantly greater than in cowsheds and barns ($\chi^2 = 8.87$ and 11.64; $p < 0.005$ and $p < 0.001$, respectively), whereas the differences between cowsheds and barns in relation to the dominance of this species, were statistically nonsignificant ($\chi^2 < 1.1$; $p = 0.3$).

Nests of synathropic birds

Results are presented in Tables 26-33. A total of 14,444 mite specimens were isolated from the examined nests, including 8,510 mites from the family Pyroglyphidae (58.92% of the total count) [Tab. 26]. *Hirstia chelidonis* was the most abundant species (60.47% of the total population), especially in nests of *Delichon urbica, Hirundo rustica* and *Passer domesticus*, where it constituted about 99.0%, 86.6 and 29.9, respectively [Tables 26-29]. *H. chelidonis* was also the most frequent species (37.68% of the total count of nests) [Tab. 26]. *Dermatophagoides evansi*, the second most abundant pyroglyphid species, was distinctly less numerous and less common; it formed only 4.01% of the total mite population and was found in 17.4% of all nests examined. This mite was especially abundant in brood shelters of great titmice (*Parus major*) (20.85% of all mites found in the total nests of titmice).

Moreover, *H. chelidonis* was found in nests of *Turdus philomelos* (song thrush), *Tringa glareola* (wood sandpiper), *Remiz pendulinus* (penduline tit) and warblers (*Sylvia* spp), whereas *D. evansi* in nests of domestic sparrows, warblers, barn swallows and wood sandpipers [Tables 28, 30 and 32].

G. longior was isolated from brood shelters of great titmice, and nests of thrushes, domestic sparrows and swallows *H. rustica*; generally, this mite has been found in 8.7% of the examined nests and constituted 0.12% of all mites collected [Tab. 26-28, 31 and 32].

Moreover, only in single cases were the next two pyroglyphid mite species found – *D. farinae* (5 specimens in the brood-shelter of the great titmouse) and *D. pteronyssinus* (in the domesic sparrow nest) [Tables 28 and 31].

Table 26

Pyroglyphid mites found in all examined nests

Mites	Mean[1] ± S D (Min. – Max.) [Median]	Dominance[2] (%) N = 14444	Frequency[3] (%) n = 69
ACARI (Total)	209.39 ± 473.3 (0 – 3504) [58]	100.0	94.2
Pyroglyphidae	135.32 ± 463.35 (0 – 3470) [0]	64.64	44.93
Hirstia chelidonis	126.58 ± 459.74 (0 – 3470) [0]	60.47	37.68
Dermatophagoides evansi	8.39 ± 29.15 (0 – 166) [0]	4.01	17.39
D. farinae	0.07 ± 0.60 (0 – 5) [0]	0.03	1.45
D. pteronyssinus	0.01 ± 0.12 (0 – 1) [0]	0.007	1.45
Gymnoglyphus longior	0.30 ± 1.18 (0 – 8) [0]	0.12	8.70

Key: [1]mean number of mites per 1 nest; [2]percent of the total count; [3]percent of total nests examined; N = number of mites collected; n = number of nests examined.

Table 27

Pyroglyphid mites found in nests of *Hirundo rustica*

Mites	Mean[1] ± S D (Min. – Max.) [Median]	Dominance[2] (%) N = 4035	Frequency[3] (%) n = 9
ACARI (Total)	448.33 ± 401.87 (36 – 988) [241]	100.0	100.0
Pyroglyphidae	408.33 ± 422.78 (0 – 977) [106]	91.07	77.78
Hirstia chelidonis	388.44 ± 402.71 (0 – 929) [157]	86.64	77.78
Dermatophagoides evansi	19.78 ± 43.54 (0 – 128) [0]	4.41	44.44
Gymnoglyphus longior	0.11 ± 0.33 (0 – 1) [0]	0.02	11.11

Key: [1]mean number of mites per 1 nest; [2]percent of the total count; [3]percent of total nests examined; N = number of mites collected; n = number of nests examined.

Table 28

Pyroglyphid mites found in nests of *Passer domesticus*

Mites	Mean[1] ± S D (Min. – Max.) [Median]	Dominance[2] (%) N = 2464	Frequency[3] (%) n =12
ACARI (Total)	205.33 ± 292.43 (0 – 1008) [70.5]	100.0	91.67
Pyroglyphidae	77.58 ± 114.88 (0 – 293) [13]	37.78	75.00
Hirstia chelidonis	61.42 ± 92.19 (0 – 250) [3.5]	29.91	75.00
Dermatophagoides evansi	15.75 ± 32.67 (0 – 86) [0]	7.67	33.30
D. pteronyssinus	0.08 ± 0.29 (0 – 1) [0]	0.04	8.33
Gymnoglyphus longior	0.33 ± 0.89 (0 – 3) [0]	0.16	16.67

Key: [1]mean number of mites per 1 nest; [2]percent of the total count; [3]percent of total nests examined; N = number of mites collected; n = number of nests examined.

Table 29

Pyroglyphid mites found in nests of *Delichon urbica*

Mites	Mean[1] ± S D (Min. – Max.) [Median]	Dominance[2] (%) N = 4384	Frequency[3] (%) n = 3
ACARI (Total)	1461.33 ± 1803.49 (89 – 3504) [791]	100.0	100.0
Pyroglyphidae	1447.00 ± 1787.08 (83 – 3470) [788]	99.02	100.0
Hirstia chelidonis	1447.00 ± 1787.08 (83 – 3470) [788]	99.02	100.0

Key: [1]mean number of mites per 1 nest; [2]percent of the total count; [3]percent of total nests examined; N = number of mites collected; n = number of nests examined.

Table 30

Pyroglyphid mites found in nests of *Sylvia* sp.

Mites	Mean[1] ± S D (Min. – Max.) [Median]	Dominance[2] (%) N = 648	Frequency[3] (%) n = 9
ACARI (Total)	72.00 ± 116.57 (0 – 370) [29]	100.0	77.78
Pyroglyphidae	6.00 ± 13.48 (0 – 41) [0]	8.34	33.33
Hirstia chelidonis	1.44 ± 3.13 (0 – 9) [0]	2.01	22.22
Dermatophagoides evansi	4.56 ± 13.67 (0 – 41) [0]	6.33	11.11

Key: [1]mean number of mites per 1 nest; [2]percent of the total count; [3]percent of total nests examined; N = number of mites collected; n = number of nests examined.

Table 31

Pyroglyphid mites found in nests of *Parus* spp.

Mites	Mean[1] ± S D (Min. – Max.) [Median]	Dominance[2] (%) N = 801	Frequency[3] (%) n = 13
ACARI (Total)	61.61 ± 92.74 (1 – 321) [15]	100.0	100.0
Pyroglyphidae	14.15 ± 46.91 (0 – 170) [0]	22.97	23.08
Dermatophagoides evansi	12.85 ± 46.02 (0 – 166) [0]	20.85	15.38
D. farinae	0.38 ± 1.39 (0 – 5) [0]	0.62	7.69
Gymnoglyphus longior	0.92 ± 2.40 (0 – 8) [0]	1.50	15.38

Key: [1]mean number of mites per 1 nest; [2]percent of the total count; [3]percent of total nests examined; N = number of mites collected; n = number of nests examined.

Generally, the pyroglyphid mites were present in 31 nests (44.9% of the total count) [Tab. 26] and were absent in nests of marsh tits (*Parus palustris*), common blackbirds (*Turdus merula*), common starlings (*Sturnus vulgaris*), icterine warblers (*Hippolais icterina*), black redstarts (*Phoenicurus ochruros*) and in pigeon houses (*Columba livia*).

It also should be stressed that these mites occurred in brood shelters of great titmice (*P. major*) and nests of song thrushes (*T. philomelos*), but have not been found in nests of marsh tits and common blackbirds.

As mentioned above, in the nests of some bird species, pyroglyphids were more abundant in relation to the total mite populations collected. In these nests differences in abundance (per nest) between all mites isolated and the total of Pyroglyphidae or of particular (usually dominant) pyroglyphid mite species were nonsignificant (Student's *t*-tests, $p > 0.05$) [Tab. 33]. As this Table shows, the bird species, in which nests pyroglyphids constituted the majority of the mites collected, were: *D. urbica, H. rustica, P. domesticus, Parus* sp. and *Turdus* sp.

Table 32

Pyroglyphid mites found in nests of *Turdus* spp.

Mites	Mean[1] ± S D (Min. – Max.) [Median]	Dominance[2] (%) N = 1265	Frequency[3] (%) n = 13
ACARI (Total)	97.31 ± 105.86 (8 – 368) [58]	100.0	100.0
Pyroglyphidae	11.08 ± 33.28 (0 – 120) [0]	11.38	30.77
Hirsita chelidonis	11.00 ± 33.31 (0 – 120) [0]	11.30	23.08
Gymnoglyphus longior	0.08 ± 0.28 (0 – 1) [0]	0.08	7.69

Key: [1]mean number of mites per 1 nest; [2]percent of the total count; [3]percent of total nests examined; N = number of mites collected; n = number of nests examined.

Considering individual species of pyroglyphid mites, *H. chelidonis* was found more frequently in nests of *D. urbica* than in nests of *H. rustica, P. domesticus, Turdus* spp. and *Sylvia* sp. ($\chi^2 = 24.72, p < 0.00001$; $\chi^2 = 28.57, p < 0.00001$; $\chi^2 = 125.20, p < 0.00001$; $\chi^2 = 127.87, p < 0.00001$, respectively). It was significantly more frequent in nests of *H. rustica* than in nests of *Turdus* spp. and *Sylvia* sp. ($\chi^2 = 60.51$ and 62.72, respectively; $p < 0.00001$), and in nests of *P. domesticus* and both the latter genera ($\chi^2 = 54.10$ and 56.23, respectively; $p < 0.00001$), whereas differences between nests of *H. rustica* and *P. domesticus* or between nests of *Turdus* spp. and *Sylvia* sp. statistically were nonsignificant (p = 0.62 and p = 0.86, respectively).

The second pyroglyphid species, *D. evansi,* was collected more frequently from nests of *H. rusica* than from nests of *Sylvia* sp. and nests or brood-shelters of *Parus* spp. ($\chi^2 = 27.31, p < 0.00001$ and $\chi^2 = 20.22, p < 0.00001$, respectively). It was also significantly more frequent in nests of *P. domesticus* than in nests of *Sylvia* sp. and *Parus* spp. ($\chi^2 = 14.1, p = 0.0002$ and $\chi^2 = 8.88, p = 0.003$, respectively). Differences between nests of *H. rustica* and *P. domesticus* or between nests of *Parus* spp. and *Sylvia* sp. were nonsignificant (p = 0.11 and p = 0.40, respectively).

G. longior showed no clear associations with the species of birds, whose nests were positive for this mite species ($p > 0.05$). The highest difference in the frequency of *G. longior*, but statistically not significant, was found between the nests of *P. domesticus* and *Turdus* spp. ($\chi^2 = 3.5, p = 0.054$).

In nests of domestic sparrows, the species *H. chelidonis* was significantly more abundant (per nest) than *G. longior* and *D. pteronyssinus* (Student's *t*-test; t = 2.29 and 2.31, respectively; $p < 0.05$), whereas in comparison with *D. evansi* this difference was nonsignificant (t = 2.04, $p = 0.065$). Moreover, no significant differences in abundance (number of mites per nest) were found between *D. evansi, G. longior* and *D. pteronyssinus* in the examined nests of domestic sparrows ($p > 0.1$ in all cases). Also in nests of barn swallows *H. chelidonis* was significantly more numerous than *D. evansi* and *G. longior* (t = 2.86 and 2.89, respectively; $p = 0.02$), whereas the difference in abundance between both latter species was not significant (t = 1.35, $p = 0.213$). In brood-shelters of titmice only nonsignificant differences were found in the abundance (per nest) between *D. evansi*, *G. longior* and *D. farinae* (Student's *t*-test; $p = 0.35 - 0.51$). Also in the examined nests of warbles *D. evansi* was only nonsignificantly more abundant than *H. chelidonis* (t = 0.64, $p = 0.54$), whereas in the nests of thrushes, *H. chelidonis* was nonsignificantly more abundant than *G. longior* (t = 1.19, $p = 0.26$).

Table 33

Statistical analysis of the differences between numbers of particular pyroglyphid mite species and the total number of mites (or the total number of Pyroglyphidae) found in the examined nests of main species of birds (results of the Student's *t*-test).

Bird and Mite Taxa		Total Pyroglyphidae	Total mites
Passer domesticus	*Hirstia chelidonis*	1.69	1.70
	Dermatophagides evansi	2.32*	2.27*
	Gymnoglyphus longior	2.33*	2.43*
	Dermatophagoides pteronyssinus	2.34*	2.43*
	Total Pyroglyphidae	–	1.49
Hirundo rustica	*Hirstia chelidonis*	0.75	2.25
	Dermatophagides evansi	2.31*	3.36**
	Gymnoglyphus longior	2.31*	3.35**
	Total Pyroglyphidae	–	1.45
Delichon urbica	*Hirstia chelidonis*	–	1.45
	Total Pyroglyphidae	–	1.45
Sylvia sp.	*Hirstia chelidonis*	1.00	1.81
	Dermatophagides evansi	1.39	1.73
	Total Pyroglyphidae	–	1.69
Turdus spp.	*Hirstia chelidonis*	1.00	3.07**
	Gymnoglyphus longior	1.19	3.31**
	Total Pyroglyphidae	–	3.06**
Parus spp.	*Dermatophagides evansi*	1.97	2.01
	Dermatophagoides farinae	1.06	2.37*
	Gymnoglyphus longior	1.04	2.42*
	Total Pyroglyphidae	–	2.00

Key: * $p < 0.05$; ** $p \leq 0.01$.

Generally, it should be stressed that the difference between numbers of total mites and numbers of the Pyroglyphidae found in the total count of the examined nests, was statistically significant (Student's *t*-test; $t = 4.04$, $p < 0.0005$). Considering the total of birds' nests and particular species of pyroglyphid mites, *H. chelidonis* was significantly more abundant (per nest) than the remaining species of the family (Student's *t*-test; $p < 0.05$). *D. evansi* was significantly more abundant than *G. longior* ($t = 2.33$, $p < 0.05$), whereas the latter species was significantly more numerous than *D. pteronyssinus* ($t = 2.02$, $p < 0.05$). Other differences were statistically nonsignificant (Student's *t*-test; $p > 0.05$).

Pyroglyphid mites associated with small mammals

Among pyroglyphid mites, only 2 females of *E. maynei* were found in the nest of *Mus musculus* located in the poultry house (Zamość vicinity) [Tab. 25].

Population ecology of pyroglyphid house dust mites

Mite fauna in the examined flat in Sosnowiec

1. Overall results

The overall results obtained are presented in Tables 34-36. Of a total of 94 dust samples examined, 43 (45.7%) were positive for mites [Tab. 34]. The mites occurred most frequently in samples from arm-chairs (80% of these samples) and from the couch (56.8%), while they were less frequent in samples from the carpet (only 16.2% of samples were mite positive). A total of 230 mite specimens were collected in the examined flat, of which 61.3% was found in samples from the couch, 30% in samples from arm-chairs and only 8.7% in samples from the carpet. Mean relative humidity and temperature in the examined flat during 3 years of the study are presented in Table 36.

Mean weights of samples were 0.197, 0.101 and 0.145 gram for samples from the examined couch, carpet and arm-chairs, respectively.

Table 34

Species list, dominance and frequency of mites found in the examined flat in Sosnowiec (Upper Silesia, Poland)

Mite taxa	Dominance		Frequency		
	N	%	n	%[1]	%[2]
Dermatohagoides farinae	220	95.65	43	45.74	100.0
D. pteronyssinus	5	0.2	3	3.19	6.98
Euroglyphus maynei	1	0.43	1	1.06	2.33
Caloglyphus sp.	1	0.43	1	1.06	2.33
Thyreophagus sp.	1	0.43	1	1.06	2.33
Gohieria fusca	1	0.43	1	1.06	2.33
Actinedida unidentified	1	0.43	1	1.06	2.33
Total mites	230	100.0	43	45.74	100.0
Diversity (SID) = 0.0783					

Key: [1]in relation to total of samples examined; [2]in relation to samples positive for mites; N = number of specimens; n = number of samples positive; SID = Simpson's index of diversity.

Table 35

Mean numbers of mites (per gram of dust) and mean levels of the Acarex test in the total samples from particular sites in the examined flat in Sosnowiec (Upper Silesia, Poland)

Sites examined	Mites/Acarex	n	Mean	Median	S D	S E	Range
Couch	*Dermatophagoides farinae*	21	40.22	11.89	71.09	11.85	0.00 – 350.00
	Dermatophagoides pteronyssinus	1	0.83	0.00	5.00	0.83	0.00 – 30.00
	Euroglyphus maynei	1	0.35	0.00	2.08	0.35	0.00 – 12.50
	House dust mites (total)	21	41.40	11.89	73.06	12.18	0.00 – 362.50
	Intact (alive) *D. farinae*	6	4.90	0.00	17.44	2.91	0.00 – 100.00
	Intact (alive) house dust mites	7	5.21	0.00	17.45	2.91	0.00 – 100.00
	Acarex test steps	37[1]	0.22	0.75	1.45	0.24	-2.00 – 2.50
Carpet	*Dermatophagoides farinae*	6	3.23	0.00	11.54	1.90	0.00 – 66.67
	Dermatophagoides pteronyssinus	1	0.25	0.00	1.49	0.24	0.00 – 9.09
	House dust mites (total)	6	3.48	0.00	11.76	1.93	0.00 – 66.67
	Intact (alive) *D. farinae*	1	0.30	0.00	1.83	0.30	0.00 – 11.11
	Intact (alive) house dust mites	2	0.55	0.00	2.33	0.38	0.00 – 11.11
	Acarex test steps	37[1]	-1.03	-2.00	1.50	0.25	-3.00 – 1.50
Arm-chairs	*Dermatophagoides farinae*	16	42.13	23.30	54.61	12.21	0.00 – 200.01
	Dermatophagoides pteronyssinus	1	0.38	0.00	1.72	0.38	0.00 – 7.69
	House dust mites (total)	16	42.62	25.11	54.42	12.17	0.00 – 200.01
	Intact (alive) *D. farinae*	7	8.17	0.00	14.79	3.31	0.00 – 50.00
	Intact (alive) house dust mites	7	8.17	0.00	14.79	3.31	0.00 – 50.00
	Acarex test steps	20[1]	0.025	0.50	1.36	0.30	-2.50 – 1.50

Key: n = number of positive samples; S D = standard deviation; S E = standard error; [1]number of samples examined.

2. Species diversity

The species composition of domestic acarofauna in dust samples from the examined flat is listed in Table 34. Three species of pyroglyphid mites (*D. farinae, D. pteronyssinus* and *E. maynei*) were found in this flat during the study [Tables 34 and 35; Figs 7-10]. *D. farinae* was dominant (95.65% of the total count) and was found in 21, 6 and 16 samples from the couch (56.8% of samples from the couch), the carpet (16.2%) and the arm-chairs (80.0%) examined, respectively [Tables 34 and 35]; it was generally found in 45.7% of all samples examined from this flat [Tab. 34]. SIMPSON's index of diversity was highest in the carpet (D = 0.185), and was markedly lower in the couch (D = 0.08) and in the arm-chairs (D = 0.06).

Table 36

Mean values of relative humidity and temperature in the examined flat in Sosnowiec during period of the study

Calculated from:	Mean ± SD	
	Relative humidity (%RH)	Temperature (°C)
Daily measurements [n = 2902]	64.58 ± 13.98	20.78 ± 1.30
Weekly measurements [n = 156]	53.01 ± 19.60	22.20 ± 1.52
Monthly measurements [n = 37]	56.62 ± 19.75	22.24 ± 1.30

Key: SD = standard deviation; n = number of measurements.

3. Annual and seasonal changes in the mite density

Figures 4 and 7-10 present seasonal changes in pyroglyphid mite abundance in the places examined. Fluctuations of densities of the total house dust mites, live house dust mites and total domestic mites (per gram of dust) in the examined couch are illustrated on Fig. 8. Generally, in the couch and arm-chairs the increase of mite density (calculated per 1 g of dust) from August – December, and its peak in October and November or November and December, was observed during all years of investigations, except that:

– in the couch during the third year of the study, the peak of mite density was stated also in June, and the peak during the last autumn/winter season was observed slightly later than mentioned above, namely in January/February 2000 [Figs 7, 8].

– in the arm-chairs, the second peak of mite density was observed in June/July of the first year of examinations, and in February during the second year [Fig. 10];

In the carpet, mites were found only in October of the second year of the study, in January, March, June and October of the third year, and in January 2000, with the peak of mite density in June of the third year [Fig. 9].

Analysing the data on mite density fluctuations stated in this study, it may be concluded that the highest peak of mite abundance and mite exposure in the couch exists in the autumn and winter seasons, in the arm-chairs mainly in autumn and sometimes in spring and summer, whereas in the carpet mainly in the spring season [Figs 4, 7-10].

The LEVENE test of homogeneity of variances showed significant effects of the month on fluctuations of numbers per gram of dust of *D. pteronyssinus, E. maynei*, live *D. farinae* and the total live pyroglyphids ($p < 0.0005$, $p < 0.01$, $p < 0.001$ and $p < 0.001$, respectively).

On the other hand, the month had nonsignificant effects on numbers of *D. farinae* and *D. pteronyssinus* per gram of dust in samples from the couch (MANOVA; $p = 0.98$ and 0.84, respectively).

Effects of month on fluctuations of densities (per gram of dust) of *D. farinae*, total pyroglyphids and total domestic mites were significant only in relation to the samples from arm-chairs (One-way ANOVA, $p < 0.0005$ in all cases).

The difference between numbers of *D. farinae* and *D. pteronyssinus* per gram of dust was significant for all places examined (Student's *t*-test, $p < 0.005$). Also the difference between numbers of *D. farinae* and *E. maynei* per gram of dust was significant for the couch examined (*t*-test, $p < 0.005$), whereas differences in numbers of mites per gram of dust were not significant between *D. farinae* and the total house dust mites for all places examined (*t*-test, $p > 0.1$), and also between *D. pteronysinus* and *E.maynei* for samples from the couch, (*t*-test, $p > 0.5$).

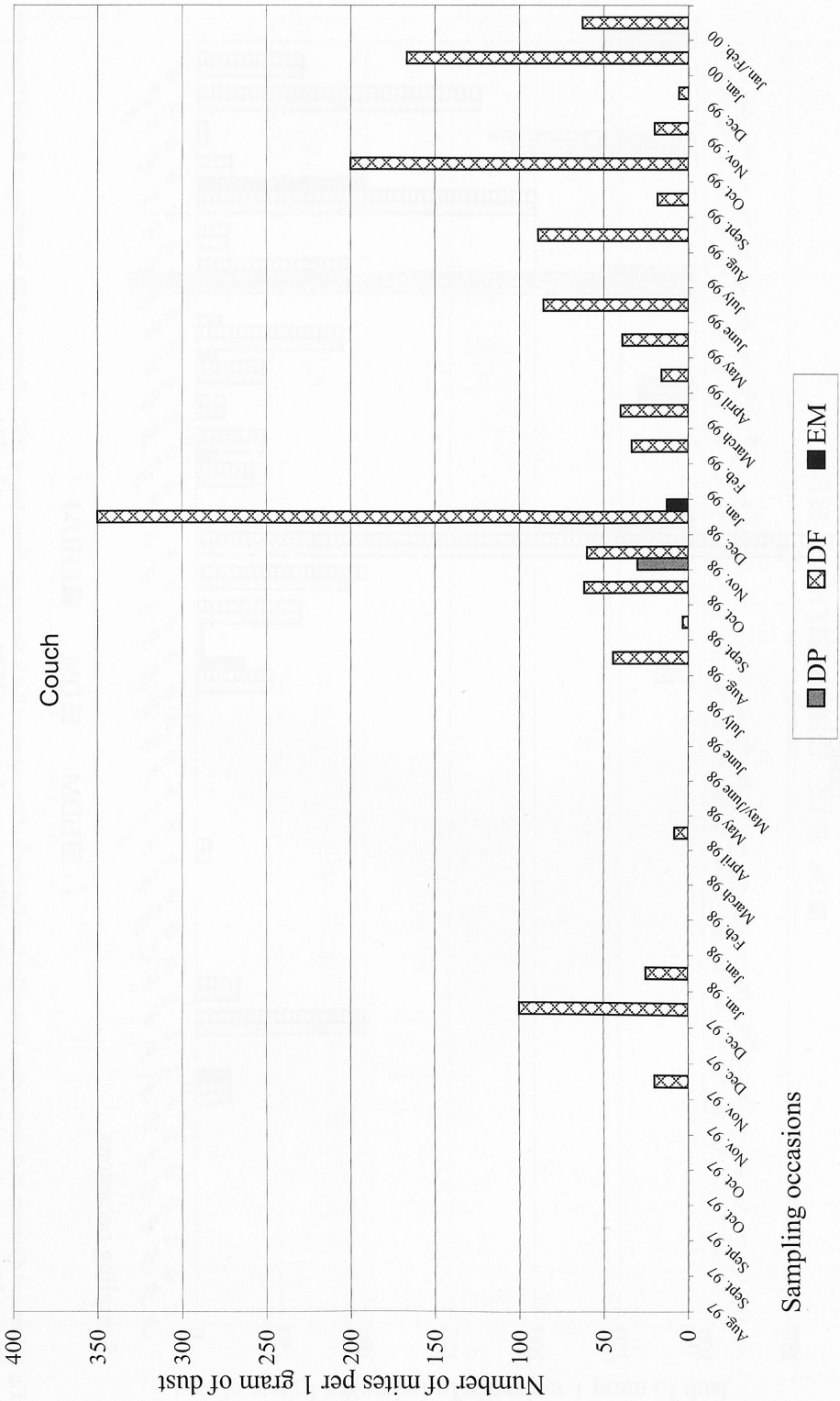

Fig. 7. Seasonal dynamics of house dust mites in samples from the couch, from August 1997 – February 2000, in relation to individual species of pyroglyphid mites. Key: DP – *Dermatophagoides pteronyssinus*, DF – *D. farinae*, EM – *Euroglyphus maynei*.

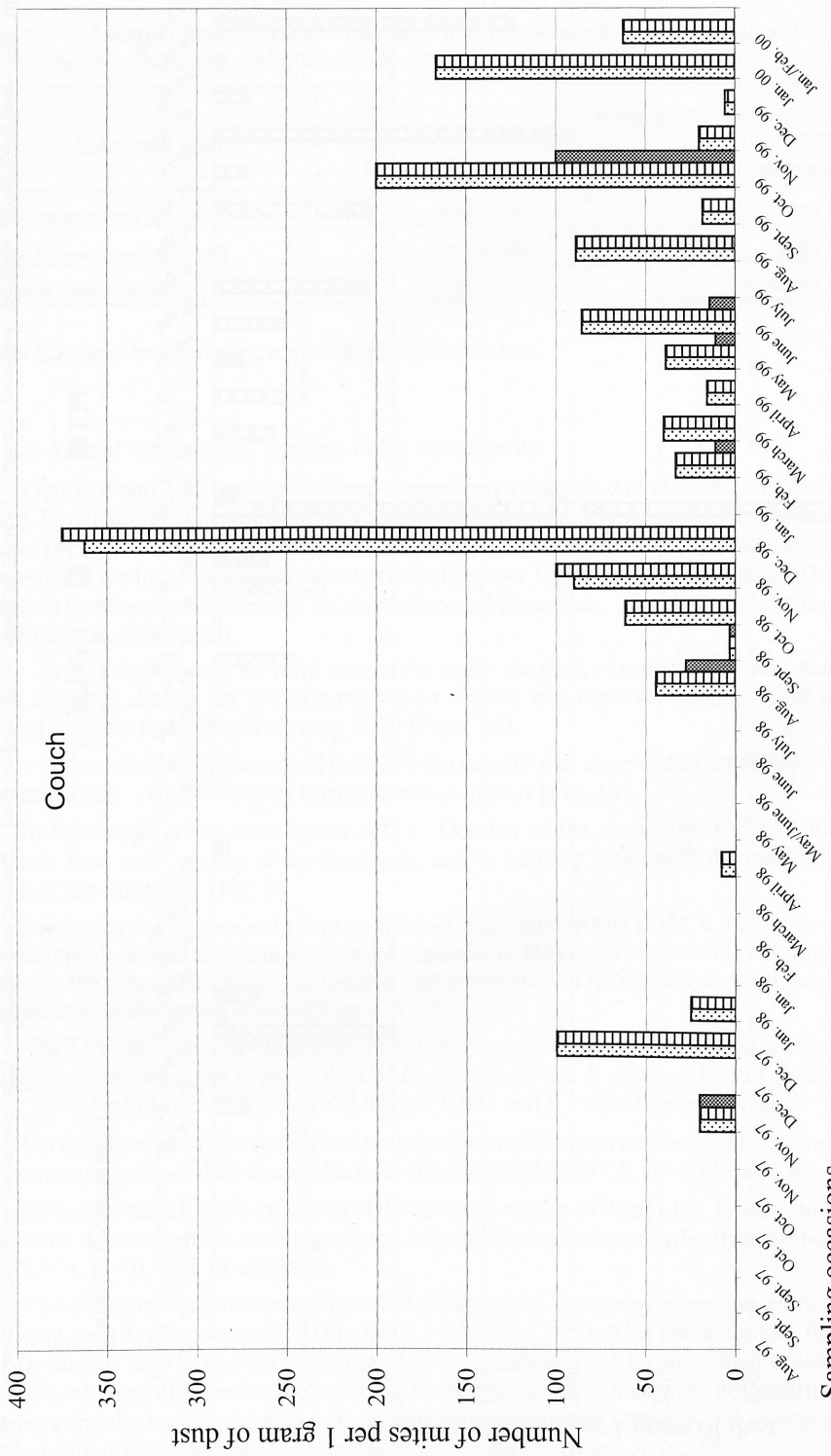

Fig. 8. Seasonal dynamics of domestic mites in samples from the couch of the examined flat in Sosnowiec, from August 1997 – February 2000, in relation to the total house dust mites, live house dust mites and total domestic mites. Key: HDM – house dust mites, LHDM – live house dust mites, DM – domestic mites.

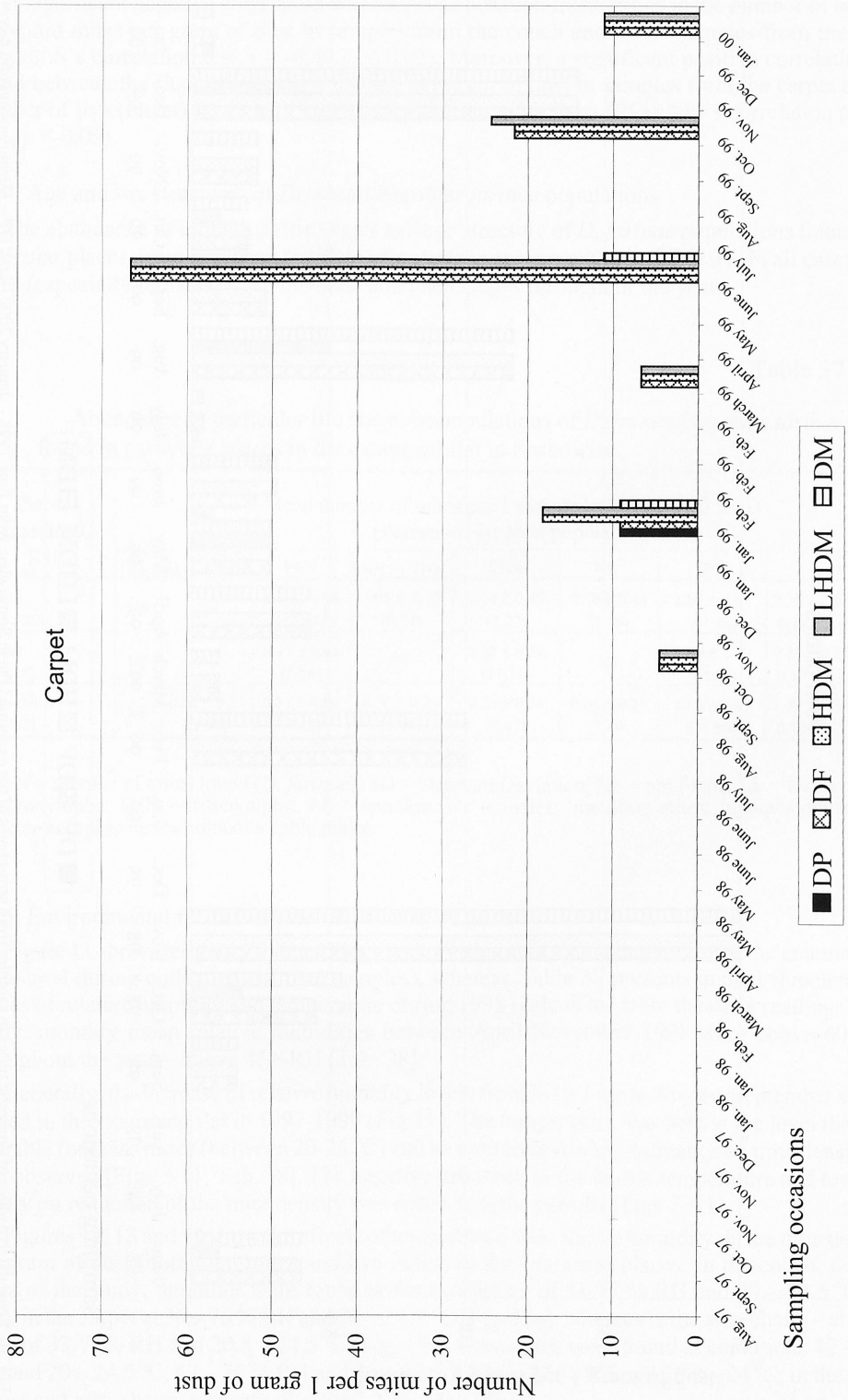

Fig. 9. Seasonal dynamics of domestic mites in samples from the carpet of the examined flat in Sosnowiec, from December 1997 – January 2000. Key: DP – *Dermatophagoides pteronyssinus*, DF – *D. farinae*, HDM – house dust mites, LHDM – live house dust mites, DM – domestic mites.

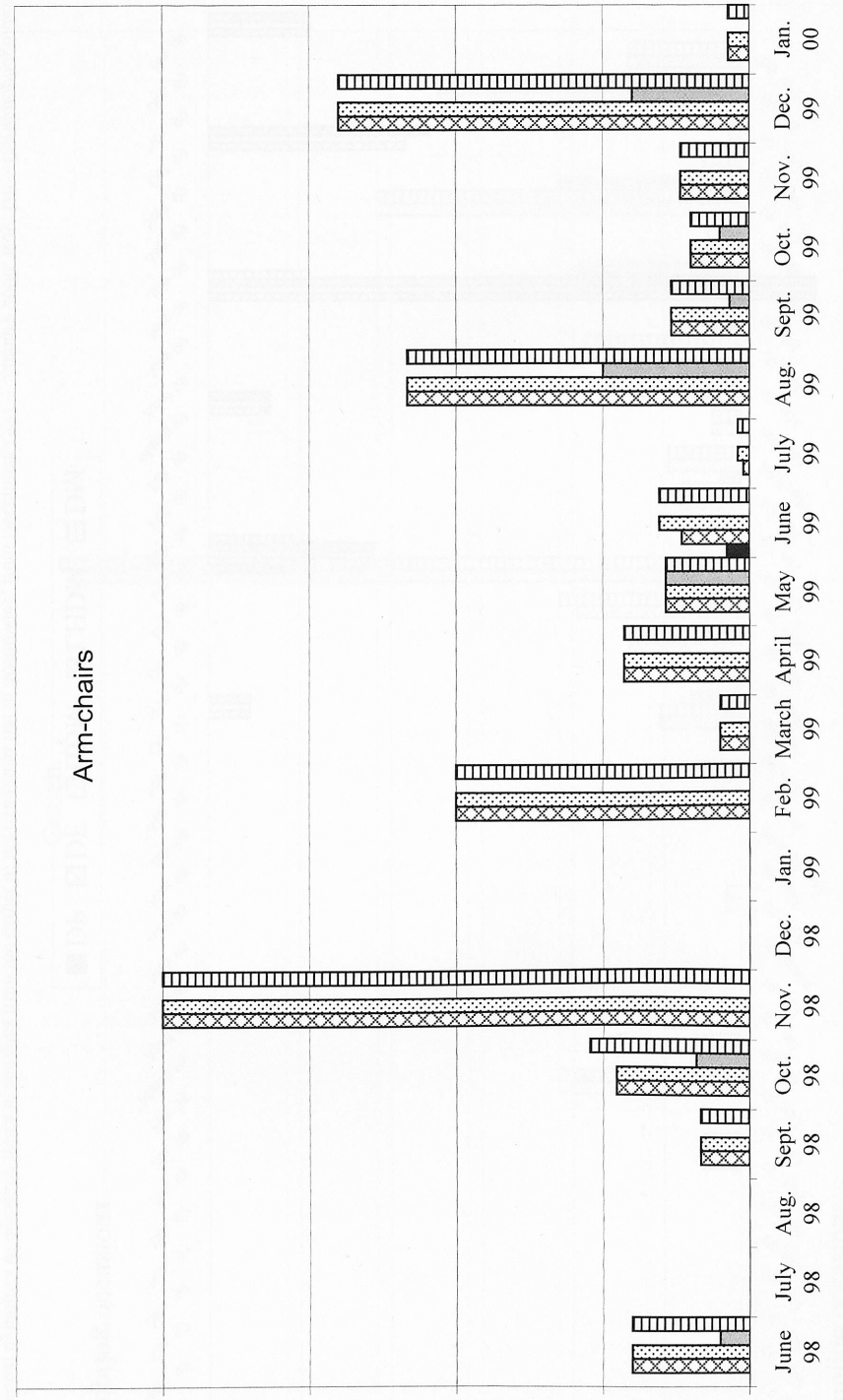

Fig. 10. Seasonal dynamics of domestic mites in samples from arm-chairs of the examined flat in Sosnowiec, from June 1998 – January 2000. Key: DP – *Dermatophagoides pteronyssinus*, DF – *D. farinae*, HDM – house dust mites, LHDM – live house dust mites, DM – domestic mites.

A significant negative correlation was observed between fluctuations in the number of total pyroglyphid mites per gram of dust in samples from the couch and in the samples from the carpet (PEARSON's correlation test; $r = -0.49$, $p < 0.05$). Moreover, a significant positive correlation was found between the fluctuations of *D. farinae* per gram of dust in samples from the carpet and the number of live (intact) *D. farinae* in the samples from arm-chairs (PEARSON's correlation test; $r = 0.51$, $p < 0.05$).

4. Age and sex structures of *Dermatophagoides farinae* populations

The abundance of individual life stages and age structure of *D. farinae* populations found in the particular places examined from the flat in Sosnowiec are presented in Table 37. In all cases, adult mites (especially females) were the most abundant stages throughout the year.

Table 37

Abundance of particular life stages in populations of *Dermatophagoides farinae* found in particular places in the examined flat in Sosnowiec.

Places examined [N]	Mean number of mites per 1 sample (mite positive) ± SD (Percent of the total population)							
	LL	LL → PNN[1]	PNN	PNN → TNN[1]	TNN	NN[2]	♀♀	♂♂
Couch [N = 135]	NF	NF	0.71± 0.90 (11.11)	0.05 ± 0.22 (0.74)	0.14 ± 0.48 (2.22)	0.10 ± 0.44 (1.48)	2.67 ± 3.61 (41.48)	2.38 ± 2.67 (37.04) 0.38 ± 0.67 (5.93)
Carpet [N = 18]	NF	NF	0.17 ± 0.41 (5.56)	NF	0.33 ± 0.52 (11.11)	NF	2.00 ± 2.76 (66.66)	0.33 ± 0.82 (11.11) 0.17 ± 0.41 (5.56)
Arm-chairs [N = 67]	NF	0.06 ± 0.25 (1.49)	0.31 ± 0.60 (7.46)	0.06 ± 0.25 (1.49)	0.25 ± 0.58 (5.97)	0.06 ± 0.25 (1.49)	1.69 ± 1.49 (41.80)	1.50 ± 1.63 (35.82) 0.19 ± 0.54 (4.48)

Key: N = number of mites found (*D. farinae*); SD = Standard Deviation; NF = not found; LL = larvae; PNN = protonymphs; TNN = tritonymphs; ♀♀ = females; ♂♂ = males; [1]moulting mites; [2]nymphs unidentified; [3]heteromorphic males/homeomorphic males.

5. Environmental factors influencing density of mites

Figure 11 shows temporal fluctuations of relative humidity and temperature in the examined flat (measured during collections of dust samples), whereas Table 38 presents annual fluctuations of values of relative humidity and temperature during 1998 (calculated from the daily readings). Generally, monthly mean relative humidities between April-November 1998 were above 60% and throughout the year – above 45%RH [Tab. 38].

Generally, the increase of relative humidity levels from May/June to August/September was observed in the examined flat in 1997-1999 (Fig.11). The temperature was held at the level that is favourable for these mites (between 20-25 °C) and its indirectly marked influence on mite density was also observed [Figs 7-11; Tab. 38]. The negative influence of the higher temperature and lower humidity on reduction of the mite density was noted in some periods [Figs 7–11].

Figures 12, 13 and 14 show the effects of temperature and relative humidity on the mite densities per gram of dust (both total mites and live mites) in the examined places. In the couch, during 3 years of the study, the mites were found under conditions of 31-77 % RH and 20 – 24.5 °C [Fig. 12a], in the carpet at 36 – 76 % RH and 20 – 24.5 °C [Fig. 13a], whereas in the arm-chairs – at conditions of 33-77% RH and 20.8 – 24.5 °C [Fig. 14a]. Live mites were found at conditions 42 – 76 % RH and 20 – 24.5 °C, 42 – 76 % RH and 20 – 24.5 °C, 36 – 77 % RH and 20.8 – 24 °C, in the couch, carpet and arm-chairs, respectively [Figs. 12b, 13b, 14b].

Table 38

Annual fluctuations of mean relative humidity and temperature in the examined flat in Sosnowiec during 1998 (daily measurements)

Months	Number of measurements	Mean value (± SD)	
		Relative humidity (%RH)	Temperature (°C)
January	105	53.80 ± 6.27	20.45 ± 0.78
February	72	52.95 ± 5.36	20.30 ± 0.72
March	132	56.58 ± 3.97	20.54 ± 0.52
April	84	62.95 ± 7.08	21.32 ± 2.27
May	94	73.05 ± 4.43	21.32 ± 2.55
June	82	76.58 ± 5.29	20.18 ± 1.00
July	62	65.05 ± 4.94	23.16 ± 0.80
August	329	74.58 ± 11.53	21.70 ± 1.48
September	669	77.84 ± 8.53	19.89± 0.94
October	806	68.51± 8.43	21.15 ± 0.72
November	305	61.50 ± 5.12	20.64 ± 0.50
December	162	55.86 ± 4.78	19.91 ± 1.04

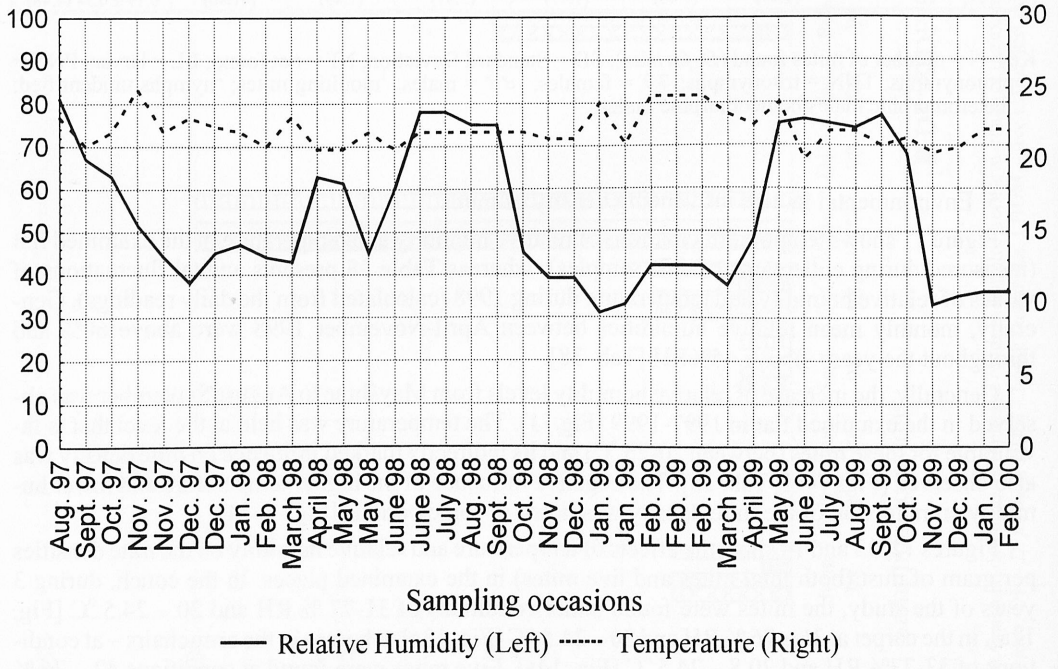

Fig. 11. Temporal fluctuations of relative humidity and temperature in the examined flat (measured during all collections of dust samples).

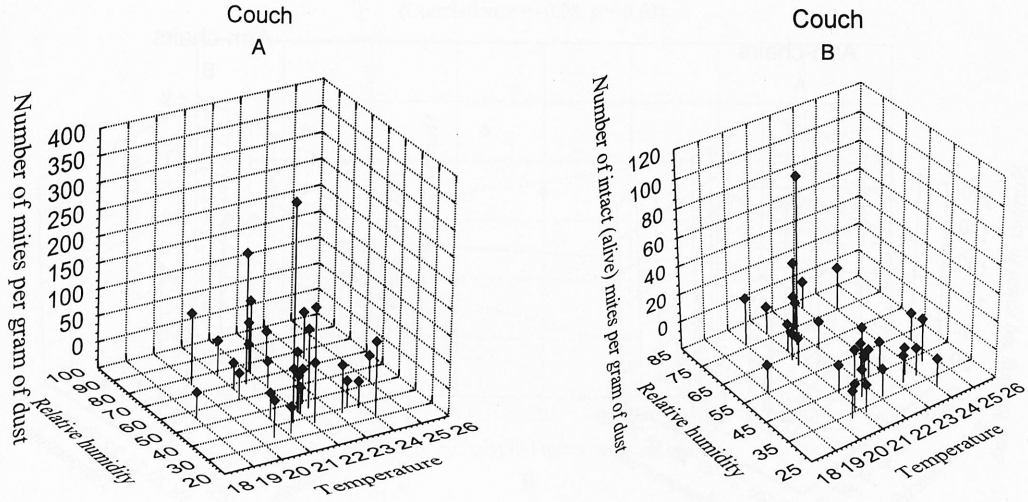

Fig. 12. Influence of relative humidity and temperature on abundance of house dust mites in samples from the couch of the examined flat in Sosnowiec (August 1997 – February 2000), in relation to the total house dust mites (A) and live house dust mites (B).

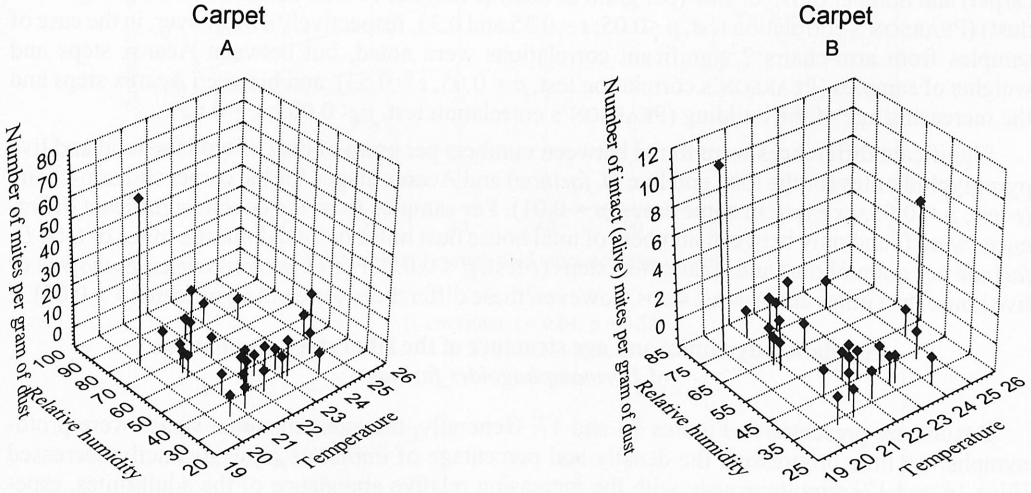

Fig. 13. Influence of relative humidity and temperature on abundance of house dust mites in samples from the carpet of the examined flat in Sosnowiec (August 1997 – February 2000), in relation to the total house dust mites (A) and live house dust mites (B).

6. Guanine levels

Annual fluctuations of levels of mite allergens in samples of dust from the examined flat in Sosnowiec are presented in Table 6. Figure 15 shows the correlation between the number of dust mites per gram of dust and Acarex test stages (guanine levels) in all places examined. This correlation was statistically significant only in the case of the examined carpet (PEARSON's correlation test; $p < 0.05$) [Fig. 15b]. Significant correlations were also found between Acarex test steps (in samples from the

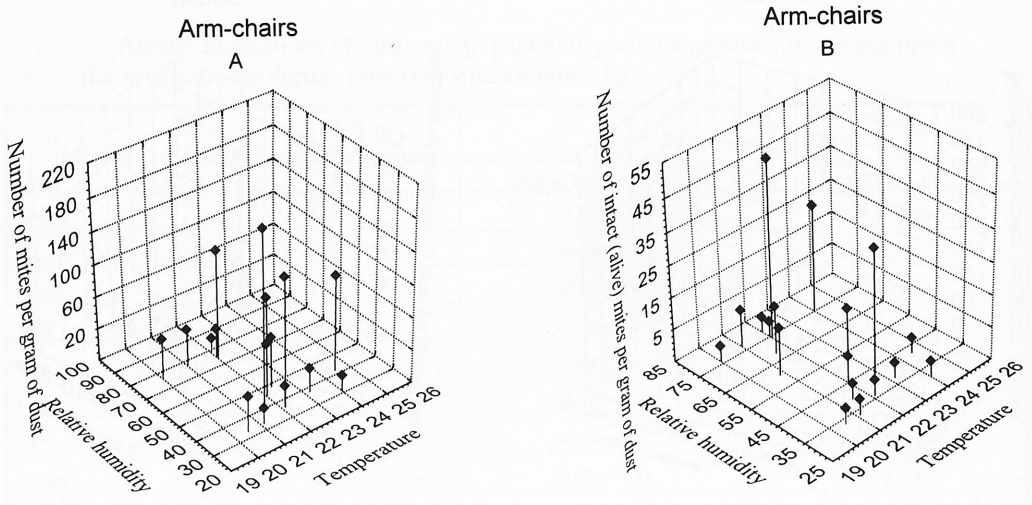

Fig. 14. Influence of relative humidity and temperature on abundance of house dust mites in samples from arm-chairs of the examined flat in Sosnowiec (August 1997 – February 2000), in relation to the total house dust mites (A) and live house dust mites (B).

carpet) and number of *D. farinae* (per gram of dust) or number of total domestic mites (per gram of dust) (PEARSON's correlation test, $p < 0.05$; r = 0.35 and 0.33, respectively). Moreover, in the case of samples from arm-chairs 2 significant correlations were noted, but between Acarex steps and weights of samples (PEARSON's correlation test, $p < 0.05$; r = 0.53), and between Acarex steps and the increasing age of the building (PEARSON's correlation test, $p < 0.005$; r = 0.63).

Significant differences were found between numbers per gram of dust of both the total and live pyroglyphid mites (or the total and live *D. farinae*) and Acarex stages for the carpet and arm-chairs (*t*-test, $p < 0.05$, or even, in some cases, $p < 0.01$). For samples from the couch, significant differences were found only between numbers of total house dust mites or total domestic mites or total *D. farinae* per gram of dust and Acarex test steps (*t*-test, $p < 0.05$). For *D. pteronyssinus, E. maynei* or live house dust mites and Acarex steps, however, these differences were not significant ($p > 0.05$).

Population dynamics and age structure of the laboratory populations of *Dermatophagoides farinae*

Results are presented in Figures 16 and 17. Generally, the most abundant stages were protonymphs. As time progressed, the density and percentage of immature mites distinctly decreased [Figs 16 and 17] simultaneously with the increasing relative abundance of the adult mites, especially females [Fig. 17]. Thus, the research has revealed temporal dynamics of an age structure of the laboratory population *D. farinae* which, however, was held in optimal conditions of relative humidity and temperature (98a).

Multiple regression analysis demonstrate significant partial correlation only between the incubation time (in months or in days) and changes of the mean relative dominance of larvae (R = 0.997, $p = 0.05$) and between the incubation time (in days) and changes in the mean number of homeomorphic males per gram of the culture medium (R = 0.998, $p < 0.05$).

Significant differences were found (*t*-test) between the incubation time in days and changes in the mean relative dominance (percent of the total population) for tritonymphs, females, heteromorphic and homeomorphic males (in all cases $p < 0.05$), between the incubation time in months and changes in the mean relative dominance for larvae ($p < 0.005$) and tritonymphs ($p < 0.001$), and in

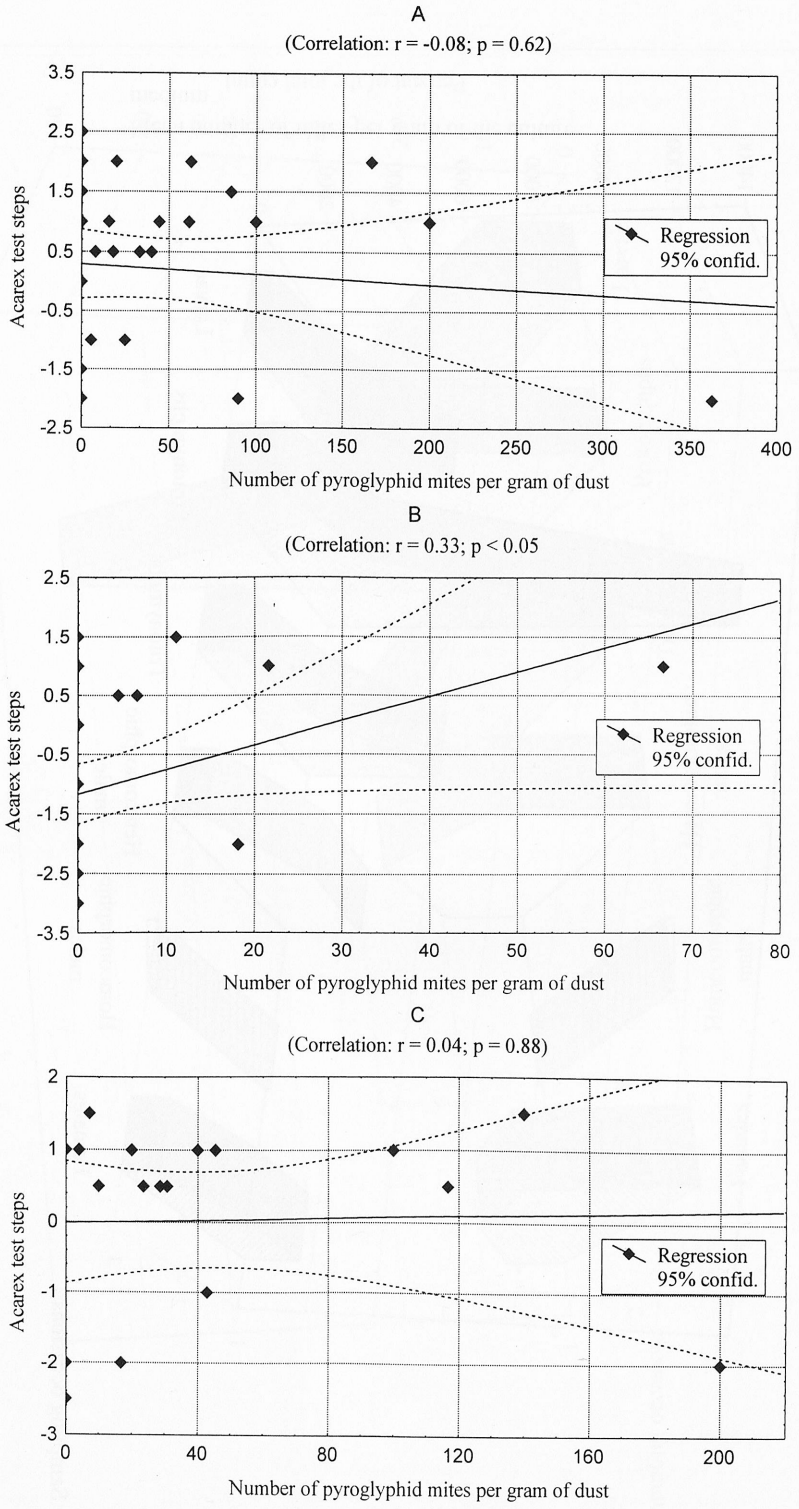

Fig. 15. Correlation between number of dust mites per gram of dust and Acarex test steps (guanine levels) in all places sampled from the examined flat in Sosnowiec. Key: (A) couch, (B) carpet, (C) arm-chairs.

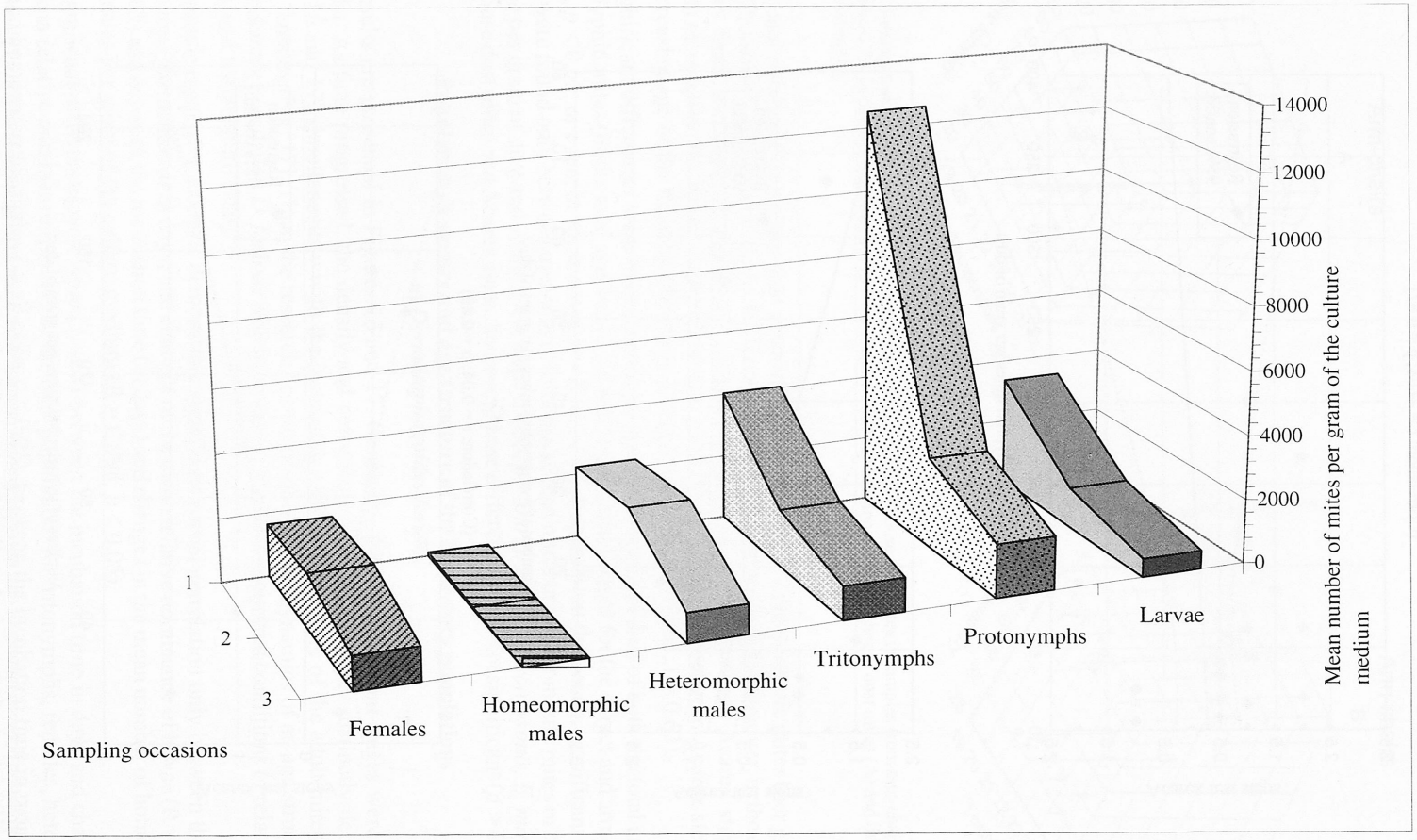

Fig. 16. Temporal changes in age structure in the laboratory population of *Dermatophagoides farinae* expressed as the mean number of mites of the individual life stage per gram of the culture medium.

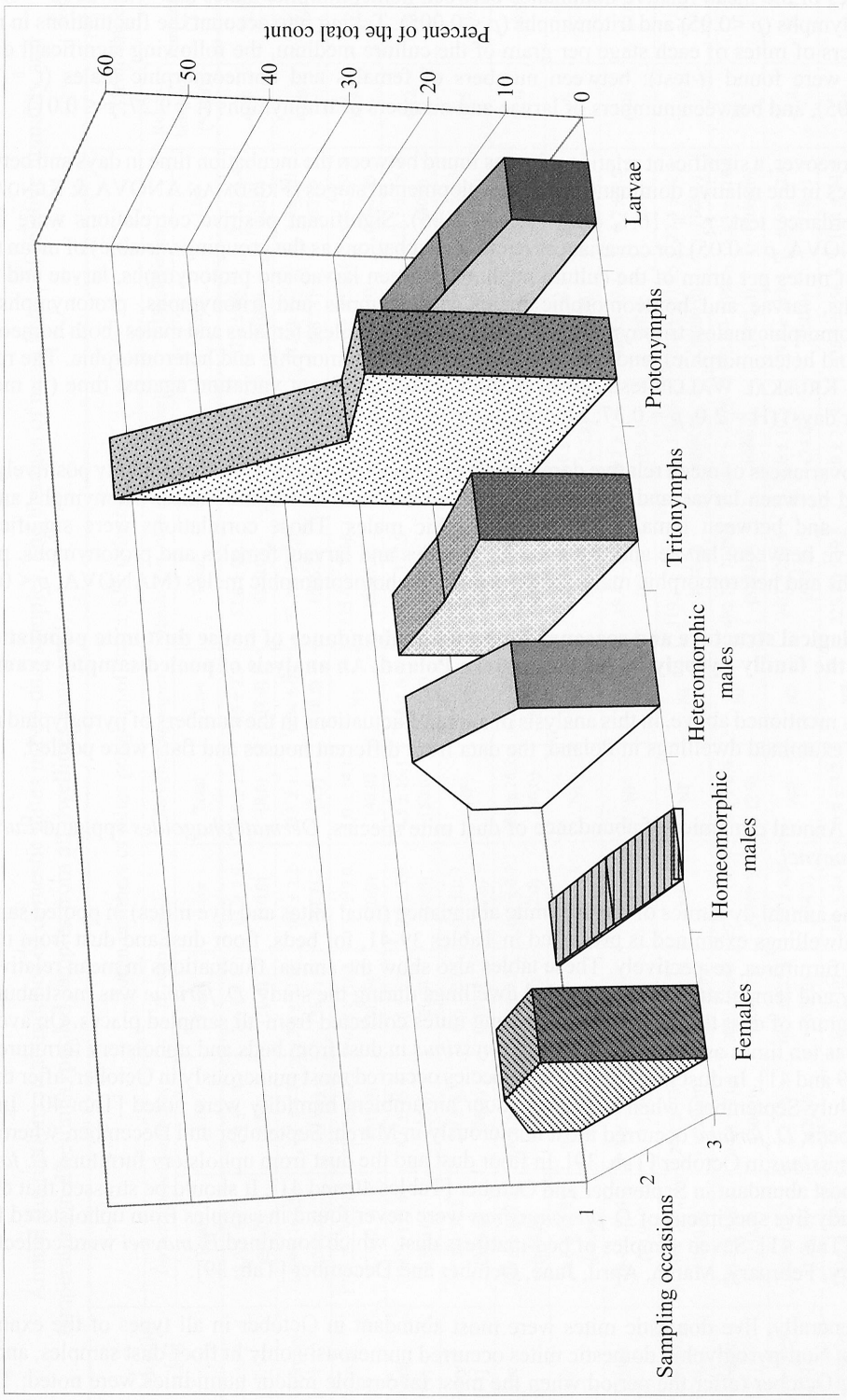

Fig. 17. Temporal changes of the relative dominance of individual life stages (expressed as the percentage of the total population) in the laboratory population of *Dermatophagoides farinae*.

changes of the mean relative dominance between homeomorphic males and – larvae ($p < 0.005$), protonymphs ($p < 0.05$) and tritonymphs ($p < 0.005$). Taking into account the fluctuations in mean numbers of mites of each stage per gram of the culture medium, the following significant differences were found (*t*-test): between numbers of females and homeomorphic males ($t = 7.36$; $p < 0.05$), and between numbers of larvae and numbers of tritonymphs ($t = 9.27$; $p \leq 0.01$).

Moreover, a significant relationship was found between the incubation time in days and between changes in the relative dominance of all developmental stages (FRIEDMAN ANOVA & KENDALL's Concordance test, $\chi^2 = 16.1$, d.f. = 6, $p < 0.05$). Significant positive correlations were found (MANOVA, $p < 0.05$) for covariances (time of incubations as the grouping variable) of mean numbers of mites per gram of the culture medium between larvae and protonymphs, larvae and tritonymphs, larvae and homeomorphic males, protonymphs and tritonymphs, protonymphs and homeomorphic males, tritonymphs and homeomorphic males, females and males (both homeomorphic and heteromorphic), and between both males homeomorphic and heteromorphic. The results of the KRUSKAL WALLIS test, however show a nonsignificant variation against time (in months and/or days) ($H = 2.0$, $p = 0.37$; Median test $\chi^2 = 3.0$, $p = 0.22$).

Covariances of mean relative dominances of individual instars were significantly positively correlated between larvae and protonymphs, larvae and homeomorphic males, tritonymphs and females, and between females and heteromorphic males. Those correlations were significantly negative between: larvae and tritonymphs, females and larvae, females and protonymphs, protonymphs and heteromorphic males, tritonymphs and homeomorphic males (MANOVA, $p < 0.05$).

Ecological structure and seasonal dynamics of abundance of house dust mite populations from the family Pyroglyphidae in southern Poland. An analysis of pooled samples examined

As mentioned above, in this analysis of annual fluctuations in the numbers of pyroglyphid mites in the examined dwellings in Poland, the data from different houses and flats were pooled.

1. Annual dynamics of abundance of dust mite species, *Dermatophagoides* spp. and *Euroglyphus maynei*.

The annual dynamics of the dust mite abundance (total mites and live mites) in pooled samples from dwellings examined is presented in Tables 39-41, for beds, floor dust and dust from upholstered furnitures, respectively. These tables also show the annual fluctuations in mean relative humidity and temperature in the sampled dwellings during the study. *D. farinae* was most abundant per 1 gram of dust throughout a year among mites collected from all sampled places. On average, this was ten times as abundant as *D. pteronyssinus* in dust from beds and upholstery furniture [Tables 39 and 41]. In dust from floors both species occurred most numerously in October, after the period (July-September) when peaks of indoor air ambient humidity were noted [Tab. 40]. In dust from beds, *D. farinae* occurred most numerously in March, September and December, whereas *D. pteronyssinus* in October [Tab. 39]. In floor dust and the dust from upholstery furniture, *D. farinae* was most abundant in September and October [Tables 40 and 41]. It should be stressed that during the study live specimens of *D. pteronyssinus* were never found in samples from upholstered furnitures [Tab. 41]. Seven samples of bed-mattress dust, which contained *E. maynei* were collected in January, February, March, April, June, October and December [Tab. 39].

Generally, live domestic mites were most abundant in October in all types of the examined places. Non-pyroglyphid domestic mites occurred numerously only in floor dust samples, and also during October (after the period when the most favourable indoor humidities were noted; Tables 39–41).

Table 39

Annual fluctuations in abundance of domestic mites in bed-dust samples, and changes of mean levels of relative humidity and temperature in dwellings (pooled samples from all dwellings examined)

Months [n]	Mean numbers of mites per gram of dust ± SD (Maximum)										Mean value	
	Dermatophagoides farinae		*D. pteronyssinus*		*Euroglyphus maynei*		House dust mites (Pyroglyphidae)		Domestic mites[1]		Relative humidity (%RH)	Temperature (°C)
	Total	Live	Total	Live	Total	Live	Total	Live	Total	Live		
January [13]	48.0 ± 81.1 (270.0)	1.4 ± 3.4 (10.0)	2.6 ± 8.3 (30.0)	1.1 ± 2.9 (10.0)	0.6 ± 2.2 (8.0)	0.6 ± 2.2 (8.0)	52.0 ± 90.1 (310.0)	3.1± 6.3 (20.0)	52.2 ± 90.1 (310.0)	3.1 ± 6.4 (20.0)	41.9	22.9
February [12]	66.9 ± 164.5 (580.2)	2.0 ± 4.7 (15.4)	3.8 ± 11.0 (38.5)	0.6 ± 2.2 (7.7)	0.3 ± 1.1 (3.9)	0.04 ± 0.1 (0.5)	71.1± 167.0 (586.2)	3.7 ± 7.3 (23.8)	71.3 ± 167.2 (587.1)	3.7± 7.1 (23.1)	41.8	22.2
March [8]	1758.2 ± 3259.4 (7942.9)	93.1 ± 262.5 (742.9)	61.8 ± 118.2 (342.9)	2.7 ± 7.0 (20.0)	5.0 ± 14.1 (40.0)	NF	1825.0 ± 3356.3 (8285.7)	95.9 ± 261.5 (742.9)	1840.5± 3384.0 (8342.9)	95.9 ± 261.5 (742.9)	38.8	23.3
April [11]	87.2 ± 159.4 (510.0)	8.6 ± 15.4 (50.0)	3.5 ± 6.7 (20.0)	0.9 ± 3.0 (10.0)	4.5 ± 15.1 (50.0)	1.8 ± 6.0 (20.0)	95.3 ± 177.5 (580.0)	11.3 ± 16.4 (50.0)	99.4 ± 180.9 (590.0)	12.5 ± 18.9 (60.0)	49.2	22.3
May [14]	21.8 ± 58.1 (220.0)	2.9 ± 8.3 (30.0)	0.6 ± 2.1 (7.9)	0.2 ± 0.7 (2.6)	NF	NF	22.4 ± 57.9 (220.0)	3.1± 8.3 (30.0)	22.4 ± 57.9 (220.0)	3.1± 8.3 (30.0)	63.5	21.1
June [9]	120.6 ± 279.9 (860.0)	66.8 ± 167.6 (510.0)	1.9 ± 3.9 (11.0)	0.2 ± 0.7 (2.0)	8.9 ± 26.7 (80.0)	4.7± 14.0 (42.0)	131.3 ± 277.9 (860.0)	71.7± 166.4 (510.0)	141.4 ± 304.1 (940.0)	77.0 ± 179.5 (550.0)	72.0	19.9
July [3]	15.8 ± 24.8 (44.4)	9.6 ± 15.8 (27.8)	NF	NF	NF	NF	15.8 ± 24.8 (44.4)	9.6 ± 15.8 (27.8)	15.8 ± 24.8 (44.4)	9.6 ± 15.8 (27.8)	72.5	22.0
August [5]	18.4 ± 39.4 (88.9)	0.7 ± 1.5 (3.3)	NF	NF	NF	NF	18.4 ± 39.4 (88.9)	0.7 ± 1.5 (3.3)	18.4 ± 39.4 (88.9)	0.7 ± 1.5 (3.3)	69.4	22.0
September [16]	312.0 ± 1002.9 (4040.0)	20.1 ± 53.1 (200.0)	0.9 ± 2.7 (10.0)	NF	NF	NF	319.2 ± 1003.5 (4040.0)	18.8 ± 51.6 (200.0)	323.8 ± 1013.5 (4080.0)	27.1 ± 42.5 (100.0)	77.0	21.0
October [27]	184.2 ± 618.3 (3233.3)	14.8 ± 31.0 (100.0)	307.8 ± 824.4 (3066.7)	57.6 ± 203.8 (1000.0)	0.1 ± 0.6 (2.9)	NF	492.1 ± 1028.8 (3233.3)	69.7 ± 210.9 (1066.6)	573.8 ± 1098.6 (3233.3)	82.3 ± 212.4 (1066.6)	70.8	18.2
November [17]	27.9 ± 68.2 (280.8)	2.3 ± 6.5 (20.0)	66.2 ± 155.3 (528.0)	2.7 ± 8.3 (34.0)	NF	NF	94.3 ± 201.6 (688.5)	5.0 ± 10.8 (34.0)	99.6 ± 213.4 (750.0)	6.5 ± 12.4 (38.5)	42.4	21.4
December [15]	200.6 ± 532.9 (2080.0)	NF	26.7 ± 103.3 (400.0)	8.9 ± 34.4 (133.3)	0.8 ± 3.2 (12.5)	NF	228.2 ± 539.5 (2080.0)	9.0 ± 34.4 (133.3)	235.5 ± 558.8 (2160.0)	10.1 ± 34.4 (133.3)	38.5	21.7

Key: [1]both pyroglyphid and non-pyroglyphid; n = number of samples; NF = not found.

Table 40

Annual fluctuations in abundance of domestic mites in floor-dust samples, and changes of mean levels of relative humidity and temperature in dwellings (pooled samples from all dwellings examined)

Months [n]	Mean numbers of mites per gram of dust ± SD (Maximum)								Mean value	
	Dermatophagoides farinae		*D. pteronyssinus*		House dust mites (Pyroglyphidae)		Domestic mites[1]		Relative humidity (%RH)	Temperature (°C)
	Total	Live	Total	Live	Total	Live	Total	Live		
January [11]	1.0 ± 3.4 (11.1)	NF	NF	NF	1.0 ± 3.4 (11.1)	NF	1.0 ± 3.4 (11.1)	NF	40.8	22.9
February [22]	2.9 ± 10.7 (50.0)	0.1 ± 0.5 (2.3)	1.2 ± 4.0 (16.7)	0.4 ± 1.9 (9.1)	4.1± 14.5 (66.7)	0.5 ± 2.0 (9.1)	4.8 ± 18.0 (83.3)	0.5± 2.0 (9.1)	41.5	22.3
March [23]	0.3 ± 1.4 (6.7)	NF	0.5± 2.6 (12.5)	NF	0.8 ± 2.9 (12.5)	NF	0.8 ± 2.9 (12.5)	NF	47.8	22.4
April [6]	NF	NF	NF	NF	NF	NF	NF	NF	48.4	22.4
May [8]	NF	NF	0.3 ± 0.8 (2.3)	NF	0.3 ± 0.8 (2.3)	NF	0.3 ± 0.8 (2.3)	NF	64.5	19.8
June [3]	22.2 ± 38.5 (66.7)	3.7 ± 6.4 (11.1)	0.3 ± 0.6 (1.0)	0.3 ± 0.6 (1.0)	22.6 ± 38.2 (66.7)	4.0 ± 6.1 (11.1)	22.6 ± 38.2 (66.7)	4.0 ± 6.1 (11.1)	68.1	20.4
July [4]	NF	NF	NF	NF	NF	NF	NF	NF	75.3	22.0
August [7]	0.1 ± 0.4 (1.0)	NF	NF	NF	0.1 ± 0.4 (1.0)	NF	1.1 ± 2.3 (6.0)	0.7 ± 1.3 (3.0)	74.5	22.0
September [5]	53.3 ± 73.0 (133.3)	NF	NF	NF	53.3 ± 73.0 (133.3)	NF	60.0 ± 83.0 (166.7)	6.7 ± 14.9 (33.3)	77.0	21.0
October [27]	41.5 ± 103.7 (400.0)	11.1 ± 35.8 (133.3)	46.6 ± 148.1 (742.9)	11.6 ± 43.6 (200.0)	88.1 ± 169.3 (742.9)	22.7 ± 54.0 (200.0)	677.0 ± 2863.7 (14971.4)	150.9 ± 569.7 (2971.4)	71.0	17.7
November [22]	3.0 ± 5.9 (25.0)	0.5 ± 1.8 (8.3)	0.7 ± 1.9 (5.9)	NF	3.8 ± 6.6[2] (25.0)	0.6 ± 1.8 (8.3)	4.5 ± 7.8 (25.0)	0.6 ± 1.8 (8.3)	42.4	21.3
December [7]	NF	NF	NF	NF	NF	NF	NF	NF	38.3	22.6

Key: [1]both pyroglyphid and non-pyroglyphid; [2] including *Dermatophagoides* spp. unidentified; n = number of samples; NF = not found.

The influence of month on annual fluctuations in densities of mites (per gram of dust) (assessed by the analysis of variance, one-way ANOVA) was significant for all types of the examined places ($F = 2.31$, 2.52 and 15.98; $p.05$, $p.01$ and $p.001$, for bed-dust samples, floor-dust samples and for samples from upholstery furnitures, respectively). Generally, mites (both pyroglyphid house dust mites and total domestic mites) were most abundant in March (in bed-dust samples) and in September/October (in all places examined) (Tab. 39-41).

Table 41

Annual fluctuations in abundance of domestic mites in dust samples from upholstery furnitures, and changes of mean levels of relative humidity and temperature in dwellings (pooled samples from all dwellings examined)

Months [n]	Mean numbers of mites per gram of dust (mite positive) ± SD (Maximum)								Mean value	
	Dermatophagoides farinae		*D. pteronyssinus*		House dust mites (Pyroglyphidae)		Domestic mites[1]		Relative humidity (% RH)	Temperature (°C)
	Total	Live	Total	Live	Total	Live	Total	Live		
January [5]	29.4 ± 61.9 (140.0)	8.0 ± 17.9 (40.0)	26.7 ± 59.6 (133.3)	NF	56.1 ± 73.6 (140.0)	8.0 ± 17.9 (40.0)	56.1 ± 73.6 (140.0)	8.0 ± 17.9 (40.0)	34.0	22.3
February [5]	53.8 ± 55.6 (122.7)	0.9 ± 2.0 (4.5)	0.9 ± 2.0 (4.5)	NF	54.7 ± 57.0 (127.3)	0.9 ± 2.0 (4.5)	54.7 ± 57.0 (127.3)	0.9 ± 2.0 (4.5)	41.0	22.4
March/April/ /May [4]	20.4 ± 19.1 (42.9)	7.1 ± 14.3 (28.6)	NF	NF	20.4 ± 19.1 (42.9)	7.1 ± 14.3 (28.6)	20.4 ± 19.1 (42.9)	7.1 ± 14.3 (28.6)	56.5	21.9
June [3]	21.7 ± 19.0 (40.0)	3.3 ± 5.8 (10.0)	2.6 ± 4.4 (7.7)	NF	24.9 ± 18.7[2] (40.0)	3.3 ± 5.8 (10.0)	24.9 ± 18.7 (40.0)	3.3 ± 5.8 (10.0)	70.4	20.9
July [3]	5.6 ± 9.6 (16.7)	NF	NF	NF	5.6 ± 9.6 (16.7)	NF	5.6 ± 9.6 (16.7)	NF	77.0	22.0
August [2]	58.3 ± 82.5 (116.7)	25.0 ± 35.3 (50.0)	NF	NF	58.3 ± 82.5 (116.7)	25.0 ± 35.3 (50.0)	58.3 ± 82.5 (116.7)	25.0 ± 35.3 (50.0)	74.0	22.0
September/ /October [3]	393.3 ± 640.8 (1133.3)	48.9 ± 70.2 (130.0)	NF	NF	393..3 ± 640.8 (1133.3)	48.9 ± 70.2 (130.0)	393..3 ± 640.8 (1133.3)	48.9 ± 70.2 (130.0)	72.5	21.3
November [6]	11.6 ± 19.0 (45.5)	3.0 ± 7.4 (18.2)	1.3 ± 2.9 (7.1)	NF	12.9 ± 18.3 (45.5)	3.0 ± 7.4 (18.2)	17.4 ± 20.1 (54.5)	6.3 ± 11.1 (27.3)	42.0	21.3
December [3]	120.0 ± 105.8 (200.0)	NF	NF	NF	120.0 ± 105.8 (200.0)	NF	120.0 ± 105.8 (200.0)	NF	39.0	21.5

Key: [1]both pyroglyphid and non-pyroglyphid; [2] including *Dermatophagoides* spp. unidentified; n = number of samples; NF = not found.

Significant annual differences in monthly mean numbers of the mites *Dermatophagoides* spp. per gram of dust between main types of the examined places, were found only for *D. farinae* between floor dust samples samples from upholstery furnitures (t-test = 2.35), and for samples from upholstery furnitures between the numbers of *D. farinae* and the numbers of *D. pteronyssinus* (t-test = 2.24) ($p < 0.05$ in both cases). The annual differences in monthly mean numbers per gram of dust between *D. farinae* (the dominant species) and the total count of domestic mites was significant only for samples from upholstered furniture (t-test = 2.43, $p < 0.05$).

Moreover, annual differences in monthly mean numbers of mites per sample mite positive, between the alternate months, were significant (t-test) for *D. pteronyssinus* ($p < 0.01$) but not significant for *D. farinae* ($p > 0.05$). This difference was also significant between both these species (t-test, $p < 0.02$).

2. Total age structure of pyroglyphid mite species

The age structure of pooled populations of *D. pteronyssinus* and *D. farinae* differed. In the total population of *D. farinae*, a dominance of protonymphs was found (larvae constituted 1.07%, protonymphs 40.70%, tritonymphs 8.93%, unidentified nymphs 1.97%, females 22.96%, heteromorphic

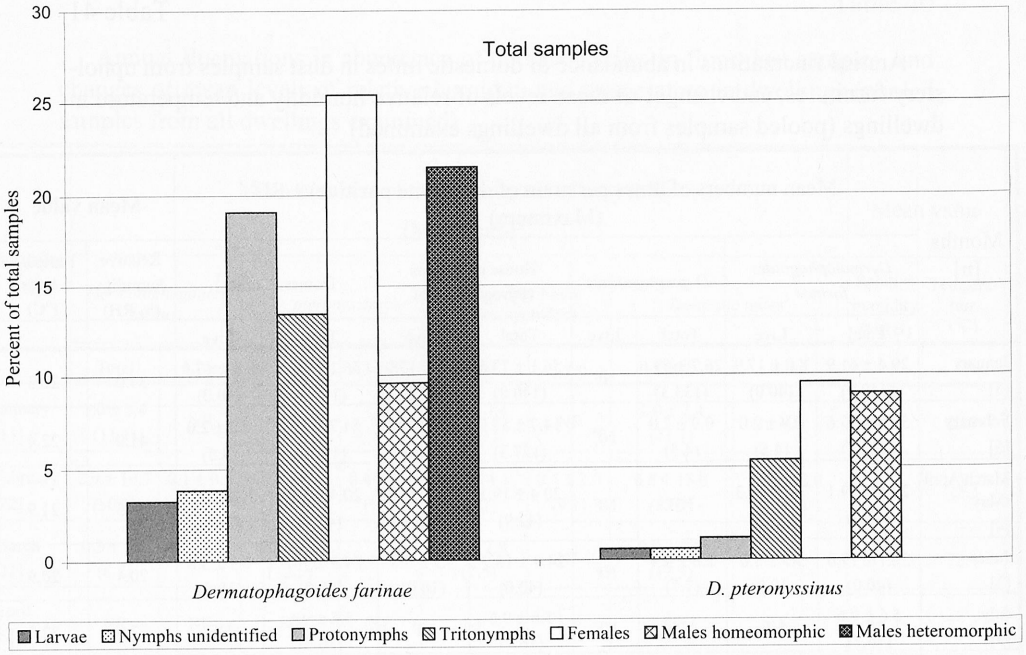

Fig. 18. Relative frequency of individual life stages of *Dermatophagoides farinae* and *D. pteronyssinus* in relation to the total count of samples examined in Poland (n = 335).

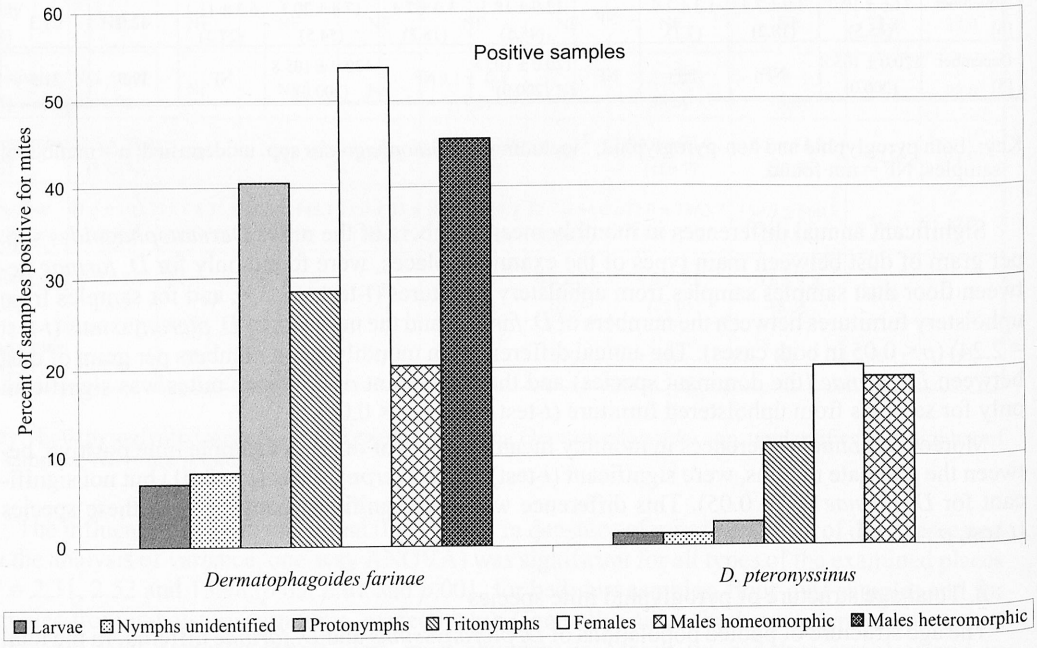

Fig. 19. Relative frequency of individual life stages of *Dermatophagoides farinae* and *D. pteronyssinus* in samples positive for mites (n = 158), in relation to the pooled samples examined in Poland (n = 335).

males 18.51%, homeomorphic males 5.69% and moulting mites 0.17%), as was also found during the culture study. In pooled populations of *D. pteronyssinus*, larvae constituted 0.54%, protonymphs 9.40%, tritonymphs 13.93%, unidentified nymphs 0.54%, females 45.39%, males 30.02% and moulting mites 0.18%.

In the pooled populations of *E. maynei*, females were the most numerous life stage (73.77%), followed by males (14.75%) and tritonymphs (6.56%). Larvae and protonymphs of this species constituted 1.64% and 3.28% of the total count, respectively.

3. Abundance and occurrence of individual life stages

The arithmetic means per 1 sample (positive for mites) of individual stages of *D. farinae, D. pteronyssinus* and *E. maynei* in the total of samples and in samples from certain localities examined are presented in Tables 42 and 43, respectively. The most abundant stage in populations of *D. farinae* were protonymphs, whereas in populations of *D. pteronyssinus* and *E. maynei* adult mites, mainly females (especially in the case of the latter species). Only in samples from Cracow was the protonymph the most abundant stage in populations of *D. pteronyssinus* [Tab. 43].

The relative occurrence of individual stages of *D. farinae* and *D. pteronyssinus,* as a percentage of all samples examined and in relation to samples positive for mites, is illustrated in Figures 18 and 19, respectively. The most frequent stage in populations of the two dominant species were females, followed by males (heteromorphic in the case of *D. farinae*) and nymphs (protonymphs in the case of *D. farinae* and tritonymphs in the case of *D. pteronyssinus*), both in relation to the total samples examined and to the samples positive for mites [Figs 18 and 19]

4. Seasonal dynamics of age structures of dust mite populations

Table 44 shows seasonal dynamics of the age structure in populations of *D. farinae* and *D. pteronyssinus* in relation to pooled samples from all dwellings examined, expressed as mean number of mites in each life stage per 1 sample (mite positive). Annual fluctuations in relative dominance (percent of the total population of the species) of particular life stages in the populations of *D. farinae* and *D. pteronyssinus* are presented in Figures 20 and 21, respectively.

Table 42

Mean numbers per one sample (mite positive) of particular life instars, in pooled populations of *Dermatophagoides farinae, D. pteronyssinus* and *Euroglyphus maynei*

Stage / Species	Larvae	Proto-nymphs	Tritonymphs	Nymphs unidentified	Males homeo-morphic	Males hetero-morphic	Females	Total
Dermatophagoides farinae	0.16	6.14	1,35	0.28	0.86	2.79	3.46	15.75
D. pteronyssinus	0.02	0.33	0.50	0.02	1.07	DO	1.62	4.05
Euroglyphus maynei	0.01	0.01	0.02	0.00	0.06	DO	0.26	0.39

Key: DO = Does not occur in the life cycle.

Table 43

Abundance of life stages of *Dermatophagoides farinae, D. pteronyssinus* and *Euroglyphus maynei* in pooled populations from dust samples from dwellings in main localities actually examined in Poland.

Stages	Mean number of mites per 1 sample (mite positive)																	
	Katowice			Sosnowiec			Cracow			Łódź			Bielsko-Biała			Upper Silesia (total)		
	DF	DP	EM	DF	DP	EM	DF	DP	EM	DF	DP	EM	DF	DP	EM	DF	DP	EM
Larvae	0.49	NF	0.03	0.02	NF	NF	0.13	0.13	NF	NF	0.14	NF	NF	NF	NF	0.21	NF	0.01
Protonymphs	19.77	0.03	0.03	0.48	NF	NF	2.87	3.61	NF	0.57	0.71	NF	1.05	NF	NF	8.08	0.02	0.02
Tritonymphs	3.40	0.03	0.11	0.23	0.06	NF	0.87	0.93	NF	0.57	5.14	NF	0.22	0.88	NF	1.89	0.11	0.03
Nymphs (unidentified)	0.74	NF	NF	0.04	NF	NF	NF	0.07	NF	NF	0.29	NF	0.17	NF	NF	0.40	NF	NF
Females	7.14	0.57	1.01	2.21	0.04	0.02	1.33	1.60	NF	0.29	20.57	NF	2.67	3.00	NF	4.28	0.31	0.40
Males	4.91[1] 1.63	0.58	0.26	1.61[1] 0.31	NF	NF	1.60[1] 0.33	1.33	NF	0.43[1] 0.00	11.71	NF	1.39[1] 1.11	1.75	NF	3.60[1] 0.99	0.33	0.08
Total population	37.44[2]	1.22[2]	1.44	4.94[2]	0.10	0.02	7.27[2]	7.67	NF	1.86	41.14[2]	NF	6.61	8.28[2]	NF	19.58[2]	0.77	0.54

Key: DF = *Dermatophagoides farinae*; DP = *D. pteronyssinus*; EM = *Euroglyphus maynei*; NF = not found; [1] males heteromorphic /homeomorphic; [2] including moulting mites.

P o p u l a t i o n s o f *D. f a r i n a e* [Tab. 44, Fig. 20] – Homogeneity of variances in annual fluctuations in number of mites per 1 sample was significant only for tritonymphs and homeomorphic males (LEVENE's test, $p = 0.005$ in both cases). Nonsignificant annual differences in numbers of the individual mite instars of *D. farinae* per sample mite positive, between alternate months, were observed for all developmental stages (KOLMOGOROV-SMIRNOV two-sample test, $p > 0.05$). Annual differences in monthly mean numbers of the individual mite instars of *D. farinae* per sample mite positive, between alternate months, however, were significant (*t*-test), for larvae ($p < 0.0001$), tritonymphs ($p < 0.005$), heteromorphic males ($p < 0.05$), and homeomorphic males ($p < 0.001$). Significant differences in annual fluctuation in monthly mean numbers of the individual stages of this species per sample mite positive (*t*-test), were observed between:

- larvae and tritonymphs ($p < 0.01$);
- larvae and females ($p < 0.001$);
- larvae and heteromorphic males ($p < 0.005$);
- larvae and homeomorphic males ($p < 0.05$);
- larvae and total population of the species ($p < 0.005$);
- protonymphs and the total population ($p < 0.001$);
- tritonymphs and the total population ($p < 0.005$);
- tritonymphs and females ($p < 0.005$);
- tritonymphs and males heteromorphic ($p < 0.05$);
- females and homeomorphic males ($p < 0.0005$);
- females and the total population ($p < 0.01$);
- both types of males ($p < 0.005$);
- heteromorphic males and the total population ($p < 0.01$);
- homeomorphic males and the total population ($p = 0.005$).

The influence of month on the changes in abundance of mites *D. farinae* per sample (assessed by the multiple regression analysis) was significant for the total populations of this species ($R = 0.7, p < 0.05$), for tritonymphs ($R = 0.21, p = 0.01$), females ($R = 0.16, p < 0.05$) and heteromorphic males (R

Annual fluctuations in abundance of life stages of dust mite species *Dermatophagoides farinae* and *D. pteronyssinus* in dwellings (pooled samples from all dwellings examined in Poland)

Months	Mean numbers of mites per 1 sample (mite positive) ± SD											
	Populations of *Dermatophagoides farinae*						Populations of *Dermatophagoides pteronyssinus*					
	LL	PNN	TNN	♀♀	♂♂	Total population[2]	LL	PNN	TNN	♀♀	♂♂	Total population[2]
January [N=12]	NF	0.67 ± 0.65	0.75 ± 0.94	2.92 ± 4.96	2.33 ± 2.27 0.42 ± 0.90	6.92 ± 7.57[3]	NF	0.08 ± 0.29	NF	0.25 ± 0.45	0.33 ± 0.65	0.67 ± 1.23[3]
February [N=14]	0.29 ± 1.07	35.57 ± 121.94	4.43 ± 12.64	9.07 ± 24.31	4.71 ± 11.27 1.50 ± 4.78	56.21 ± 177.77	NF	0.07 ± 0.27	0.21 ± 0.58	0.50 ± 0.94	0.50 ± 1.40	1.29 ± 2.20
March [N=8]	NF	6.37 ± 13.72	3.25 ± 6.04	8.62 ± 16.39	6.00 ± 11.67 3.25 ± 6.23	29.50 ± 54.09	NF	NF	0.13 ± 0.35	1.13 ± 1.73	0.38 ± 0.74	1.63 ± 2.20
April [N=13]	0.38 ± 0.96	11.77 ± 36.83	4.00 ± 10.29	5.85 ± 12.82	8.92 ± 20.75 2.38 ± 6.63	34.77[3] ± 89.04	NF	NF	0.31 ± 0.63	0.38 ± 1.39	1.00 ± 1.41	1.69 ± 3.04
May [N=10]	NF	0.20 ± 0.42	1.00 ± 2.21	0.90 ± 1.45	1.40 ± 1.90 0.50 ± 1.27	4.40 ± 6.52	NF	NF	NF	0.30 ± 0.95	0.10 ± 0.32	0.40 ± 0.97
June [N=7]	0.71 ± 1.25	11.57 ± 25.42	3.00 ± 3.56	2.57 ± 2.30	1.71 ± 2.21 0.86 ± 1.21	20.71 ± 29.85	NF	NF	0.14 ± 0.38	0.43 ± 0.79	0.14 ± 0.38	0.71 ± 1.11
July [N=4]	NF	0.25 ± 0.50	0.25 ± 0.50	4.00 ± 6.68	0.50 ± 1.00 0.75 ± 0.96	6.25 ± 8.62	NF	NF	NF	NF	NF	NF
August [N=7]	NF	0.29 ± 0.76	NF	1.43 ± 1.27	1.86 ± 2.12 NF	3.71 ± 3.73	NF	NF	NF	NF	NF	NF
September [N=12]	0.50 ± 1.45	6.25 ± 18.55	1.10 ± 2.30	3.58 ± 5.57	2.67 ± 5.03 0.17 ± 0.39	14.25 ± 29.13	NF	NF	0.08 ± 0.29	NF	0.17 ± 0.58	0.25 ± 0.62
October [N=34]	0.12 ± 0.41	1.71 ± 4.71	0.91 ± 3.85	2.82 ± 7.93	2.32 ± 4.83 0.82 ± 3.33	9.03 ± 21.73[3]	NF	NF	0.47 ± 2.12	1.62 ± 4.65	1.06 ± 2.82	4.71 ± 11.15[3]
November [N=26]	0.04 ± 0.19	1.61 ± 6.22	0.38 ± 1.06	1.23 ± 2.14	1.19 ± 4.11 0.19 ± 0.49	5.46 ± 14.09	0.11 ± 0.43	1.92 ± 8.84	1.92 ± 6.95	6.46 ± 27.41	3.92 ± 16.11	15.50 ± 57.89[3]
December [N=11]	0.27 ± 0.65	1.55 ± 2.70	0.27 ± 0.47	2.73 ± 4.58	2.00 ± 2.97 0.64 ± 0.92	7.73 ± 10.32	NF	NF	0.18 ± 0.60	0.18 ± 0.40	NF	0.36 ± 0.92
Total [N=158]	**0.16 ± 0.68**	**6.14 ± 39.08**	**1.35 ± 5.23**	**3.46 ± 10.05**	**2.79 ± 8.07** **0.86 ± 3.23**	**15.75 ± 61.97[3]**	**0.02 ± 0.18**	**0.33 ± 3.63**	**0.50 ± 3.05**	**1.62 ± 11.48**	**1.07 ± 6.78**	**4.05 ± 24.29[3]**

Key: N = number of samples (mite positive); SD = Standard Deviation; NF = not found; LL = larvae; PNN = protonymphs; TNN = tritonymphs; ♀♀ = females; ♂♂ = males; [1]heteromorphic males/homeomorphic males; [2]total population of the species; [3]including also moulting mites and unidentified nymphs.

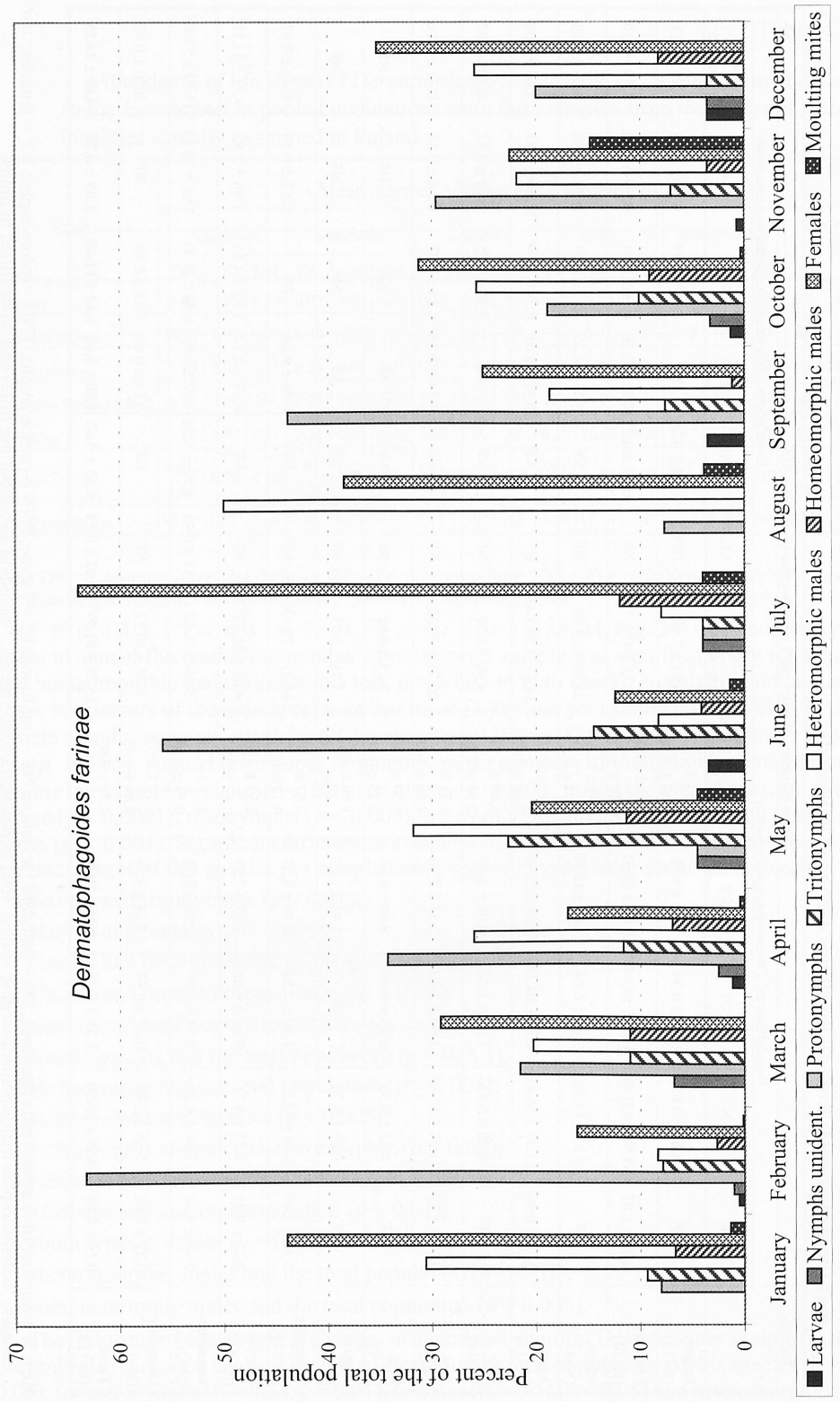

Fig. 20. Annual dynamics of individual developmental stages (expressed as the percentage of the total population) in pooled populations of *Dermatophagoides farinae* actually found in the examined dwellings in Poland.

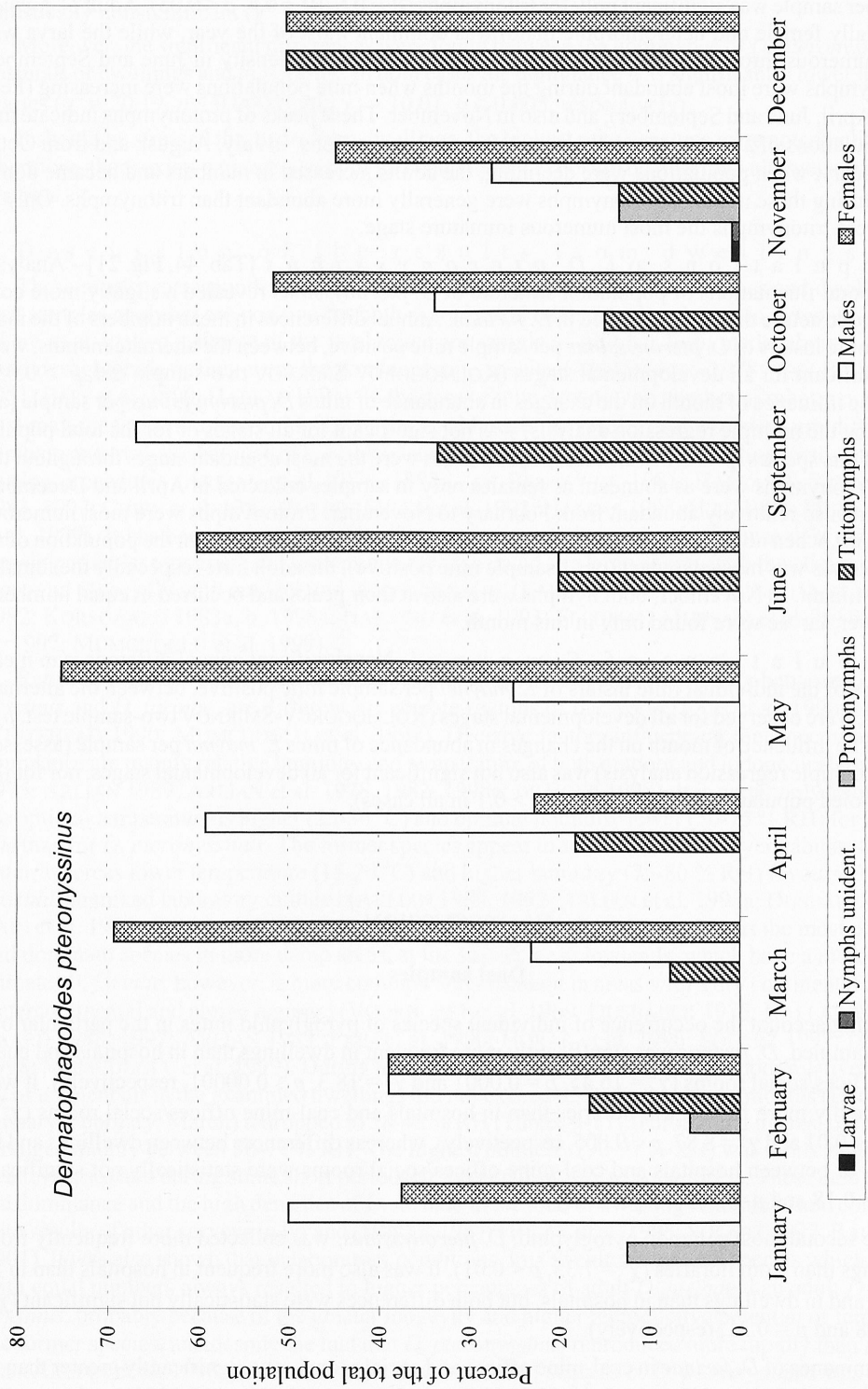

Fig. 21. Annual dynamics of individual developmental stages (expressed as the percentage of the total population) in pooled populations of *Dermatophagoides pteronyssinus* actually found in the examined dwellings in Poland.

= 0.16, $p < 0.05$). Whereas, the influence of month on the changes in mean (monthly) number of mites per sample was significant only for tritonymphs ($R = 0.6$, $R^2 = 0.4$, $p < 0.05$). Adult *D. farinae* (especially female and heteromorphic male) was dominant most of the year, while the larva was least numerous throughout the year, except for the peak of their density in June and September. Protonymphs were most abundant during the months when mite populations were increasing (February, April, June and September), and also in November. These peaks of protonymphs indicate that the populations of *D. farinae* usually have 4-5 annual generations. In July, August, and from October-January, when populations were declining, the adults increased in numbers and became dominant. During these months, protonymphs were generally more abundant than tritonymphs. Only in May were tritonymphs the most numerous immature stage.

P o p u l a t i o n s o f *D. p t e r o n y s s i n u s* [Tab. 44, Fig. 21] – Analysis of temporal fluctuations of population structure of *D. pteronyssinus* revealed a slightly more constant age structure than was observed in *D. farinae*. Annual differences in mean numbers of the individual mite instars of *D. pteronyssinus* per sample mite positive, between the alternate months, were nonsignificant for all developmental stages (KOLMOGOROV-SMIRNOV two-sample test, $p > 0.05$). Also, the influence of month on the changes in abundance of mites *D. pteronyysinus* per sample (assessed by the multiple regression analysis) was not significant for all stages or for the total populations of this species ($p > 0.1$ in all cases). Adult mites were the most abundant stages throughout the year. Tritonymphs were as abundant as females only in samples collected in April and December, and were also relatively abundant from February to November. Protonymphs were most numerous in January, when no trinonymphs were found. In October and November, when the population of *D. pteronysinus* was most abundant (per 1 sample mite positive), the adult mite (especially the female) was dominant. In November, both nymphs were also at their peaks and occurred in equal numbers. Moreover, larvae were found only in this month.

P o p u l a t i o n s o f *E. m a y n e i.* Nonsignificant annual differences in mean numbers of the individual mite instars of *E. maynei* per sample mite positive, between the alternate months, were observed for all developmental stages (KOLMOGOROV-SMIRNOV two-sample test, $p > 0.05$). The influence of month on the changes in abundance of mites *E. maynei* per sample (assessed by the multiple regression analysis) was also not significant for all developmental stages, nor for the total pooled population of this species ($p > 0.1$ in all cases).

IV. DISCUSSION

Dust samples

Taking account the occurrence of individual species of pyroglyphid mites in the particular objects examined, *D. farinae* was significantly more frequent in dwellings than in hospitals and coal-mine offices/social rooms ($\chi^2 = 16.45$, $p = 0.0001$ and $\chi^2 = 18.3$, $p \leq 0.00001$, respectively). It was significantly more frequent in libraries than in hospitals and coal-mine offices/social rooms ($\chi^2 = 7.72$, $p < 0.01$ and $\chi^2 = 8.87$, $p < 0.005$, respectively), whereas differences between dwellings and libraries, or between hospitals and coal-mine offices/social rooms were statistically not significant (χ^2; $p = 0.18$ and $p = 0.83$, respectively).

The second most common pyroglyphid, *D. pteronyssinus,* was collected more frequently from dwellings than from libraries ($\chi^2 = 7.35$, $p < 0.01$). It was also more frequent in hospitals than in libraries and in dwellings than in hospitals, but both differences were statistically not significant (χ^2; $p = 0.08$ and $p = 0.31$, respectively).

Dominance of *D. farinae* in coal-mine offices and social rooms, was significantly greater than in dwellings, hospitals and libraries ($\chi^2 = 33.3$, 48.2 and 49.8, respectively; $p \leq 0.00001$), whereas dif-

ferences between dwellings, hospitals and libraries in relation to the dominance of this species, were statistically nonsignificant ($\chi^2 < 2.6, p > 0.1$).

Moreover, the significant differences were found between the dominance of *D. pteronyssinus* in hospitals or dwellings and in libraries. In both cases the dominance was significantly lower in the libraries ($\chi^2 = 20.19, p \leq 0.00001$ and $\chi^2 = 10.01, p < 0.005$, respectively).

It should be stressed that apart from dwellings, the highest mite densities were noted in libraries. Therefore, there exists a potential risk of an occupational exposure on dust mite allergens among librarians.

Discussion of the results from dwellings

These results corresponded well with the literature where 32-100% of homes and dwellings or dust samples analysed are positive for both pyroglyphid mites or other domestic mites. In surveys where a qualitative estimate of the total mites per sample of dust has been made, about 43-100% were pyroglyphids or they were the dominant mite species (ARLIAN et al. 1978; VAN BRONSWIJK 1981; FAIN et al. 1990; HALLAS 1991). In the case of mite density, the number of mites per gram of dust may range from a few to 16,000 or more, although the results of the surveys are difficult to compare and evaluate because of the lack of standardization of both dust collecting methods and reporting procedures (ARLIAN et al. 1978, 1992; VAN BRONSWIJK 1981; HALLAS & KORSGAARD 1983, 1997; CHIEN et al. 1987; PLATTS-MILLS et al. 1992; HALLAS 1998; HILL 1998; MUMCUOGLU et al. 1999). It has been shown, however, that occurrence and abundance of house dust mites may vary in particular topographical regions and are associated to a large degree with the climate of a region, and especially with outdoor and indoor humidity (LANG & MULLA 1978; ARLIAN et al. 1978, 1982; KORSGAARD 1983a, b, 1998a; HARVING et al. 1993; FELDMAN-MUHSAM et al. 1985; REE et al. 1997; MUMCUOGLU et al. 1999).

Ratios of numbers of the particular pyroglyphid dust mite species, especially between *D. pteronyssinus* and *D. farinae*, are different in separate regions of the world (FAIN et al. 1990; HART & 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 (DUSBÁBEK 1975; ARLIAN 1989; ARLIAN et al. 1978, 1982, 1998a; DE BOER 1998). It is commonly known that the optimal temperature is higher (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 1989, 1992; ARLIAN et al. 1998a; DUSBÁBEK 1975; FAIN et al. 1990). Within the wide zone of temperate climate *D. pteronyssinus* is the most common and dominant species in more damp areas, at the seaside or in lowlands, which have a more humid climate. *D. farinae,* however, is more common and abundant in areas with a dry continental climate (intercontinental and alpine regions) (VOORHORST et al. 1969; DUSBÁBEK 1975; HALLAS & KORSGAARD 1983, 1997; ARLIAN 1989; FAIN et al. 1990; HORAK et al. 1996; SOLARZ 1997; DE BOER 1998; MUMCUOGLU et al. 1999). During most of the year, the mean monthly indoor relative humidity of ambient air in the examined dwellings did not exceed 65 %. In the winter months (December, January, February, March) it dropped to 38-48 % RH [Tables 9-11]. Throughout the rest of the year, it ranged mainly between 50-79 % RH. The highest humidity (90-97 % RH) was rarely noted, only in a few cases and during some short periods of a year (from July to September). These data explain the dominance and the high densities of *D. farinae* in the total of dwellings examined and consistent with results of other surveys in Poland (HORAK 1987; HORAK et al. 1996; SOLARZ 1997; RACEWICZ 2001). It was also shown that in laboratory conditions, mixed cultures of both species which started with equal numbers always resulted in higher percentages of adult *D. farinae* than adult *D. pteronyssinus,* probably because of the greater longevity and higher reproductive potential of females of the former species, and despite the fact that *D. pteronyssinus* reproduced more rapidly than *D. farinae* (ARLIAN et al. 1998a). Moreover, the developmental success of *D. pteronyssinus* was greater over a wider temperature range than for *D. farinae* (ARLIAN et al. 1998a).

To summarize, although research has revealed some differences in 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, and between particular places within the same dwelling (ARLIAN et al. 1999a).

E. maynei is usually less abundant in dust samples than *D. pteronyssinus* and *D. farinae*, but in some favourable indoor conditions, under high constant humidity (80-85 % RH) and milder temperatures, may predominate and occur more frequently (FELDMAN-MUHSAM et al. 1985; FAIN et al. 1990; COLLOFF 1991a, b; ARLIAN et al. 1992). This mite appears to be less able than *D. pteronyssinus* to withstand low humidity (COLLOFF 1991a, b; ARLIAN et al. 1998a). It has a higher critical equilibrium activity (CEA) than *D. pteronyssinus* and is confined to more damp habitats (COLLOFF 1991a, b). The observed predilection of *E. maynei* to beds is consistent with data reported by WALSHAW & EVANS (1987) from Liverpool. On the other hand, these authors, and HART & WHITEHEAD (1990) in Oxfordshire (UK), found weak or no correlation between the numbers of *E. maynei* and relative humidity of a bedroom. Moreover, in laboratory conditions, this species has much lower reproductive potential and population growth rates than *Dermatophagoides* spp. (ARLIAN et al. 1998a).

Mites of families Glycyphagidae, Chortoglyphidae and Acaridae are considered to be much more sensitive to dessication than pyroglyphids (VAN BRONSWIJK 1981; FELDMAN-MUHSAM et al. 1985; FAIN et al. 1990; HALLAS & KORGAARD 1997). It has also been suggested that some domestic mite species thrive in very damp conditions; this group include domestic acarids, glycyphagids (*L. destructor, G. domesticus*) and cheyletids (*Cheyletus* spp). Therefore, the presence and abundance of these mite species can be used as an indicator of humid environments (FAIN et al. 1990; SOLARZ 1997). The relatively low frequency of mites in a total of samples from dwellings examined and relatively lower abundance of glycyphagids, acarids, cheyletids and *E. maynei* mites is clear, taking into account the aforementioned values of indoor relative humidity observed in these dwellings (FAIN et al. 1990; SOLARZ 1998). In general, these mites are not as abundant or frequent in Europe as in the Tropics (VAN BRONSWIJK 1981; FAIN et al. 1990; ROSA & FLECHTMANN 1979; VARGAS & MAIRENA 1991; MEHL 1998; FRANJOLA & MALONNEK 1995; MUMCUOGLU et al. 1999).

The mean concentration of mites in examined samples and mite frequency was at the lower end of the published range for more humid regions (VAN BRONSWIJK 1981; CHIEN et al. 1987; FAIN et al. 1990; HALLAS & KORSGAARD 1983, 1997; HART & WHITEHEAD 1990; MUMCUOGLU et al. 1999) and was comparable with some European results from France, Denmark and Holland (LASCAUD 1978; VAN BRONSWIJK 1981; FAIN et al. 1990; HARVING et al. 1993), and comparable also (or higher) with other results from Poland (HORAK et al. 1996; SOLARZ 1998; RACEWICZ 2001). In Denmark, for example, HALLAS & KORSGAARD (1997) found average concentrations of mites approximately tenfold higher than those actually observed in Poland, with the exception of Bielsko-Biała, where those values are comparable.

A wide range of abiotic environmental indoor factors have been analysed for their influence on pyroglyphid house-dust-mite populations in the hope that limiting factors may be exploited in control (KORSGAARD & IVERSEN 1991; VAN DER HOEVEN et al. 1992; HARVING et al. 1993; SAKAKI & SUTO 1995; HART 1998). In many studies, positive correlations were found between mite densities or allergen levels and relative (or absolute) air humidity of the dwelling (KORSGAARD 1983a; HART & WHITEHEAD 1990; HARVING et al. 1993; HART 1998). HART (1998), published the following environmental factors positively influencing mite levels: humidity, type of heating, type of mattress (springs), type of bedding (without impermeable covers), age of mattress, carpets, soft furnishings, soft toys, age of house, frequency of cleaning, number of inhabitants, presence of smoking persons and pets. It was also suggested that differences in the prevalence of mites between dwellings are a reflection of associations between the environmental requirements of mites or their biological characteristics (especially in relation to air humidity), and degree of indoor dampness, largely influenced by household activities, family size, dwelling space, cooking or washing frequency, and

some other factors (KORSGAARD & IVERSEN 1991; VAN DER HOEVEN et al. 1992; SAKAKI & SUTO 1995; SOLARZ 1997; SIMPSON et al. 2001). These suggestions also correspond with the results actually obtained, except for the number of rooms (house or flat size), which was considered as the dry factor in Japan (SAKAKI & SUTO 1995). Moreover, the age of a building was actually classified as the "dry" factor in the case of flats (urban area), whereas in the case of single-family houses (subagricultural settlement) as the humid factor, which is more consistent with the literature (VOORHORST et al. 1969; KORSGAARD & IVERSEN 1991; HART 1998).

The influence of different housing conditions on dust mite populations in dwellings has been previously analysed and published as the part of an actual study concernig the risk of exposure to pyroglyphid mites and their allergens in Poland (SOLARZ 2001). The density of mites was influenced mainly by the type of heating, temperature, type of sleeping accommodation (couch), type of floor (carpeted) or furniture (upholstered) and type of building (single-family house, old house), whereas levels of the mite allergens were associated with the mite density, relative humidity, type of building and type of heating (SOLARZ 2001).

A previous study in Wellington (New Zealand) showed that having carpets on floors was the most important determinant of floor *Der p* 1 levels (WICKENS et al. 2001). Moreover, having more than two children was associated with higher levels of *Der p* 1 in the carpets (WICKENS et al. 2001).

The concentration of guanine and the *Der p* 1 allergen was highest in the bed dust of Costa Rican homes. Some factors, such as humidity, small houses for large families, and type of bedding, probably also favoured the heavy mite infestation (SOTO-QUIROS et al. 1998).

It was also recently suggested that at the present time, the only way to guarantee lower mite allergen levels in modern homes in the "western world" is to remove the carpets and to encase the mattress (or other sleeping accommodation) and bedding (SIMPSON et al. 2001).

Discussion of the results from hospitals

In 8 hospitals located in Katowice and Sosnowiec, examined in years 1981-1986 (SOLARZ 1998), the most abundant mites also were members of the family Pyroglyphidae (57.5% of a total mite population), 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. The latter species was actually not found. Moreover, the density of mites (per gram of dust) beforehand was approximately twice as high in dust from beds than in dust from floors (SOLARZ 1998).

It should be stressed that in hospitals house dust mites were less frequent and abundant compared to dwellings. These results correspond 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 the actually examined hospitals of the Upper Silesia region [Tables 20 and 21].

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). 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). 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).

To summarize, the results actually obtained show that 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).

Discussion of the results from libraries

It should be stressed that besides dwellings, the highest mite densities were noted in libraries. Therefore, there exists a potential risk of an occupational exposure on 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 in tenfold higher numbers in relation to samples which were mite positive) (SOLARZ 1998). Moreover, analysing data of these previous surveys in libraries, effects of RH, temperature and weight of sample on the mite abundance were not significant ($p>0.1$).

Discussion of the results from offices, institutes and other work places or public utilities

Data presented in this paper confirmed the results of several acarologists of small numbers of mites in the hotel rooms and other social buildings or public places, such as schools, cinemas, child-minding centres, senior citizens' centres, students' hotels, military barracks and naval ships, suggesting that the environment in these places is unsuitable for the 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). In schools located in the city of Rotterdam (Holland), dust from carpeted classroom floors contained more house dust mite allergen than dust from smooth classroom floors, but much less than dust from floors in dwellings (ZOCK & BRUNEKREEF 1995). But the most important factor for an occurrence and breeding of pyroglyphid dust mites is the presence of human beings, 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 places of mite occurrence, they were, however – besides the dwellings – more abundant in libraries than in hospitals [Tables 20-22]. Repeated routine cleaning practices, as well as maintenance of low relative humidity, could in part explain the small abundance of mites in public buildings (GREEN et al. 1992; BABE et al. 1995; RACEWICZ 2001).

As suggested by the results of VOBRÁZKOVÁ et al. (1985), the numbers of house dust mites in nursery schools of Prague was dependent on the state of the building, airing of the dormitories, cleaning, and the level of dustiness of the external environment.

In my opinion, some other biotic or abiotic factors, not yet clear, decides that book-shelves in libraries are 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 pyroglyphid dust mites.

It is noteworthy that, to the best of my knowledge, libraries, hospitals and the other examined public places were actually analysed for the first time for an influence of so many housing conditions for an occurrence of house dust mites and other allergenic mites (SOLARZ 1998).

Coal-mines

It should be stressed that the pyroglyphid dust mite was found in this environment for the first time. The possibilities of mite invasion in coal-mines are probably multiple; for example – brought in by miners (on the body, in clothing, with food products), in wood, foresy on rodents or insects (SOLARZ & SOLARZ 1996). Nests of rats or mice living underground in coal mines are also probably important sources in this environment. Considering pyroglyphids, the main vectors of these mites are human beings – the miners.

Farming environments

Both species commonly occur in nests of passeriform birds (see above). They also have been found in farming environments in Poland (SOLARZ et al. 1997). *G. longior* has also been recorded from granaries in the UK and Canada, from the litter of a poultry house in Switzerland, and from house dust in Poland (HUGHES 1976; FAIN et al. 1990; MUMCUOGLU & LUTSKY 1990; CHMIELEWSKI 1995; SOLARZ 1998, 2000a). This mite plays a role in the house dust mite allergy (ARLIAN 1991; FAIN et al. 1990; HILL et al. 1993).

For the urban population, sensitivity to particular species of storage mites and their cross-reactivity with pyroglyphid dust mites found in house dust are not important because exposure to storage mite species is minimal [Tables 8, 9, 15, 22 and 34] (SOLARZ 2001). For farmers and other agricultural workers, however, both storage and house dust mites may act as inhalant allergens. Therefore, for people living in agricultural or subagricultural settlements, sensitivity to various species of domestic mites and storage mites and cross-reactivity between species may be of clinical significance [Tab. 17] (ARLIAN et al. 1993a, b; ŚPIEWAK et al. 1995; SOLARZ et al. 1997).

Nests of birds and nests of mammals

Mattresses, pillows, bedding, curtains, upholstered furniture, soft toys, pets' beds, clothing and floor dust – all these niches are important sources of pyroglyphid dust mites and mite allergens in dwellings, also in new houses, where they are introduced, for example, with furniture or blankets, and even with new carpets (HEWITT et al. 1973; BLYTHE et al. 1975; RAO et al. 1975; VAN BRONSWIJK 1981; FAIN et al. 1990; KORSGAARD & IVERSEN 1991; VAN DER HOEVEN et al. 1992; POPE et al. 1993). The main vectors of these mites are human beings (HEWITT et al. 1973; KORSGAARD & IVERSEN 1991). Bird nests are considered as the natural habitats of pyroglyphid mites, and flats or houses have possibly been invaded secondarily by mites originating from nests of small synanthropic passeriform birds (such as sparrows or swallows), or from individual birds (VAN BRONSWIJK 1981; CHMIELEWSKI 1975, 1977, 1982b; FAIN et al. 1990; COLLOFF 1998a). The natural sources of allergenic mites in stores are still not quiet known (HALLAS & IVERSEN 1996). Possible sources of these mites in farming environments are also the nests of synanthropic birds (HUGHES 1976; WHARTON 1976; VAN BRONSWIJK 1981; FAIN et al. 1990; SOLARZ et al. 1997, 1998, 1999). On the other hand, it has been suggested that the majority of the mite population is brought from the cultivated field into the stores, and that the open field is the main source of storage-mite populations (HALLAS & IVERSEN 1996), whereas the bird nests are less important (SANDNER & WASYLIK 1973).

It should be stressed that 4 of the pyroglyphid mite species found in bird nests in Poland, both actually and previously (CHMIELEWSKI 1975, 1977, 1982b; HUGHES 1976; VAN BRONSWIJK 1981; FAIN et al. 1990; SOLARZ et al. 1998, 1999), are the typical house dust mites (*D. pteronyssinus* and *D. farinae*), or they have been collected from house dust samples (*G. longior* and *D. evansi*). *D. pteronyssinus* commonly occurs in house dust throughout the world, but also in nests of domestic sparrows, house swallows and martins (CHMIELEWSKI 1975; VAN BRONSWIJK 1981; FAIN et al. 1990). It has been previously reported from sparrows' nests in Poland only by CHMIELEWSKI (1975, 1977, 1982b), although it has not been found during other surveys in our country (WASYLIK 1959, 1964, 1971, 1973; SANDNER & WASYLIK 1973; SOLARZ et al. 1998, 1999) . *D. evansi* and *G. longior* also belong to pyroglyphids which are the nidicolous mites but sporadically occur in

house-dust samples (FAIN et al. 1990; SOLARZ et al. 1995). Only *H. chelidonis*, the most abundant mite in bird nests in the present study, is not a house-dust mite, although there exists the possibilty of an occurrence of this species in dwellings (FAIN et al. 1990). Actual findings of this mite in house dust samples confirm this suggestion (SOLARZ 2001). *H. chelidonis* has been described from the nest of a house martin (*D. urbica*) in England (Belford) and from a nest of *P. domesticus* in Belgium (as *Hirstia passericola,* most probably a synonym) (FAIN et al. 1990). This species has also been found in nests of other bird species in Poland (CHMIELEWSKI 1975, 1977, 1982a). *H. chelidonis* also occurs sporadically in farming environments (SOLARZ et al. 1997; MEHL 1998). *D. farinae,* besides the samples of house-dust, has been so far reported from stored plant products, poultry houses, beehives (HUGHES 1976; VAN BRONSWIJK 1981), city-pavement dust (Prague, Czech Republic) (SAMŠIŇÁK & VOBRÁZKOVÁ 1983, 1985), in dust from cabins on ocean liners (WEGNER 1980), and dust from harbour buildings in Gdynia (Poland) (WIĘCKO 1986). *D. farinae* has occasionally been found on the skin of patients with *dermatitis* and in connection with mammals (FAIN et al. 1990).

The results actually obtained and the literature data mentioned above, suggest that nests of certain synanthropic birds are not the most important sources of the typical pyroglyphid house-dust-mites in dwellings, such as *D. pteronyssinus* or *D. farinae*. But the nests may be a potential source of introduction of some other pyroglyphid species – *H. chelidonis*, *D. evansi* or *G. longior* – into human habitats.

Moreover, it should be stressed that *E. maynei* was found for the first time in the nest of a mouse. The typical series of this species was found on decomposing cotton seed cake at Gembloux (Belgium) (FAIN et al.1990). It has since been found in house dust in Belgium and many others countries. It has been also recorded from stored herbs in Grudziądz (Poland) (KARNKOWSKI 1990).

Population ecology of pyroglyphid house dust mites

A single flat study

1. Annual and seasonal changes in the mite density. Age and sex structures of *D. farinae* populations

Annual fluctuations of mites in house dust from a single mattress in Denmark also showed a burst in the mite density in September and October (HALLAS & KORSGAARD 1983). In Prague (Czech Republic) *D. farinae* was most abundant in mattress dust samples from June to December, with two peaks observed in August and in November/December during the first and second year of the study, respectively (DUSBÁBEK 1975). Similar results on house-dust mite dynamics were previously obtained in Sosnowiec (Poland) (SOLARZ 1997) and in Bucharest (Romania) (VAN BRONSWIJK 1981).

The dominance of adults shows that these populations become increasingly older and that the population growth rates are largest or declining (WOODFORD et al. 1979; COLLOFF 1992). High longevity of *D. farinae* females (ARLIAN et al. 1998a) may in part account for the highest numbers of this adult stage in the populations of *D. farinae* found in the examined flat.

2. Environmental factors influencing density of mites

Laboratory culture studies show that dust mites do not tolerate relative humidities below 60% (or 55% for *D. farinae*) (ARLIAN 1989, 1992; HALLAS 1991; KORSGAARD & IVERSEN 1991; ARLIAN et al. 1998b, 1999a). However, many house dust surveys suggest that for dwellings there is a lower limit of relative humidity, corresponding to 45% at 20-25°C; below these temperatures mites will desiccate and die (KORSGAARD & IVERSEN 1991; HALLAS & KORSGAARD 1997; KORSGAARD 1998a; HART 1998; ARLIAN et al. 1998b, 1999a). On the other hand, in certain studies, an indoor humidity of 45% RH corresponds to a level of mite density of 100 mites per gram of dust (the threshold limit value of the risk of exposure to house dust mites) and higher (KORSGAARD 1998a, b; MUMCUOGLU et al. 1999).

It is commonly known that dust mites are more resistant to desiccation at lower temperature values because their Critical Equilibrium Activity (CEA) (or Critical Equilibrium Humidity – CEH) is dependent on the air temperature level, and stays lower with its decrease (reduction) (ARLIAN 1989, 1992; CHANG et al. 1998; HART 1998). This is important for mite abundance in the flat examined in periods when indoor humidity above 60% RH was rarely reported [Figs 7-11].

Some experimental data indicate that while subjected to temperatures of 20–30 °C at 30–40 % RH, female *D. farinae* survived 7–14 days (BRANDT & ARLIAN 1976; CHANG et al. 1998). On the other hand, it has also been suggested that maintaining mean daily relative humidity below 50% effectively restricts population growth of dust mites, even when humidity rises above this level for 2-8 hours per day (ARLIAN et al. 1999b). But to completely prevent population growth of *D. farinae*, the relative humidity must be maintained below 35% for at least 22 hours per day when the daily RH is between 75 and 85% for the remainder of the day (ARLIAN et al. 1999b). Moreover, dust mite populations are found world-wide also in dwellings where indoor relative humidity periodically fluctuates much lower than 65% for extended periods of time during each 24 hours (VAN BRONSWIJK 1981; FAIN et al. 1990; ARLIAN et al. 1998a; HART 1998; SOLARZ 1998). At relative humidities between 30-50%, the mites *D. farinae* are less susceptible to desiccation than *D. pteronyssinus,* which was almost completely absent in the examined samples (ARLIAN et al. 1998a).

Significant relationships were found between the numbers of pyroglyphid mites per gram of dust and the temperature and RH values (separately for dust from the couch, carpet and arm-chairs examined). In all these cases, YATES corrected χ^2 was ≥ 99.99 ($p < 0.0001$). As mentioned above, it is commonly known that the critical equilibrium humidity is temperature dependent, especially for *D. farinae* (ARLIAN 1989, 1992; ARLIAN et al. 1990, 1998 a, b; CHANG et al. 1998). Some laboratory studies have shown that the temperature and relative humidity directly influence the duration of the mite life cycle, fecundity, survival, rate of feeding, and mite population dynamics (LARSON 1969; BRANDT & ARLIAN 1976; ARLIAN 1992; ARLIAN & DIPPOLD 1996; ARLIAN et al. 1998 a, b, 1999 a, b; CHANG et al. 1998; SALEH et al. 1991).

The increasing age of the building (in the course of the study) was significantly correlated only with the number of species, both pyroglyphid and total domestic mites in samples from the couch (PEARSON's correlation test, $p < 0.05$; $r = 0.45$ and 0.37, respectively). It is consistent with some other literature data that the age of a mattress was not related to allergen levels or mite levels in the dust samples (VAN DER HOEVEN et al. 1992).

3. Guanine levels

Results obtained by HALLAS et al. (1993) suggest that considerable amounts of guanine originate from sources other than house dust mites and that guanine quantifications (Acarex test) are of limited diagnostic value.

Population dynamics and age structure of the laboratory populations of *Dermatophagoides farinae*

The final increase of adults [Figs. 16 and 17] shows that population growth rates are at their peak or declining, and that the population becomes increasingly older (WOODFORD et al. 1979; COLLOFF 1992). This was probably because of the growing mite population density and/or because of the processed food consumption. It has also been shown (ARLIAN et al. 1998a) that mite populations may thrive better over a wider range of relative humidity when relative humidity conditions are dynamic rather than static as they were in the actual experiment. At the static conditions of relative humidity, *D. farinae* has much lower population growth than *D. pteronyssinus* (ARLIAN et al. 1998a).

Therefore, these results are helpful in the interpretation of age structures actually found in the natural populations of *D. farinae*, especially in the case of populations, which have an age structure indicative of a decline in the natural populations over the sampling period.

It should be also stressed, that surveys on the population dynamics of house dust mites (*D. farinae*, *D. pteronyssinus* and *E. maynei*) in laboratory conditions have been previously conducted by ARLIAN et al. (1998a). But those detailed experiments included only mutual relation between these species, without any analysis of age population structures of the particular species.

Ecological structure and seasonal dynamics of abundance of house dust mite populations from the family Pyroglyphidae in southern Poland. An analysis of pooled samples examined

1. Annual dynamics of abundance of dust mite species, *Dermatophagoides* spp. and *Euroglyphus maynei*.

Comparing the actual results with the seasonal dynamics of dust mite population previously observed in Upper Silesian flats (SOLARZ 1997), higher numbers of mites per gram of dust in winter were found during the actual study [Fig. 4].

2. Total age structure of pyroglyphid mite species

The distinctly lower number of protonymphs in comparison with tritonymphs and both adults in the pooled population of *D. pteronyssinus* seems to be characteristic for this mite, and was also reported by VOORHORST et al. (1969) from Holland, GRIDELET & LEBRUN (1973) from Belgium and by DUSBÁBEK (1979, 1995) from Prague (Czech Republic). In populations of *D. farinae,* there were usually found similar numbers of both nymphal stages and of adults (VOORHORST *et al.* 1969; DUSBÁBEK 1975), or even approximately equal numbers of all the above-mentioned stages (ratio 1:1:1:1 of protonymphs, tritonymphs, females and males, respectively) (DUSBÁBEK 1979). In both species, larvae were the least abundant developmental stage, especially those of *D. pteronyssinus*. The low number of larvae in populations of both species has also been stated in other studies (VOORHORST et al. 1969; GRIDELET & LEBRUN 1973; DUSBÁBEK 1975; ARLIAN et al. 1983; SOLARZ 2000b).

The total population structure of *E. maynei* is very similar to that observed by VOORHORST et al. (1969) and by COLLOFF (1992).

3. Seasonal dynamics of age structures of dust mite populations

These results are, in general, similar to those obtained previously in Poland (Upper Silesia region) in 1981-1986 (SOLARZ 1997, 1998, 2000b). Moreover, HALLAS & KORSGAARD (1997) found that populations of mites of the genus *Dermatophagoides* in dust from Danish dwellings have 4 annual generations. It has also been suggested that resting stages (and probably most of the larvae) are usually underepresented in samples (ARLIAN et al. 1983; HALLAS 1998). Therefore, mite numbers are low when they are in the resting (quiescent) stages of development, but the true size of the population is usually smaller or greater (HALLAS 1998).

The observed fluctuations of *D. pteronyssinus* densities in dwellings during the year with the highest abundance in the autumn months (October/November), are also consistent with most of the literature data from temperate climate regions (e.g. VAN BRONSWIJK 1981; DUSBÁBEK 1979; FAIN et al. 1990; VOORHORST et al. 1969; SOLARZ 1997). The higher abundance of *D. farinae* between February and April, actually observed, is astonishing. The slightly more favourable conditions for mites occurring during this period probably stimulate the surge of mites (mainly protonymphs), which presumably emerge from those which are quiescent (resting) (especially larvae and tritonymphs) (ARLIAN et al. 1983) [Tab. 44; Fig. 19]. On the other hand, the majority of these mites were damaged and, therefore, dead at the moment of collection of the dust samples.

V. FINAL CONCLUSIONS

– *Dermatophagoides farinae* is generally the dominant species in dwellings in Poland.

– Single-family houses (subagricultural settlement) were dominated by the chortoglyphid mite *Ch. arcuatus* and by *D. pteronyssinus*, whereas flats (urban and industrial area) – by *D. farinae.*

– The populations of *D. farinae* in dwellings in Poland usually have 4-5 annual generations.

– Research has revealed that temporal dynamics of an age structure is characteristic also for the laboratory populations of *D. farinae* held in optimal conditions of relative humidity and temperature.

– The dominance of adults in populations of *D. pteronyssinus* actually found in dwellings (pooled samples analysis) shows that population growth rates are at their peak or declining, and/or that these populations become increasingly older.

– Numbers of dust mites 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. Despite this, a higher abundance of mites (calculated per 1 gram of dust or per 1 sample) from August-December, and its peak in October, was generally observed during all years of the study.

– It should be stressed that during winter and spring the house dust mites (especially *D. farinae*) are also potential sources of allergens in dwellings in Poland.

– At the present time, the only way to guarantee lower mite allergen levels in modern dwellings is to remove the carpets and encase the mattress (or other sleeping accommodation) and bedding.

– Factors which tends to be associated with higher mite levels are: (a) increasing number of occupants (especially in small dwellings), (b) older homes, (c) single-family houses, (d) presence of carpets and upholstered furniture, (e) couches or sofas used as sleeping accommodations, (f) higher humidity, (g) low cleaning frequency, (h) working house-wife, (i) open kitchen, versus (a) smooth floors (uncarpeted), (b) wooden furniture, (c) frequent cleaning, (d) unemployed housewife, (e) central heating, (g) closed kitchen, (h) gas-cooking, and (i) smaller families in larger dwellings.

– Libraries are the places where, besides the dwellings, significant numbers of house dust mites and total domestic mites were recovered.

– Nests of synanthropic and semisynanthropic birds are not the important sources of pyroglyphid mites in dwellings in Poland, as well as the lofts of houses in urban areas.

– Sensitivity to non-pyroglyphid domestic mites found in house dust is generally not important in the examined localities in Poland because exposure to these species is minimal, with the exception of single-family houses in agricultural settlements, where the abundance of chortoglyphid mites may be of clinical importance.

– In farming environments examined in Poland, both storage and house dust mites may act as inhalant allergens. Therefore, for agricultural workers, all species of domestic mites should be considered for diagnostic testing and possible immunotherapy.

– The study suggests that allergenic mites, including also species of the family Pyroglyphidae, should be considered as occupational risk factors contributing to the occurrence of respiratory and dermal diseases among librarians, coal miners and agricultural workers.

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GUIDE TO AUTHORS

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The first page should contain: the title of the paper, full Author's name, abstract, key words, repeated author's name and full address (for every coauthor). In papers dealing with lower taxa, the higher ones should be noted in the title [e.g. Nestling food of *Phylloscopus bonelli* (Passeriformes: Sylviidae)]

Longer papers should be divided into several chapters numbered with Roman numerals. Acknowledgements should be gathered under a single heading (acapit) at the end of introduction.

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Nomenclature. First used binominal Latin names, according to Intern. Code of Zoological Nomenclature, should be used full i.e. together with not abbreviated names of their authors and dates after coma – be careful using brackets) [e.g. *Passer domesticus* (LINNAEUS, 1758) but *Aquila pomarina* BREHM, 1831]. If repeated later on in text the names might be abbreviated [e.g. *P. domesticus, A. pomarina*].

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References. The list of references must be complete and prepared in the following method:

Journal: COOPMANS P., KRABBE N. 2000. A new species of flycatcher (Tyrannidae: *Myiopagis*) from eastern Equador and eastern Peru. *The Winston Bulletin*, **112**(3): 305-312.

Book: VAURIE C. 1959. The birds of the Palearctic fauna. Passeriformes. Witherby, London.

Chapter: OSBORN J. W. 1978. Morphogenetic gradients: fields versus clones. In: P. M. BUTLER and K. A. JOYSEY (Eds.) – Development, function and evolution of teeth. Academic Press, London-New York-San Francisco. Pp: 171-201.

In the case of papers written in the other than Latin letters, if there is English (or German, or French) title in the summary it may be used:

TOMKOVICH P. S. 1985. Sketch of the Purple Sandpiper (*Calidris maritima*) biology on Franz Josef Land. *Ornitologiya*, **20**: 3-17. (In Russian with English summary).

If there is not English summary or even title – author's name must be transcribed and title of the paper also transcribed (using anglo-american transcription) or translated into English:

DEMENTEV G. P., GLADKOV N. 1952. Ptitsy Sovetskogo Soyuza. **2**. or: [The birds of the Soviet Union], **2**. (In Russian).

Manuscripts not conforming to the requirements will be returned for revision.