Prevalence of House Dust Mites in Two Levels of Dorms (Hotel and Motel) of Jaddah District Western Saudi Arabia

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Abstract: This study was designed to test the null hypothesis that the different level of the dorms has a real effect on the quantitative and qualitative existence of the house dust mites (HDM). Also to determine the most important factors that control the distribution and colonization of HDM. The study was conducted at Jeddah city western Saudi Arabia. 12 dorms were tested; 6 hotels and 6 motels. The samples were collected twice a month along three months (Dec, Jan., Feb. 2009). Mites were separated using modified Berleses tunnel. Ten species of HDM were extracted from studied dwellings . The mite assembelage in motels was dominated by *Dermatophagoides pteronyssinus* (23.7%). In hotels to the mite collection was co-dominated by *D. pteronyssinus* (27.6 %) and *D. farinae* (21.8 %). The mean total individuals in motels was 5012 individuals per 50 grams of dust in correspond to 2149 individuals per 50 grams of dust in the hotels. Up to 66.6% of the motels had a population of more than 100 individuals per 1 gram of dust, however non of the studied hotels embraced more than 50 individuals per 1 gram of dust. In conclusion the level of the dorms had a clear effect on the quantitative existence of HDM, but a qualitative effect can not be identified. Also, it was speculated that the most frequent cleaning as well as density and economic status of residents were the main factors matched with a direct impact on the mite contamination rate of the dorms.
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1. Introduction

House dust mites are ubiquitous in public buildings and homes worldwide. They are medically important creatures, where many species are the source of allergens that sensitize and induce allergic reactions in genetically predisposed persons (**Arlian, 2000 & 2002**). The most prevalent allergy-causing mites in homes differ geographically between homes within a geographical region and among areas within a home (**Arlian at al., 2002; Edrees 2009**).

Indoor relative humidity, temperature and enough food are generally considered to be the most important factors determining community composition and population dynamics of the major groups of dust arthropods. The optimum condition for development being between 18 – 27 °C (**Soltani *et al.*, 2011**) with a relative humidity of 70% - 75% (**Valero and Serrano, 2004**). Their major food source is skin scales, textile fibres, food crembs, hair and wood pets fungi, plant pollen and organic deprise (**Vande Lustgraat, 1978; Edrees, 2009 and Soltani *et al.*, 2011**).

Under optimal breeding conditions about 5000 of house dust mite individuals may be present in just 1g of mattress dust but up to 15600 has been recorded (**Soltani *et al.*, 2011**). It has also been shown that rugs constitute a suitable habitat for house dust mites (**De Boer, 1990; De Boer and Kuller, 1995**). **De Boer *et al.* (1999)** mentioned that a rug from the living room floor of a dutch home was found to contain more than 10.000 individuals/m2 in early April. **Edrees (2009)** recorded that about 115 mites/g of dust and 90 mites/g of dust was extracted from carpet floor of bedroom and living room of healthy persons homes in middle region of Jeddah respectively. However in the same area carpets from the bedroom and living room floors in asthmatic person homes were found to contain 321 mites/g of dust and 593 mites/g of dust respectively. Densities above 100 mites/g of dust are considere as a risk factor for sensitization to allergies such as rhinitis, conjunctivitis, atopic eczema and asthma, whereas 500 mites/g of dust is a major risk factor in acute asthma in those allergic to HDM (**Korsgaard, 1983; Arlian *et al.*, 1992; Service, 2004; Soltani *et al.*, 2011**).

Most surveys of house dust mite fauna conducted around the world report that the allergy-producing mites are worldwide species that occur in homes, schools, churches, day care centers, office workplace; seats in automobiles; clothes; stuffed toys, banks; libraries, museums, hotels and ski lodges and other public places (**Arlian *et al.*, 2002**).

With respect to mites found in dwellings a survey of 41 dwellings in upper Silesia, Poland **Solarz (1998)** found the most to be infected with both

D. farinae and *D. pteronyssinus*. The former was the most abundant species overall, but in some dust samples, *D. farinae* was the predominant species (33.3 %) while in other samples *D. pteronyssinus* was more prevalent (27.5%). In some cases both species were equally prevalent. **Soleimani and Rafinejad (2008)** studied the fauna of house dust mites in hotels an inns of Bandar Abbas Iran, they indicated that the rate of house dust mites infections were 91.8, 85.7; 8.2, 10.9 and 0, 3.4% for *D. pteronyssinus*, *D. farinae* and *Cheyletus malaccensis*, respectively.

It is important to know the major mite breeding locations and which mite species are present in a public places when performing diagnostic testing prescribing immunotherapy. Although the presence of numerous dwellings dorms in Jeddah city western Saudia Arabia due to the religious tourism, no study on such medically important organisms have been conducted about the distribution, abundance and diversity in such public buildings. Accordingly this study was achieved in Jeddah city to test the null hypothesis that the different level of the dorms has a real effect on the quantitative and qualitative existence of the house dust mites, hence on the identification of the most important factors that control the distribution and colonization of such microarthropod organisms.

2.Materials and Methods

The present study was conducted at Jeddah city, western Saudi Arabia. The house dust mite samples were collected from 12 dorms (6 hotels and 6 motels). Using a vacuum cleaner (Boch 191 T) with disposable bag, dust was sampled from known area of carpet floor (4 m^2 for 5 min.) from six randomly selected rooms inside each dorm. The samples were collected twice a month along three months, Decembre, January and February, 2009. Mites were separated using modified Berleses funnel as recommended by **Al-Assiuty *et al.*(1993)** and **Edrees, 2009**.

Site description:

12 dorms of Jeddah city were tested. The city is located in a coastal region. It has a hot and humid climate. The tested dorms represented two levels:

The lower level group "Motels"

Six motels were selected. These were in "Slums" i.e. areas of a low quality living conditions, at Al- Hendawya and Bab Sherif areas, as here the buildings were more than 25 years old. The room temperatures in these buildings ranged between 24-26 °C. the humidity level ranged between 72- 75 %. The buildings usually comprised of three floors and the floors were made of cement covered with old chappy rugs. The rug thickness was 3 centimetres. Each room contained 4 wood beds. During the study season the average number of the dwellers was almost 335 person per motel per month. Some of the rooms contained fans, while others contained old fashioned air conditions. The average amount of dust collected each time ranged between 5- 10 g/m^2. Cleaning was done once or twice a month, using vacuum cleaners, however without using any detergents either nor the floors or the furnitures.

The higher level group "Hotels"

This group comprised six hotels, these were almost four-star-hotels in semi-publio areas, not so far from Bab-Sherif area. The buildings ranged between 10- 15 years of age. The room temperature ranged between 22- 25 °C, and the humidity level ranged between 65- 70 %. Each building comprised of 3 floors, and the floors were made ceramic covered with carpets of 4 cm thickness. Each room contained 4 wood beds. The average number of the dwellers was 180 person per hotel per month. The rooms contained modern air conditions. The average amount of dust collected was 2 g/m^2. Cleaning was done on weekly regular basis using vacuum cleaners, detergent and liquid cleaners were usually used for cleaning.

Statistical analysis

The pooled data (count per $4m^2$x 6 rooms x 3 months) was determined per 50 gram of dust. Data of population densities were logarithmically transformed to achieve homogeneous variance. Means of house dust mite density between and within the two levels of the chosen dorms were compared by non-parametric Kruskal- wallis test. Bray- Curtis similarity index was used to measure the degree of overlap between house dust mite compositions in different dorms (**Krebs, 1999**). This index was calculated for all building pairs using the pooled community data per dwelling. To test if the mite assemblage was affected by the environmental variables and to determine which parameter(s) were responsible a PCA bi-plot of samples and species was made and environmental variables were included.

3. Results

All house dust mite species extracted from the two chosen groups of dorms were counted and identified. Tables 1&2 list the species composition per building. Ten species of HDMs were represented at the 12 sampling sites. The mite assemblage in motels was dominated by *Dermatophagoides pteronyssinus* (23.65 % of the total individuals) and in hotels mite collection was co-dominated by *Dermatophagoides pteronyssinus* (27.6% of the total

individuals) and *Dermatophagoides farinae* (21.8 % of the total individuals) (Tables 1&2 and Fig. 2). All the recorded species occurred at all sites and there was no difference in species richness and species diversity among the dorms of the same level, motels or hotels. However, species richness differed significantly among the two levels of dorms (Tables 1&2).

The density of the collected HDM from motels differed significantly ($P<0.01$) as compared with that of recorded from hotels. Since the mean total individuals in motels was 5012 ind/50 g of dust correspond to 2149 ind/50 g of dust in hotels. Kruskal- Wallis test also was applied to the data pooled overall sampling months. This showed no significant differences ($P> 0.05$) between dorms of the same level, with exception of dorms H5 and H6 in hotel group and dorms M3 and M6 in motel group, where densities found to be significantly differed, since the least population densities were achieved in these dorms (Fig. 1).

Similarity in species composition between pair wise assemblages was analysed using the Bray-Curtis similarity index. Table 3 shows a strong overlapped figures between dorm pairs within the same level. The Bray-Curtis similarity index ranged from 0.74 to 0.93 within hotels and from 0.79 to 0.94 within motels. However, the Bray-Curtis similarity index between communities at different levels of dorm pairs was significantly lower (similarity ranged from 0.46 to 0.75) than within the same level.

In order to evaluate the structure of the house dust mite assemblages, further HDM species were numerically arranged in descending order and a rank abundance curves (Figs. 3a, 3b and 3c) were made for both levels of dorms. Figs. 3 a&b represents the data of the higher and lower level of dorms (hotels and motels). There was a linear decrease of log abundance with species rank, which is consistent with the geometric series model for community structure. Figure 3c indicates the rank abundance lines of all chosen dorms. It was clearly that the bundle of lines does not functionally separate according to the differences between dorms, this may indicates that there is no effect on the dominance structure of mite assemblages.

To describe the relationships among the number of individuals of every dominant mite species (4 species from hotels and 5 species from motels) and environmental variables; i.e. occupant density, age of building, relative humidity, dust quantity, cleaning and carpet sickness, an ordination diagram using PCA was made (Fig. 4). Data show a strong positive association of *Dermatophagoides pteronyssinus* with carpet sickness and cleaning manner. However, *Aleuroglyphus ovatus* showed a positive correlation with occupant density, relative humidity, dust quantity and building age. Little effect of the chosen factors on *Dermatophagoides farine* could be observed.

Figure 5 shows a biplot of the first two axes of the PCA, position of the sampling sites and their associations with the five dominant mite species in both levels of dorms. The two arbiterary curves in the figure separated mostly between hotel-group (1-6 open circles), right area of the graph and motel-group (7-12 open circles) left area of the graph. Also, between the position of the five dominant species (open triangles), the overlapped area (shaded area) comprised the shard four dominant species in both levels of dorms these are: *Dermatophagoides pteronyssinus*, *D. farinae*, *Cheyletus malaccensis*, *Aleuroglphus ovatus*. The fifth dominant species *Suidasia nesbettii* lies out of overlapped area to the left side graph where it was more associated to the lower level of dorms (motels). It is interesting to note that the functional position of each studied dorm among the graph (Fig. 5) was the total number of the individuals of the dominant species in each dorm of hotels and motels.

As for the association between the abundance of HDM individuals with the environmental variables figure 6 shows that buildings exposed to a regular cleaning manner using vacuum cleaners, and/or detergent and liquid cleaners (hotels 5 and 6 and motels 9 and 12, Fig. 6) showed the least number of house dust mites. However, the largest individual number in motel 10 (Fig. 6) was found to be strongly associated to the dust quantity, high relative humidity and high resident number.

Table 1. List of house dust mite species and the total number of individuals /sample (50g of dust) and their relative contributions in the six hotels.

Species	H1	RC %	H2	RC %	H3	RC %	H4	RC %	H5	RC %	H6	RC %	Total	RC %
Dermatophagoides pteronyssinus	659	27.98	515	21.4	606	25.95	580	24.59	748	41.6	448	27.33	592.7	27.58
Dermatophagoides farinae	500	21.23	667	27.71	580	24.84	457	19.37	314	17.46	287	17.51	467.5	21.76
Cheyletus malaccensis	282	11.97	337	14	267	11.43	317	13.44	95	5.284	193	11.78	248.5	11.56
Suidasia nesbettii	267	11.34	235	9.763	264	11.31	257	10.89	146	8.12	133	8.115	217.0	10.1
Carpoglyphus lactis	150	6.369	139	5.775	204	8.737	112	4.748	132	7.341	164	10.01	150.2	6.988
Blomia tropicals	141	5.987	157	6.523	111	4.754	127	5.384	100	5.562	115	7.016	125.2	5.825
Aleuroglyphus ovatous	129	5.478	148	6.149	94	4.026	175	7.418	73	4.06	58	3.539	112.8	5.251
Acarus siro	117	4.968	109	4.528	80	3.426	148	6.274	113	6.285	183	11.17	125.0	5.817
Blomia freeman	63	2.675	52	2.16	70	2.998	115	4.875	47	2.614	30	1.83	62.83	2.924
Tyrophagus putrescentiae	47	1.996	48	1.994	59	2.527	71	3.01	30	1.669	28	1.708	47.17	2.195
Total	2355	100	2407	100	2335	100	2359	100	1798	100	1639	100	2149	100
Shannon diversity index(H')	H' = 2.014		H' = 2.003		H' = 1.991		H' = 2.096		H' = 1.849		H' = 2.038		H' = 2.027	
Equitability	J = 0.874		J = 0.870		J = 0.865		J = 0.910		J = 0.803		J = 0.885		J = 0.880	
Species richness	SR = 1.159		SR = 1.156		SR= 1.160		SR = 1.159		SR = 1.201		SR = 1.216		SR = 1.173	

Table 2. List of house dust mite species and the total number of individuals /sample (50g of dust) and their relative contributions in the six motels.

Species	M1	RC %	M2	RC %	M3	RC %	M4	RC %	M5	RC %	M6	RC %	Total	RC %
Dermatophagoides pteronyssinus	1258	23.73	1465	27.05	1028	26.35	1231	21.29	1279	23.86	852	19.76	1186	23.65
Dermatophagoides farinae	1092	20.61	985	18.19	645	16.53	1242	21.48	992	18.51	755	17.51	951.8	18.99
Cheyletus malaccensis	601	11.34	500	9.234	516	13.22	817	14.13	459	8.562	713	16.54	601.0	11.99
Suidasia nesbettii	845	15.94	727	13.43	408	10.46	857	14.82	922	17.2	542	12.57	716.80	14.3
Carpoglyphus lactis	169	3.188	449	8.292	136	3.485	318	5.5	266	4.962	125	2.900	243.80	4.865
Blomia tropicals	79	1.491	82	1.514	42	1.076	59	1.02	48	0.895	66	1.531	62.670	1.25
Aleuroglyphus ovatous	538	10.15	448	8.273	458	11.74	582	10.07	637	11.88	423	9.812	514.36	10.26
Acarus siro	260	4.905	283	5.226	221	5.664	254	4.393	278	5.186	279	6.472	262.50	5.237
Blomia freeman	142	2.679	141	2.604	127	3.255	92	1.591	141	2.631	109	2.528	125.30	2.501
Tyrophagus putrescentiae	317	5.981	335	6.187	321	8.227	330	5.707	339	6.323	447	10.37	348.20	6.947
Total	5301	100	5415	100	3902	100	5782	100	5361	100	4311	100	5012	100
Shannon diversity index(H')	H' = 2.024		H' = 2.051		H' = 2.049		H' = 2.023		H' = 2.035		H' = 2.083		H' = 2.056	
Equitability	J = 0.879		J = 0.891		J = 0.890		J = 0.879		J = 0.884		J = 0.905		J = 0.893	
Species richness	SR = 1.049		SR = 1.047		SR = 1.088		SR = 1.048		SR = 1.048		SR = 1.075		SR = 1.056	

Table 3. The degree of overlap between house dust mites composition in different dorms (6 hotels and 6 motels) calculated for all building pairs using Bray-Curtis similarity index.

Dorms	H1	H2	H3	H4	H5	H6	M1	M2	M3	M4	M5	M6
H1		0.903	0.93	0.921	0.823	0.781	0.615	0.606	0.751	0.579	0.610	0.707
H2			0.895	0.890	0.742	0.761	0.625	0.615	0.754	0.588	0.620	0.717
H3				0.889	0.785	0.771	0.612	0.603	0.743	0.575	0.604	0.703
H4					0.775	0.776	0.616	0.607	0.740	0.571	0.605	0.697
H5						0.829	0.507	0.499	0.631	0.474	0.502	0.589
H6							0.468	0.465	0.575	0.442	0.468	0.531
M1								0.912	0.847	0.938	0.943	0.843
M2									0.832	0.883	0.922	0.820
M3										0.799	0.830	0.892
M4											0.917	0.821
M5												0.813
M6												

Within the same level (hotels H1- H6)

Within the same level (motels M1- M6)

Between the two levels motels and hotels

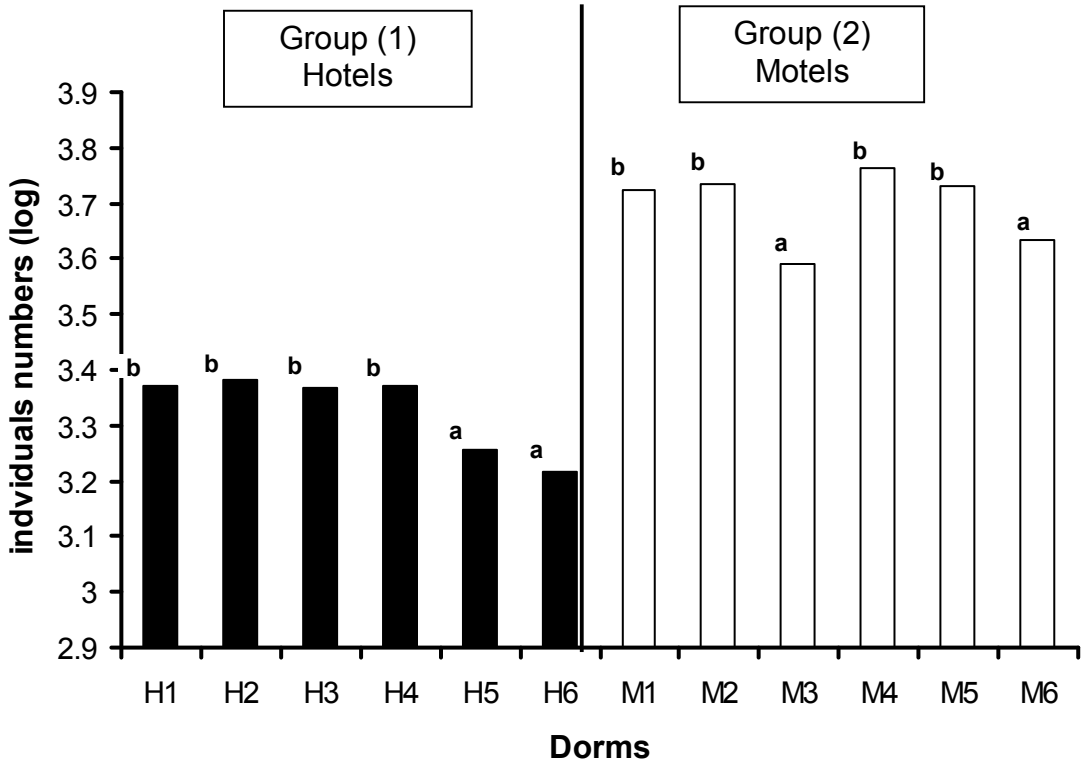

Figure 1. The population density per 50 gram of dust of the total mites (10 species) in the 6 motels and 6 hotels (H1- H6) and six motels (M1- M6). The same letters of a and b indicate insignificant difference between each pairs among each group and vice versa

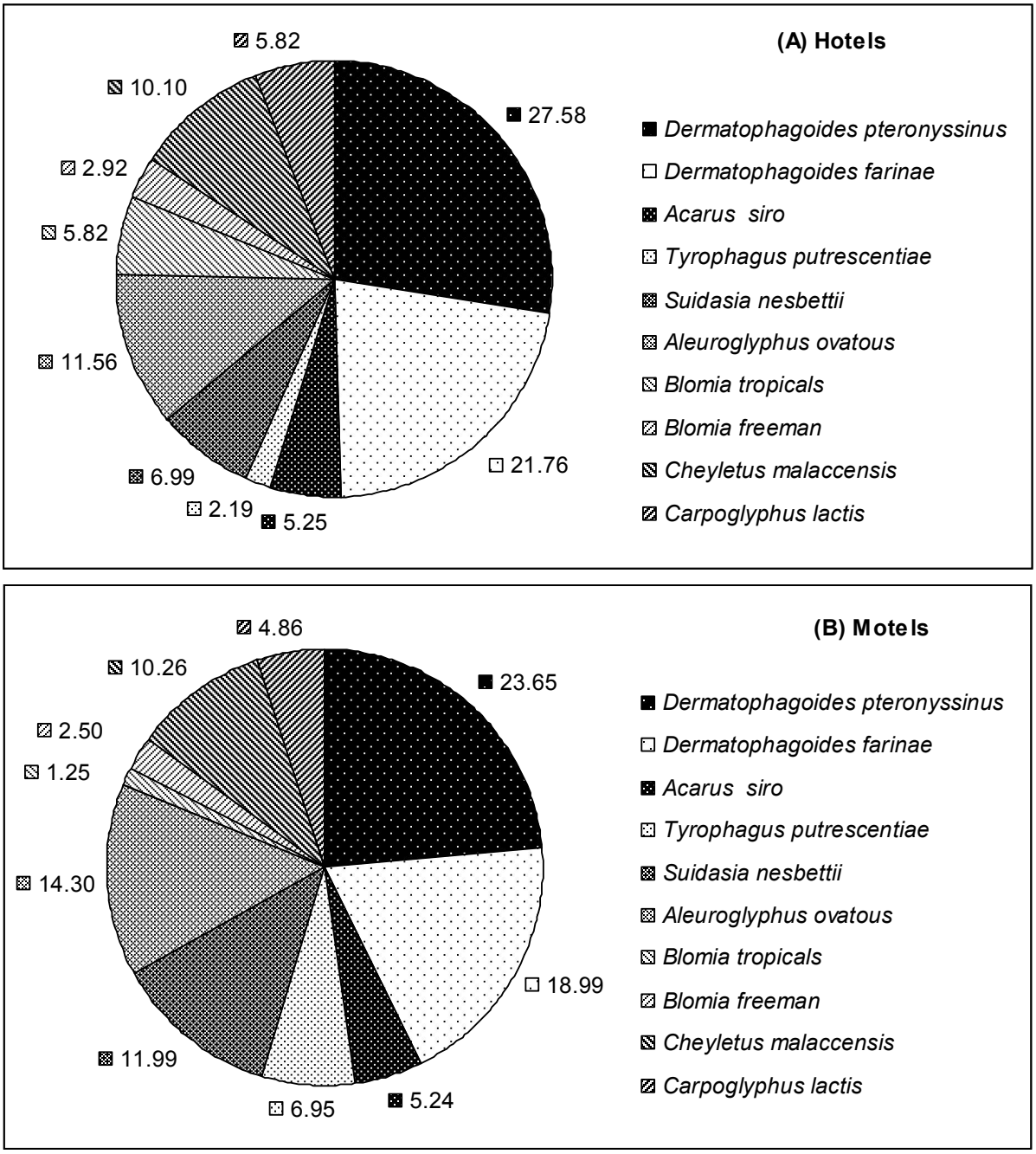

Figure 2. The relative occurrence of the ten species of the house dust mite individuals from (A) Hotels and (B) Motels.

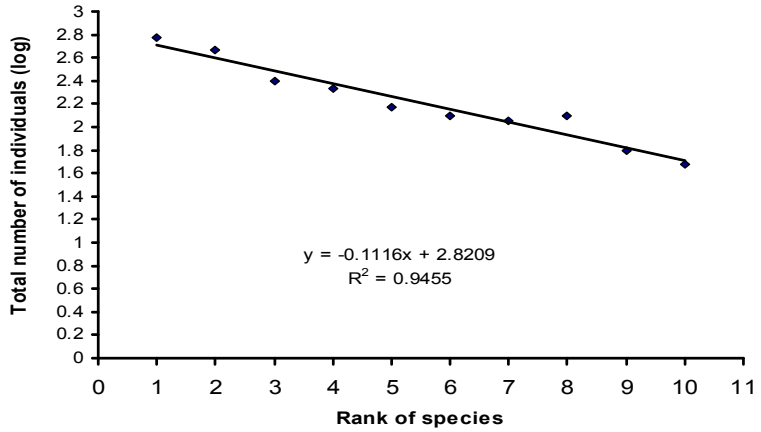

Figure 3a. Rank abundance of the total house dust mite assemblages at hotels

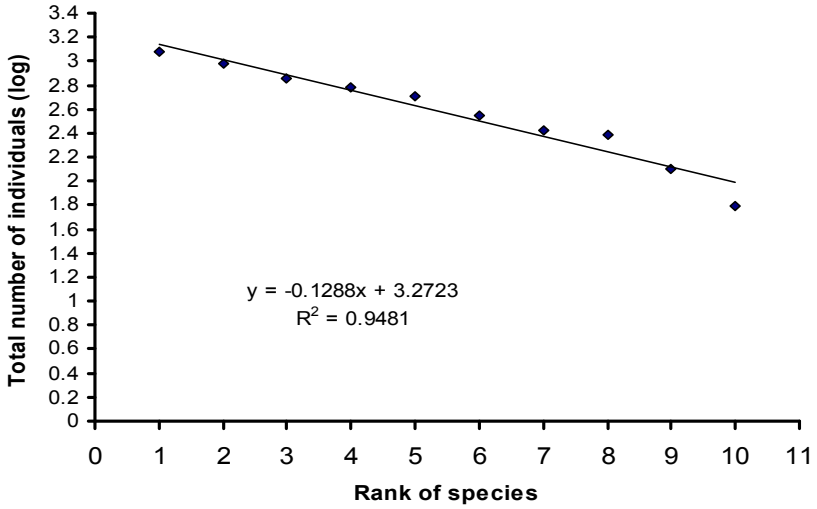

Figure 3b. Rank abundance of the total house dust mite assemblages at Motels

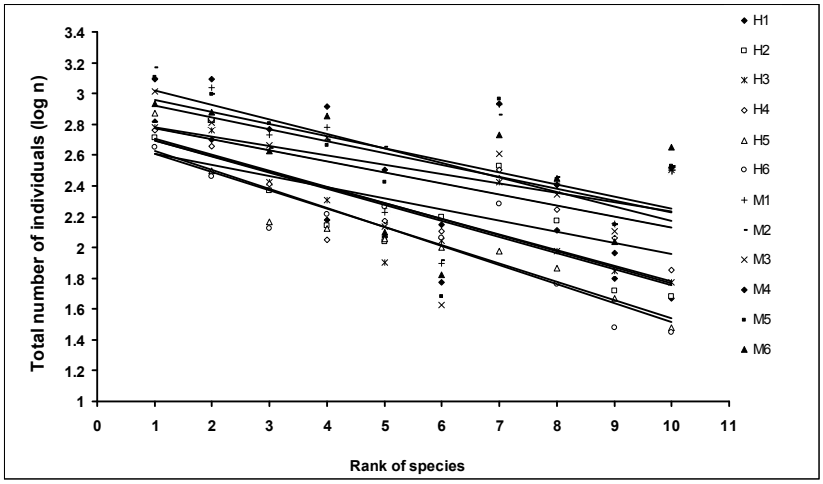

Figure3c. Regression lines for the rank abundance relationships of house dust mite communities at all 12 dorms (6 hotels (H1-H6) and 6 motels (M1 – M6).

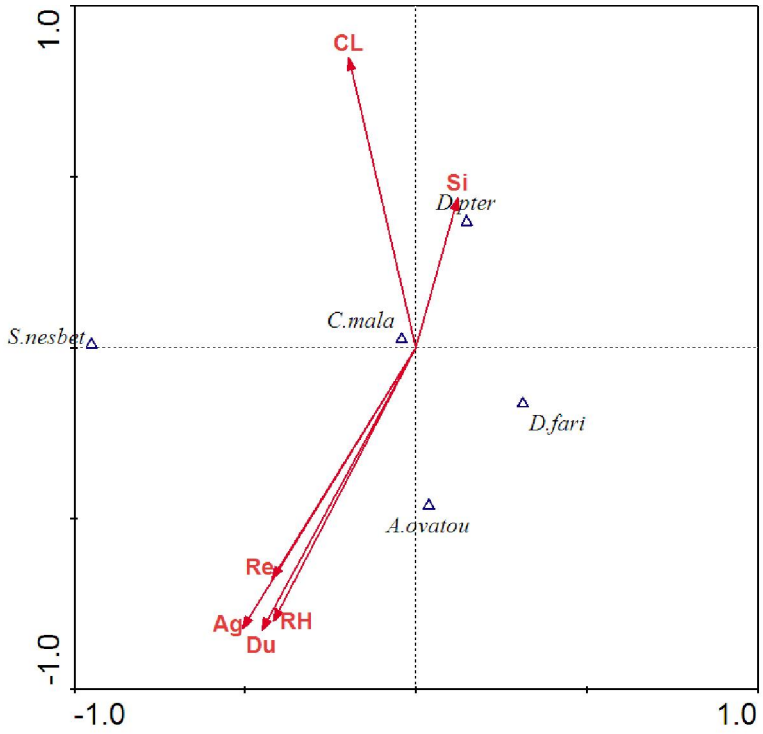

Figure 4. Ordination of the truncated house dust mite assemblages, Showing the position of the five dominant species and their associations with six environmental variables (Rc= occupant density, Ag = age of building, RH= relative humidity, Du= dust quantity, CL= cleaning and Si= Carpet sickness). Species are indicated by open triangles and environmental variables by arrows.

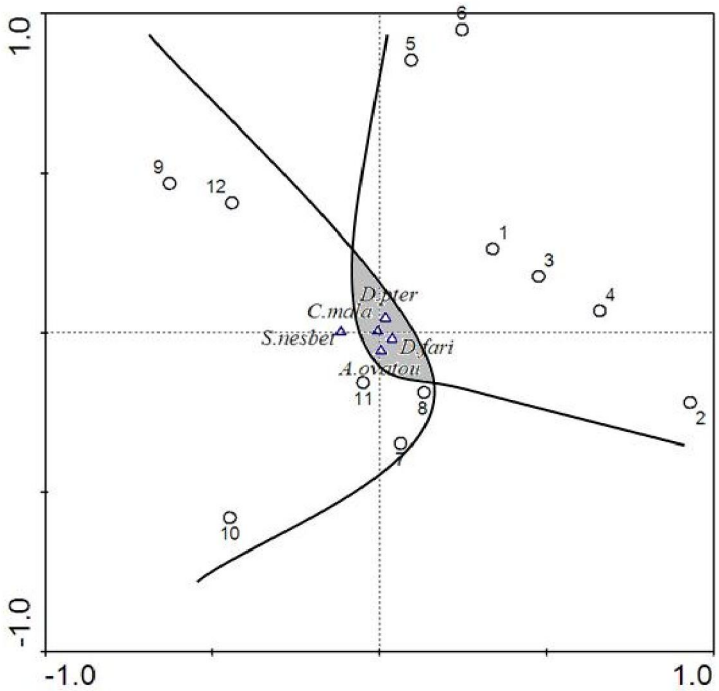

Figure 5. Shows a biplot of the first two axes of PCA position of the sampling sites and their associations with the dominant mite species in both levels of dorms for explanation legend figure 6.

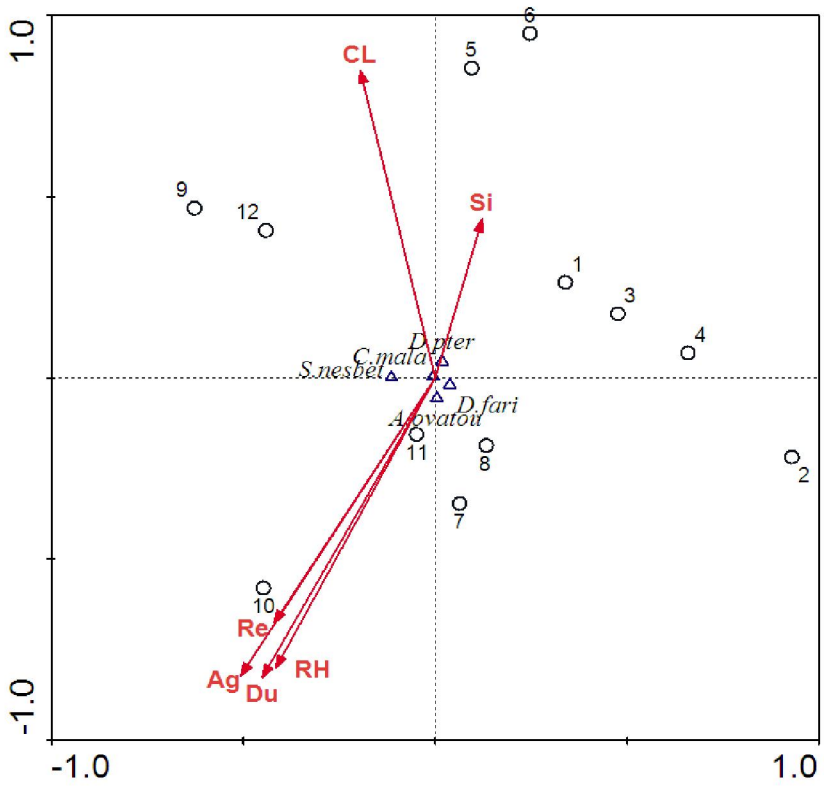

Figure 6. Ordination of the truncated house dust mite asseamlages (five dominant spp.) Showing the position of (sample sites) and their associations with environmental variables and the position of the five dominant speciesSites are indicated by open circles (1- 6 hotels, 7-12 motels). Mite species by open triangulars and environment al variables by arrows. for explanation legend figure 4.

4.Discussion

The house dust mite fauna in the hotels and the motels had not been studied previously in Saudi Arabia. In this study ten HDM species in the two levels of dorms were recorded. The most common allergy-causing mites that occur in different studied dorms were; *Dermatophagoides pteronyssinus* (23.7% in the motels and 27.6% in the hotels) and *D. Farinae* (18.9% in the motels and 21.8% in the hotels) but other species were also well represented especially *Cheyletus malaccensis*, *Aleuroglphus ovatus* and *Suidasia nesbettii*. **Arelian *et al.* (2002)** indicated that most surveys of mite fauna conducted around the world report that the two species *D. pteronyssinus* and *D. farinae* were usually both present in a region and occur together in homes although one species was usually the more prevalent. **Solaz (1998)** surveyed 41 dwellings in upper Silesia, Poland. It was found that the most surveyed dwelling were co-infested with both *D. pteronyssinus* and *D. farinae*. The latter species was the most abundant overall, but in some dust samples it was the predominant species (33.3%) while in other samples *D. pteronyssinus* was more prevalent (27.5%). In the most recent study, the rate of house dust mite infections in hotels and inns of Bandar Abbas Iran for *D. pteronyssinus*, *D. farinae* and *Cheyletus malaccensis* were 91.8, 85.7; 8.2, 10.9 and 0, 3.4% respectively (**Soleimani and Rafinejad, 2008**).

In the current study as mentioned above *Cheyletus malaccensis* was found to reach a high level of relative dominance (11.6% in the hotels and 12% in the motels). However, **Soleimani and Rafinejad (2008)** found this species among three mite species in relatively low number as a rare species in the inns in Bandar Abas- Iran. It could be indicated that this mite has been reported to be predaceous mite on several other mite species. It is suggested that the pattern of the high number of its representatives in the present data match the high species richness (9 spp.) that may support a successful life for such predatory mite via a more diverse prey.

The data of this study showed that the motels appear to have the largest abundance of the total mites (5012 ind/50 g of dust) in correspond to 2149 ind/50 g of dust in the hotels. Obviously the two levels of dwellings surveyed in this study differed not

only in mite abundance but also in various other habitat factors known to influence HDM developments such as the cleaning and sanitation manner, dust quantity, resident density and their economic status, relative humidity and ventilation, floor covering. Numerous studies demonstrate the relation between HDM occurance and building disinfectants (**Schober *et al.*, 1987**) vacuuming and ventilation (**Tovey and Marks, 1998**) and humidity (**Lintner *et al.*, 1993**). **Tovey *et al.*, 1998** stated that dry vacuum cleaners are useful to pick up excess dust and to reduce reservoirs allergy-causing mites.

With respect to the impact of the resident density and their economic status on the house dust mite abundance. **Valero and Serrano (2004)** indicated that house dust mites feed mainly on flakes of human skin. A single adult person sheds between 0.5-and 1 g per day, enough to feed 100.000 house dust mites a day. On the other hand, in the most recent study **Soltani *et al.* (2011)** mentioned that HDM frequency different between eastern and western areas in Iran, this pattern matches the economic status of residents in these areas. This may indicate direct impact of economic condition and life style on the mite contamination rate. The fact that live mites were found on clothing (**Neal *et al.*, 2002**) is evidence that clothing is a vehicle for mite dispersal and colonization in such public dormes specially the low level buildings (motels).

It is also evident that carpets serve as a major reservoir of many indoor allergy-producing mites. On sampling with a vacuum cleaner carpet yield more dust, this will reduce mite abundance. Cleaning on weekly regular basis using detergent and liquid cleaners, this achieves a significant reduction in such mites. A dry indoor relative humidity through a good ventilation will reduce mite density.

In this study up to 66.6% of the motels had a population density of more than 100 individuals per 1 gram of dust, however non of the studied hotels was found to housed more than 50 individuals per 1 gram of dust. Densities above 100 mites per 1 gram of dust are consider as the threshold at which mite allergen concentration is clinically important (**Korsgaard, 1983; Arlian *et al.*, 1992**). This suggests that the most allergic genetically predisposed residents in the motels in Jeddah city are exposed to a risk factor for sensitization to allergens produced from mites.

Conclusion:

The level of dorms had a clear effect on the quantitative existence of the house dust mites but a qualitative effect cannot be identified. Also, it was speculated that the most frequent cleaning of as well as density and economic status of residents were the main factors matched with a direct impact on the mite contamination rate of dorms.

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