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Distribution Dynamics of Dust Mites in Two Locations of Patient Homes with Respect to the Allergical Kind

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Abstract: This study has been carried out to describe the distribution dynamics and abundance of house dust mites from two different locations (Bedroom and living room) within homes; their occupants suffer from different allergical kinds. Samples were taken each month during autumn season. Nine house dust mite species were identified. The abundance of the extracted dust mites from patient homes was higher than in non-patient homes. Living rooms were found to be embraced the highest individual numbers. The present data have indicated that differences between homes of chronic asthmatic persons and skin allergic occupant homes were significant. Two figures of interspecific relationship (Predation and competition) between the extracted mite fauna were recorded. In conclusion this study confirmed that house environment and the life style of occupants as well as their healthy status were the essential parameters enhance the house dust mite flourshing which in turn contribute to the spreading of dust mite allergens.

Key word: *Dermatophagoides pteronyssinus* · *Dermatophagoides farinae* · *Cheyletus malaccensis* · pyroglyphid · *Tyrophagus putrescentiae*

INTRODUCTION

House dust mite usually refers to those species of the mites family *Pyroglyphidae*, that are Known to commonly occure, although sometimes regionally, in the dust of human dewellings [1]. On the other hand, house dust mites constitute probably the most important source of allergens inside homes. Clinical evidence reveals a strong relationship between dust mite allergen levels and asthma, rhinitis [2], eczema, posriasis and scurf [3]. It was also clear that many allergic patients improved spontaneously when hospitalized in a clean room with regularly sterilized mattresses, carpets and rugs [4]. The contribution of fixed carpets and plankets as a source of house dust mites allergen in the home becomes relatively more important. It has also been shown that rugs constitute a suitable habitat for house dust mites [4,5]. De Boer *et al.* [6] mentioned that a rug from the living room floor of a Dutch home was found to contain more than 10.000 mites/m^2 in early April. On the other hand, Lintner and Brame [3] indicated that different climates in regions of the united states had no significant effect on the quantity of *Dermatophagoides pteronyssinus* or *D. farinae* allergen. However, regional climate differences seemed to influence the prevalence of either *D. pteronyssinus* or *D. farinae*. Several studies have indicated that the presence of suitable niches such as types of houses as they consisted of one floor with hygroscopic walls and characterized with high relative humidity without ventilation, oldness of concrete the building, crowdedness with residents are the most favorable factors influence the prevalence of different species of dust mites [7-9] in Saudia Arabia with exception of few studies about the morphology and abundance and house dust mites allergen [9-13], it could be decided that no study on such small delicated creatures have been conducted about the distribution dynamics in different locations within the home their occupants suffer from different kinds of allergy. Thus the comprehensive ecological studies on house dust mites are extremely important for a possible integrated control that can be taken to eliminate house dust mites and their allergens from the indoor environment. Consequently the aim of this study was

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to explore some of these issues by describing the distribution dynamics and abundance of house dust mites from two different locations bedroom and living room within homes their occupants suffer from (a) asthma and rhinitis or (b) eczema, posriasis and scurf.

MATERIALS AND METHODS

In order to evaluate the different locations within the home and the healthy effect of residents on the distribution dynamics and population density of house dust mites. Sampling was designed on the base of extensive survey covering four sites, Al-Thogher, Al-Fayhaa, Al-Nasim and Al-Sulymania in middle region of Jaddah. Sampling was carried out at monthly intervals during autumn 2008 from 30 homes of which 10 homes of healthy people serve as a control group and other 10 homes their occupants suffer from chronic asthma and rhinitis, the last 10 homes of the patient with eczema, posriasis and scurf. Dust samples were taken from known area about 15 m^2 of carpet floor from two locations inside each home (bedroom and living room) the room area ranged between 20-25 m^2. Carpets usually were of polyester and had been in use for at last two years. Dust was sampled using a vaccum cleaner (Boch 191T) with disposable bag. This procedures yield an average of 50 g dust. Mites were extracted using the modified Berlese's funnel, as recommended by Balogh [14]. Al-Assiuty *et al.* [15] recommended the use of a 25 W electric lamp suspended 10 cm above each sample. The downward migration of mites took place within two- four days. A small plastic container containing a mixture of 70 % isopropyl alcohol and ethylene glycol (9 to 1) was to receive the separated fauna. Specimens were collected with the help of high magnification an ordinary binocular stereomicroscope. Perminant preparation of specimes was carried out as described by Daniel *et al.* [16]. Identification of mounted specimens were carried out according to Colloff and Spieksma [17].

Data Processing: Population densityes were evaluated for each recorded species of dust mites as well as for one category of the total mites. The total number of individuals for each species was determined per sample (50 gram fine dust). K- dominance curve was graphically illustrated to explain the differences between mite communities under different house environments. For statistical analysis three ways analysis of varience ANOVA was used [18] using healthy status three levels (1) healthy, (2) chronic asthma & rhinitis, (3) eczema, posriasis and scurf), location within home two levels (bedroom & living room) and time three levels (September, October and November)as factors. Data of population density were transformed to log (n+1) to achieve homogeneos variance. Community composition was evaluated by the Shannon- Wiener index of diversity $\hat{H} = - \sum pi \log pi$ [19]. The obtained data were subjected to χ^2 test for comparison between homes and rooms.

RESULTS

The list of dust mites as well as the mean number of individuals / sample (sample = 50 gram dust) and their relative contributions from the chosen sampling sites are given in Table 1. The dust mites extracted were classified into five families of seven genera and nine species.

Table 1 shows that the arthropod fauna of examined carpets dust consisted mainly of pyroglyphidae (51.4% of the total mite individuals). This family was represented by *Dermatophagoides pteronyssinas* (29.9% of the total mite individuals) and *Dermatophagoides farinae* (21.5% of the total mite individuals). Figure 1 clearly shows that of the total dust mites extracted, the abundance of mites in patient homes with multiallergical skin disease is almost greater (53.34% of the total mite individuals) than at homes of asthmatic patients and homes of healthy peoples (38.11 and 8.55% of the total mite individuals, respectively). Concerning the home locations, data (Table 1) revealed that the relative population abundance of total dust mites was about two times (64.8%) higher in carpets of living rooms than in carpets of bed rooms (35.2%). Aminorities of the dust mite fauna of the total mite individuals from living room (6%) and bedroom (14%) of healthy people were recorded (Figure 2). Also, from the same figure the relative abundance of mites in living room and bedroom of persons suffer from multiallergical skin diseases is almost greater than that of recorded in the same locations their occupants suffer from chronic asthma. Population density of the total dust mites in the three types of homes of the two locations within home are given in Figure 3. Densities are notably lower in homes of healthy people than in the chronic asthmatic person home and multiallergical skin person homes (χ^2 test $P< 0.05$). Also, there was a significant difference ($P< 0.05$) between the mite population densities of chronic asthmatic person

Table 1: List of house dust mite species and the total number of individuals/sample (50 g dust) and their relative contributions in the two sampling rooms of patients and non-patients occupants. For explanation see legend Fig. 1

	Bedroom						Living room						
Species	Hb	r.c (%)	Asb	r.c (%)	Mb	r.c (%)	Hl	r.c (%)	Asl	r.c (%)	Ml	r.c (%)	% of total
Family Pyroglyphidae													
Dermatophagoides pteronyssinus	889	15.49%	5142	32.00%	6122	30.00%	812	18.01%	10580	35.69%	12299	28.22%	29.88
Dermatophagoides farinae	746	12.99%	3696	23.00%	4081	20.00%	731	16.21%	8157	27.52%	8346	19.15%	21.47
Family Cheyletidae													
Cheyletus malaccensis	660	11.50%	1926	11.99%	3061	15.00%	612	13.57%	3853	13.00%	5816	13.35%	13.28
Family Acaridae													
Acarus siro	411	7.16%	562	3.50%	448	2.20%	267	5.92%	652	2.20%	1631	3.74%	3.31
Aleuroglyphus ovatus	606	10.56%	337	2.10%	810	3.97%	321	7.12%	474	1.60%	1422	3.26%	3.06
Suidasia nesbettii	643	11.20%	1526	9.50%	2040	10.00%	568	12.60%	2430	8.20%	5232	12.01%	10.37
Family Glycyphagidae													
Blomia tropicalis	574	10.00%	1565	9.74%	2005	9.82%	231	5.12%	1919	6.47%	4076	9.35%	8.40
Blomia freeman	681	11.86%	932	5.80%	1632	8.00%	466	10.33%	948	3.20%	2862	6.57%	6.27
Family Tyrophagidae													
Tyrophagus putrescentiae	531	9.25%	384	2.39%	210	1.03%	501	11.11%	630	2.13%	1892	4.34%	3.96
Total	5741	100%	16070	100%	20409	100%	4509	100%	29643	100%	43576	100%	
% of total	35.2%						64.8%						100%

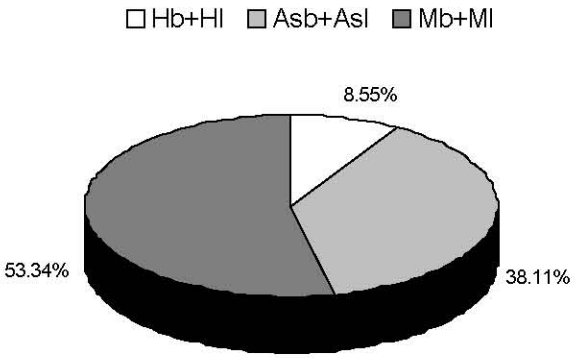

Fig. 1: Composition of the total dust mites
Hb: Bedroom of healthy persons
Hl: Living room of healthy persons
Asb: Bedroom of asthmatic persons
Asl: Living room of asthmatic persons
Mb: Bedroom of multiallergic skin disease
Ml: Living room of multiallergic skin disease

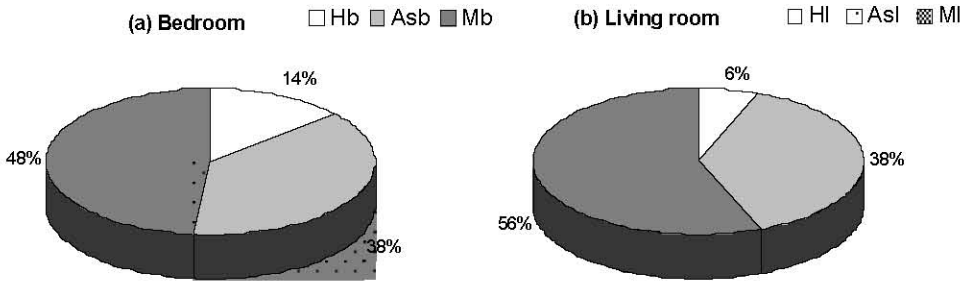

Fig. 2: Composition of the total dust mites in (a) bedroom; (b) livig room. For explanation see legend Figure 1

home and multiallergical skin person homes in both sites. The relative importance of house dust mites is also shown in Table 1 and Figure 4. In bedroom of multiallergical skin person homes *Dermatophagoides pteronyssinas* and *Dermatophagoides farinae* represent 50% of the total mite individuals. This value corresponds to 28% of the total mite individuals in healthy person homes. The same pattern of gradient is observed in living room. However, in chronic asthmatic person home both species represent the highest relative abundances 55%

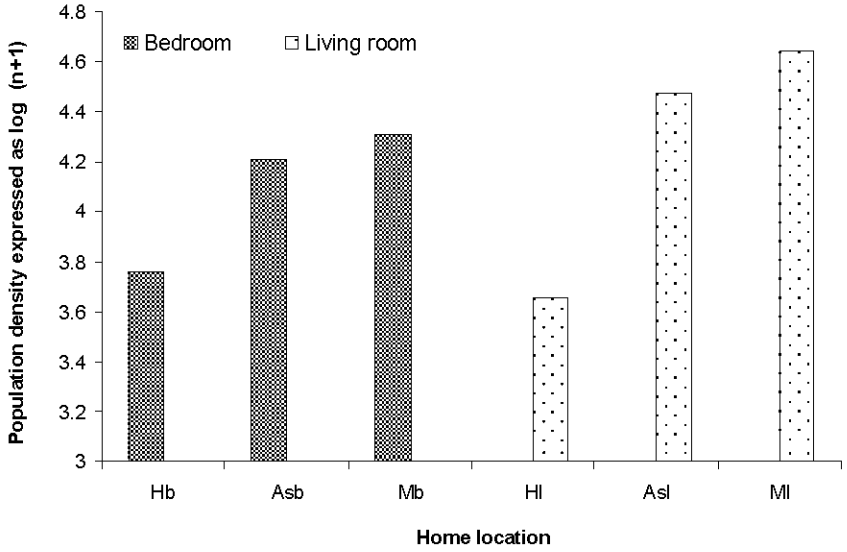

Fig. 3: The population density of total dust mites in patient and non-patient bedroom and living room. For explanation see legend Figure 1

Table 2: Species diversity (H) and equitability (J) of the house dust mite communities in sampling sites

	Home location					
	Bed room			Living room		
Parameter	Hb	Asb	Mb	Hl	Asl	Ml
Species diversity H	2.177	1.874	1.896	2.133	1.718	1.968
Equitability J	0.991	0.853	0.863	0.971	0.782	0.896

Table 3: Three- way analysis of variance for the log number of dust fauna

Source	Sum-of-squares	Df	Mean-square	F-ratio	P
Site	0.732	1	0.732	5.267	0.025
Diseases	6.639	2	3.319	23.880	0.000
Time	0.180	2	0.090	0.647	0.527
Site *diseases	0.999	2	0.499	3.593	0.033
Site* Time	0.015	2	0.007	0.053	0.949
Diseases* Time	0.101	4	0.025	0.181	0.948
Site*diseases * Time	0.263	4	0.066	0.474	0.755
Error	10.009	72	0.139		

of the total mite individuals in bedroom and 63.8% of the total mite individuals in living room. Regarding the diversity of dust mites fauna in both locations within home, it has been concluded that species diversity values recorded in bedrooms and living rooms of healthy people reflected the high similarity between community composition (Table 2). The highest Shannon index of diversity values were recorded in bedrooms and living rooms of healthy people 2.18 decits and 2.13 decits, respectively. However the diversity index showed the same pattern of variation in the two levels of patient homes, since a slight decrease in eczematic patient homes until it reached the minimum level in asthmatic patient homes. A three way ANOVA (Table 3) applied to the log of number of individuals revealed that the effect of site inside home on dust mites abundance was considered statistically significant ($P<0.025$). Also, the relationship between the dust mite abundance and allergical kind was found to be highly significant.

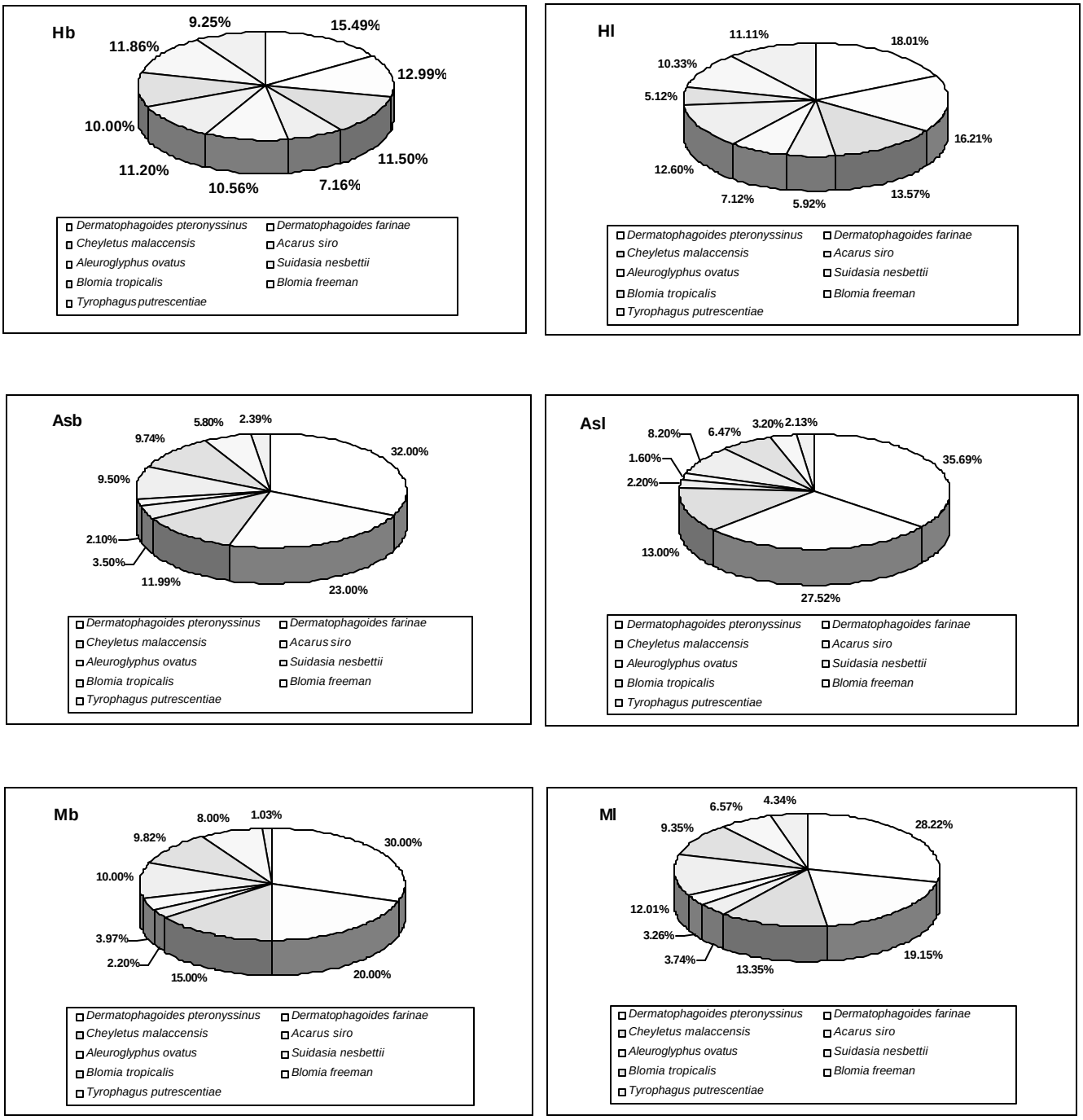

Fig. 4: Composition of dust mite species in the six sampling sites
Hb: Bedroom of healthy persons
Hl: Living room of healthy persons
Asb: Bedroom of asthmatic persons
Asl: Living room of asthmatic persons
Mb: Bedroom of multiallergic skin disease
Ml: Living room of multiallergic skin disease

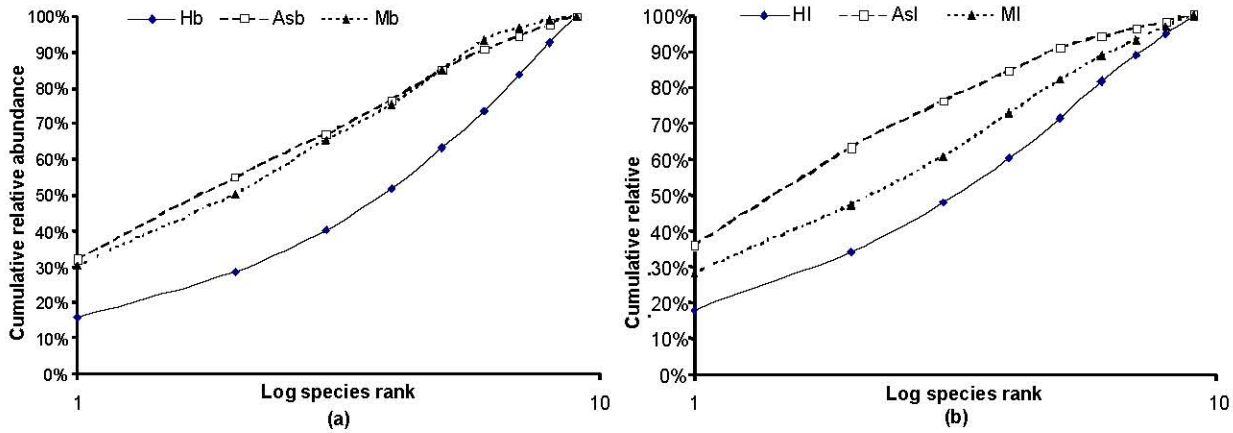

Fig. 5: K- dominance curves of house dust mite in (a) bedroom (b) living room. For explanation see legend Figure

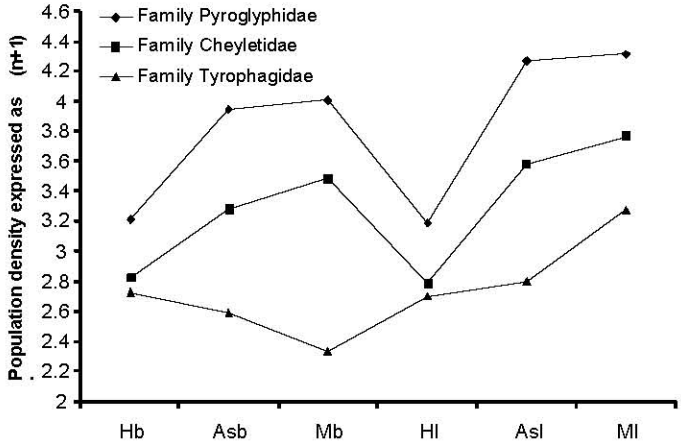

Fig. 6: Fluctuation patterns of the population densities of *Pyroglyphid* mite species (*D. pteronyssinus* + *D. farinae*), *Cheyletus malaccensis* and *Tyrophagus putrescentiae* from healthy and patient homes (For explanation see legend Figure 1)

However time as a factor was found to be not significant. Results of the ANOVA also revealed a significant site- disease interaction, but no significant difference due to site- time, disease- time and site- disease - time interactions.

Figure 5 a and b shows the pattern of K-dominance curves for house dust mites collected from carpets of bedrooms (5a) and living rooms (5b). As for the cumulative ranked abundances of dust mite species against log species rank. It could be observed that both studied locations within house showed the same curved pattern. The difference could be detected between the patient homes, since the house dust inhabiting pyroglyphid mites represent a major component in carpets of patient people homes. However, in healthy people homes the recorded mite fauna are composed of nine speices abundant. They were a less evenly distributed since equitability values are close to unity (0.99 in bedroom and 0.97 in living room). With respect to the biological association among the recorded house dust inhabiting fauna, there were two patterns of interspecific associations could be derived from the obtained data in Figure 6 and from the correlation coefficient values; the first pattern was recorded between representatives of family *Pyroglyphid*, *D. pteronyssinces* and *D. farinae* and the predator mite species *Cheyletus malaccensis* where the r-value being significantly positive (0.92). The second pattern was recorded between also both species of *Pyroglyphid* mites and *Tyrophagus putrscentiae*, where the r-value was significantly negative (- 0.69). Accordingly the positive correlation between the abundance of *Pyroglyphid* mites and *Cheyletus* species could described as a predation Figure. However the negative correlation with *Tyrophagus putrescentiae* may represents a one of the competition trend between organisms.

DISCUSSION

It has been suggested that a knowledge of the house dust inhabiting mites associated with particular home locations and different kinds of respiratory and skin allergy might provide a useful biological basis about the conditions for the development of house dust mites. Monthly changes in population abundance of dust mites have been studied in various regions and these studies have demonstrated seasonally fluctuated populations with peaks in certain periods [9, 20,21,22]. The present study indicates that monthly stable of house dust mites populations during short-term study from September till December (autumn season) could be recroded. Accordingly the effect of time on the mite abundance was found to be insignificant. This is probably related to the small differences in climate characteristics inside homes during sampling date. On the other hand, the chosen autumn season as sampling date for the present study because this season is the most favourable season for house dust mite flourishing. Domrov [23] found that the number of house dust mites drops after 6 hot days and he stated that a dry and hot summer is unsuitable for studying the normal seasonal incidence of house dust inhabiting mites.Moreover several studies have indicate that autumn is more favourable season for dust mite development [9, 21,22,24]. When community composition of house dust mite is compared between homes their residents represented two different kinds of healthy risks; respiratory allergy (chronic asthma and rhinitis) and skin diseases (eczema, posriasis and scurf). The present data revealed that homes of non-patient persons appear to have the lowest population density of the total species of dust mites. Also *Pyroglyphid* mites (*Dermatophagoides pteronyssinus* and *D. farinae*) were the common species, but other species were also well represented especially *Cheyletus malaccensis*, *Suidasia nesbettii* and *Blomia freeman*. In patient homes the reverse is true, since the highest total population densities were recorded and the *Pyroglyphid* mites *D. pteronyssinus* and *D. farinae* remained the most common mite species, however the other species were represented by a reatively low number of individuals. Arlian *et al.* [25] and Rimac *et al.* [26] indicated that the *Pyroglyphid* mites *D. pteronyssinus* and *D. farinae* were the main allergenic source in house dust and they have been described to cause hypersensitivity reactions in human with clinical manifestations in the form of allergic rhinitis, asthma and skin hazards. These results about the population abundance of dust mites and related health effect are in line with previous findings suggestive of the healthy person effect in occupant exposed to respiratory and skin hazards including mite allergens. On the other hand, the present data have indicated that differences between homes of chronic asthmatic persons and skin allergic occupant homes are significant (ANOVA), where house dust mites in homes of skin disease occupant are much more abundant than in the houses of persons with respiratory allergic disease. This is probably attributed to the fallen skin scales may create a favourable habitate as a food item for mite development. Van Bronswijk [27] observed that scales of human skin and fiber of clothing did not penetrate deeper and he also indicated that house dust mites live primarly near the surface of a mattress. Numerous dust particles such as skin scales, textile fibres and food crembs accumulate on floor and furniture of our homes and offer a rich diet to saprophytic organisms [28]. It could be indicated that the indoor temperature and relative humidity were of extreme important factors in determining a different environmental inside home conditions thus due to the differences between individual lifestyles of patient homes and homes of healthy people could lead to a subsequent divergence between the abundance of mite communites harbour both types of homes [9,12,13]. An evidence could be drived from the obtained data of the species diversity and the pattern of K- dominance curves confirms such differences between the population densities in non-patient homes and homes of respiratory and skin allergic persons.

With respect to interspecific relationship between the recorded dust mites species the obtained data revealed that a significant negative correlation between the abundance of *D. pteronyssinus*, *D. farinae* and *Tyrophagus putrescentiae*. These observations suggest that the dissimilarity in fluctuation pattern of these species under all studied conditions do not necessarily imply dissimilarity in behavioral response of these species to environmental factors. Thus it could be suggested that the inter specific negative correlation of the abundance of these species may reflects a clear compitative figure between them. Sharp and Haramoto [29] reported a possible competition between *Pyroglyphid* mites and *Tyrophagus putrescontiae*, *Glycyphagus domesticus* and *Suidasia medanensis* in floor dust. On the other hand the striking increase in relative abundance of the predator dust mite *Cheyletus malaccensis* which accompanied that of the predominated species of *Pyroglyphid* mites may represents an evidence confirm the predation habits of *Cheyletus malaccensis* against *Pyroglyphid* mite species.

Study of Lustgraaf [28] have indicated that the low incidence of Cheyletidae did not suggest that these predator mites effectively controlled the *Pyroglphid* mite populations.

The present data revealed that in patient homes the relative population abundance of the most dust mites species *D. pteronyssinus* and *D. farinae* were about two times higher in carpets of living rooms than in carpets of bed rooms. Arlian *et al.* [25] mentioned that *D. pteronyssinus* and *D. farinae* occure in homes in humid regions worldwide. Their densities vary tremendously between regions between home within a region and between locations within a home. The present results are in disagreement with Marks *et al.* [30] and Custovic *et al.* [31] who mentioned that dust from the bed often has higher house dust mite allergen concentrations than other domestic sites and beds are the only site where house dust mite allergen levels are associated with severely of asthma. Variations in the population density of house dust mites in different locations within home could be easy explain on the base of the differences in the microclimate within homes as rooms were not on the same floor. As well as individual lifestyles in living rooms (as for eating, sleeping, gesting) and occupant density can influence aspects of mite ecology. Accordingly numerous dust particles such as skin scales, textile fibers, pollen, food crumbs accumulate on floors of our living rooms and offer a rich diet to mite organisms. Not present in the back references list.

It could be concluded that this study confirmed that house environment is the essential parameter enhance the house dust mites flourshing which in turn contribute to the spreading of dust mite allergens involves variable exposure to respiratory and skin irritants.

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