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Allergenic Co-inhabitants of House Dust

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Abstract: **Indoor level of house dust mite allergens play a key role for the development and persistence of asthma and atopic sensitivity. The qualitative and quantitative knowledge of these allergens in a given region is of great importance as they cause several respiratory allergic diseases and skin allergic diseases when inhaled. House dust mites which are responsible for allergic disorders have been reported from various regions of India but the studies are scanty and scattered. Similarly, very few studies have been carried out in North India. Present study was conducted on 300 patients diagnosed with allergic rhinitis and allergic asthma. Total 756 dust samples were collected from the homes of 300 patients. Out of these, 544 dust samples were found to be positive for mites. From the positive dust samples 24,704 mite specimens were collected, out of these 21,588 mites i.e. 87.39 % from order Sarcoptiformes, hyporder Astigmata and family Pyroglyphidae. During present study 4 species of Astigmatic mites have been identified. These were *Dermatophagoides pteronyssinus* i.e. 61.74%, *D. farinae* i.e. 18.33%, *D. microceras* i.e. 6.21%, *D. aureliani* i.e. 1.11% whereas only 3116 i.e. 12.61% mite were belonging to other orders. Present study reported *Dermatophagoides pteronyssinus, D. farinae D. microceras* and *D. aureliani* as Co-inhabitants. These four species belonging to genera *Dermatophagoides* were found Co-inhabiting in almost all the samples.**

Keywords: **Allergen, *Dermatophagoides*, House dust mite, Patient, Species.**

I. INTRODUCTION

Mites are among the most diverse groups of Arthropods and they can be found in almost all habitats (Podder *et al*., 2010). The most common allergy causing mites are found in homes and they are found in those habitats which are closely associated with man. They are generally abundant in beds, bed linens, sofas, floors, window sills, clothing, curtains and carpets (van Bronswijk, 1981; Fain *et al*., 1990; Mehl, 1998; Arlian, 2002; Colloff, 2009). The name "House dust mites" has been collectively used for Pyroglyphid mites (order Astigmata) who live permanently in the house dust (Colloff, 1998b). Mites are a major cause of indoor allergies. The allergy causing mites predominantly belong to the family Pyroglyphidae, but the non-Pyroglyphidae or stored grain mites are also of clinical importance (van Hage-Hamsten and Johansson, 1998).

Mites are microscopic eight legged tiny creatures with incomplete metamorphosis related to ticks, chiggers and spiders. House dust mites are not parasitic and do not bite. The body size of house dust mites is approximately 100-400µm. These are colorless and can be distinguished from insects by absence of antennae and wings, body not divisible into head, thorax and abdomen and bear 4 pairs of legs in adults, instead of 3 pairs as in insects. Their body consists of two parts i.e. gnathosoma and idiosoma. Gnathosoma is a specialized and highly evolved body region (Vitzthum, 1940). According to Hammen (1970) it is an important structure from the standpoint of mouth part displacement. The mouth parts include the epistome, hypostome, labrum, chelicerae and padipalps of which the latter two have taxonomic significance. Idiosoma, the second division, represents the main body region of acarina (Vitzthum, 1940).

Pyroglyphid mites live and feed on dust. Dust is mostly composed of shed skin scales, spoiled foodstuff, fungi and pollen (Krantz, 1978). Each individual produces 0.5-1.0gm of dander daily (Kligman, 1964), thereby providing abundant nutrition. Dust mites are medically important as they cause allergic reactions (Evans, 1992). The Pyroglyphid mites have chelate-dentate chelicerae for feeding upon other ranges of solid food.

Most Common allergy causing mites that occur in homes worldwide are the house dust mites that are correlated with the development and persistence of asthma and many other allergic reactions in individuals. These include *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, *Euroglyphus maynei* and one storage mite *Blomia tropicalis* (Arlian *et al*., 2002; Miller, 2018*).* Of these, *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae* and *Euroglyphus maynei* are the most frequently found mite species in the house dust and *Dermatophagoides pteronyssinus* and *Dermatophagoides farinae* mites are responsible for more than 90% of HDM allergies worldwide (Thomas *et al*., 2010; Moingeon, 2014).

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The *Dermatophagoides pteronyssinus* is generally the most abundant mite species found in house dust with an incidence of about 78.8% (Hsieh, 1984; Chang and Hsieh, 1989).

Dermatophagoides pteronyssinus occur in homes in humid region and is distributed from temperate to tropical regions, *Dermatophagoides farinae* found in the drier regions and *Euroglyphus maynei* is found in temperate regions but in lesser number (Thomas *et al*., 2004).

II. MATERIALS AND METHODS

The present study was conducted on 300 patients diagnosed from allergic rhinitis and allergic asthma who visited the Ear Nose Throat Department of Rajindra Hospital, Patiala from September 2014 to May 2017. Full ENT examination has been done on all patients by Dr. Baldev Singh, Former Head of the department ENT. The data was collected by using questionnaires. All the patients were selected based on symptoms of sneezing, watery rhinorrhoea, nasal obstruction, redness of eyes, watering of eyes, itching of eyes, itching of nose, itching of ears and any asthma related symptom. Questionnaire was prepared on the basis of a questionnaire given by American Thoracic Society- Division of lung diseases and the questionnaire used by Health and Welfare Canada for a community based study of children's health (Ferris, 1978; Stern *et al*. 1989) with required modifications.

X-ray/CT scan of paranasal sinuses, nasal endoscopy and spirometry has been done on all patients. The study was approved by the human ethical committee, Punjabi university Patiala, Punjab, India with letter number 248/DLS/HG. Date: 07-01-2015.

A. SAMPLING PROCEDURE:

Dust samples were collected from the concrete single family homes of all patients. The dust samples were collected from the following sources: 1) floor 2) mattress 3) sofa and 4) carpet. From floors, dust samples were collected manually with the help of brush and from mattresses, sofas and carpets dust samples were collected by using a 1200 W vacuum cleaner (Bosch; Munchen, Germany) applied on an area of 1 m^2 for 2 minutes. Dust samples were collected in separate zip lock bags to prevent the mixing of house dusts with each other. In addition, to prevent any possible contamination, subtracting hoses and mouthpieces of the vacuum cleaners were removed and cleaned in every house. Each dust sample was labeled indicating collection time, collection site, collection date and was brought to the lab for further studies.

B. EXTRACTION:

For extraction of mites from dust, the floatation method given by Fain and Hart, 1986 has been used. The mites were isolated from the dust within 24 hours of collection of the sample. In the floatation method, 1 gram of dust was suspended in 80% ethanol for 4-6 hours. After 4-6 hours mites started floating on the surface and were isolated with the help of fine brush and needle under a stereo zoom microscope. After that, saturated sodium chloride solution prepared at room temperature, was poured to the petri dish containing dust debris to get the remaining mites. With his method the maximum number of dead and live mites can be extracted.

C. CLEARING:

60% lactic acid was used to clear the Isolated mites. Clearing was done for 24 hrs at 37ºC.

D. MOUNTING:

A single mite specimen was kept in the center of a clean slide and was mounted in Hoyer's medium, prepared according to the method given by Krantz (1978).

E. PHOTOGRAPHY:

The mites were photographed by Leica microscope at magnification 100 X and 200X.

F. IDENTIFICATION:

The mites were identified according to keys given by Krantz (1978) and Colloff (2009).

III. RESULTS

Among 300 patients, 185 patients i.e. 61.67% were suffering from allergic rhinitis, 51 patients i.e 17.0% were suffering from asthma, where as 64 patients i.e. 21.33% were suffering from both allergic rhinitis and allergic asthma (Table 1; Fig 1).

A. ANALYSIS OF DUST SAMPLES:

Total 756 dust samples were collected from the homes of 300 patients suffering from allergic rhinitis and allergic asthma. From these, 544 dust samples i.e. 71.96% were found to be positive for mites and 212 dust samples i.e. 28.04 were negative for mites (Table II; Fig. 2).

The dust samples were collected from the various locations of home viz. Floors (Pacca and Kaccha), Mattresses (Foam and Cotton), Sofas and Carpets. 412 dust sample i.e. 54.50% were collected from pacca floor (floor dust), 196 dust samples i.e. 25.93% were from foam mattresses, 116 dust samples i.e.15.34% were from cotton mattresses, 16 dust samples i.e. 2.12% were from sofas and 14 dust samples i.e. 1.85% were from carpets and 2 dust sample i.e. 0.26% were from the kaccha floor. Out of 544 positive dust mite samples, 248 dust samples i.e. 45.6% were positive for mites from pacca floor (floor dust), 164 dust samples i.e. 30.1% from foam mattresses, 104 dust samples i.e. 19.1% from cotton mattresses, 14 dust samples i.e. 2.6% from sofas, 12 dust samples i.e. 2.2% were positive for mites from carpets and 2 dust sample i.e. 0.4% from the kaccha floor (Table III and Fig. 3 & 4) In fig. 3 the X-axis of the graph showing site of collection and Y-axis showing the number of dust samples collected and in fig. 4 the X-axis of the graph showing site of collection and Y-axis showing the number of positive dust samples from different sites.

In the positive dust samples minimum of 1 and maximum of 172 mites/gm of dust sample were collected. The ratio statistics

for number of positive dust samples and collected mites have shown in table IV.

B. COMPOSITION OF IDENTIFIED MITE FAUNA:

From positive dust samples, total 04 species belonging to genera *Dermatophagoides*, family Pyroglyphidae and order Sarcoptiformes have been identified (Zhang, 2011). From the positive dust samples 24,704 mite specimens were collected from these 21,588 mites i.e. 87.39 % mites were from hyporder Astigmata belonging to order Sarcoptiformes. The identified mite species are *Dermatophagoides pteronyssinus* i.e. 61.74%, *D. farinae* i.e. 18.33%, *D. microceras* i.e. 6.21%, *D. aureliani* i.e. 1.11% whereas only 3116 i.e. 12.61% mite were belonging to other orders (Table V). The present study focuses only on species belonging to genera *Dermatophagoides* and their Co-inhabitants. Present findings reported *D. pteronyssinus, D. farinae D. microceras and D. aureliani* as Co-inhabitants. All the four species belonging to same genera i.e. *Dermatophagoides* and they were found to be Co-inhabitants in almost all the samples. The study further reported that *Dermatophagoides pteronyssinus* i.e. 61.74% was the most abundant and frequent mite species followed by *D. farinae*, *D. microceras* and *D. aureliani*.

Table I: % prevalence of allergic rhinitis, asthma and AR/asthma patients

Disease	Number of patients	% of patients
Allergic Rhinitis	185	61.67
Asthma	51	17.0
Allergic rhinitis/Asthma	64	21.33
Total	**300**	

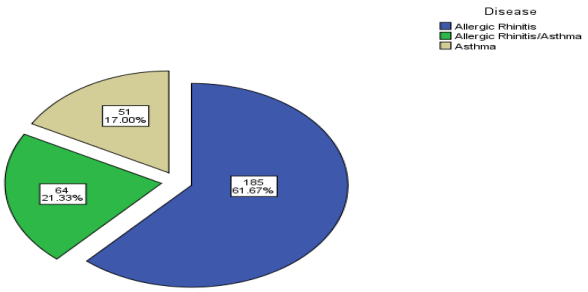

Fig. 1: % prevalence of allergic rhinitis, asthma and AR/asthma patients

Table II: % prevalence of positive and negative dust samples

Type of dust sample	No. of dust sample	% of dust samples
Positive dust sample	544	71.96
Negative dust sample	212	28.04
Total	**756**	

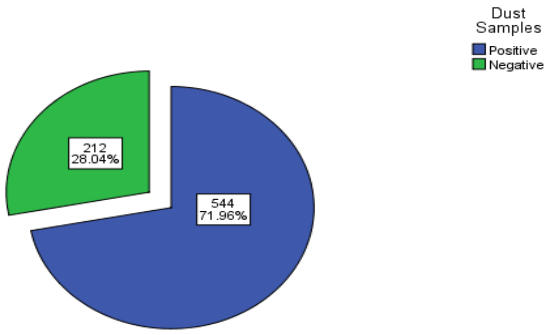

Fig. 2: % prevalence of positive and negative dust samples

Table III: % prevalence of collected samples and positive dust samples from various locations of home

Site of collection	Total samples collected	% age of samples	Positive dust samples	% age of positive samples
1	412	54.50	248	45.6
2	196	25.93	164	30.1
3	116	15.34	104	19.1
4	16	2.12	14	2.6
5	14	1.85	12	2.2
6	2	0.26	2	.4
Total	**756**	**100**	**544**	**100**

Frequency Table:

Representations:
Floor Dust (Pacca floor) = "1"
Foam Mattresses = "2"
Cotton Mattresses = "3"
Sofa = "4"
Carpet = "5"
Kaccha Floor = "6"

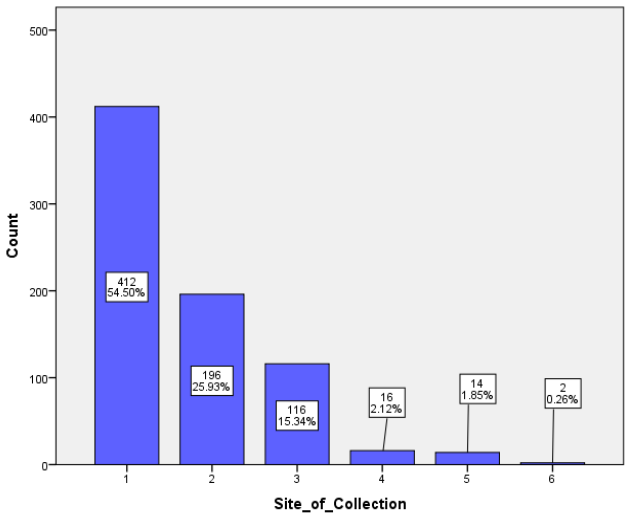

Fig. 3: % prevalence of dust samples collected from various locations of home

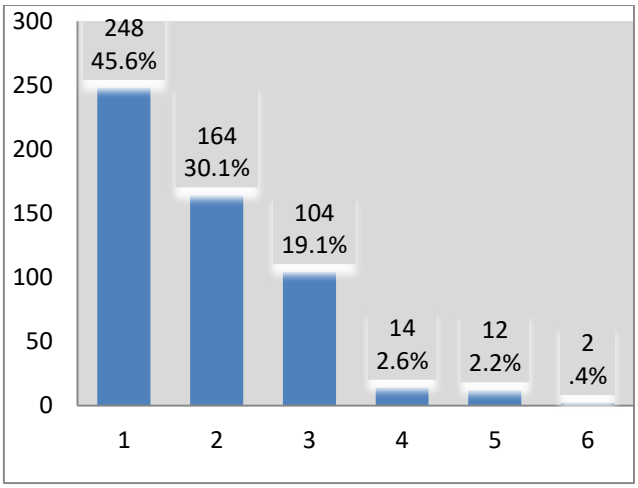

Fig. 4: % prevalence of positive dust samples collected from various locations of home

Table IV: Ratio Statistics for no. Of positive dust samples and no. of mites collected

Group	Mean	Median	Minimum	Maximum	Std. Deviation	Range	Coefficient of Dispersion
1	.087	.026	.006	1.000	.188	.994	2.870
2	.046	.013	.006	.500	.092	.494	2.845
3	.045	.009	.006	.500	.086	.494	4.052
4	.032	.034	.014	.043	.012	.030	.281
5	.099	.020	.009	.500	.187	.491	4.217
6	.018	.018	.018	.018	0.000	0.000	0.000
Overall	**.065**	**.018**	**.006**	**1.000**	**.145**	**.994**	**3.031**

Table V: % prevalence of identified house dust mites

Order	Sub order	Hyporder	Family	Mite species	Mite number	% age
Sarcoptiformes	Oribatida	Astigmata	Pyroglyphidae	*Dermatophagoides pteronyssinus*	15251	61.74
				D. farinae	4527	18.33
				D. microceras	1535	6.21
				D. aureliani	275	1.11
				Other mite fauna	3116	12.61
				Total	**24704**	100

IV. DISCUSSION

Present study included the patients diagnosed with allergic rhinitis, asthma and AR/asthma. It has been observed that higher numbers of patients were suffering from allergic rhinitis followed by AR/asthma and asthma. The present findings are in accordance to Skoner (2001), who reported that allergic rhinitis is often overlooked or under treated and also found that the pediatric population was at higher risk. He further reported that perennial IgE mediated allergic rhinitis is caused by house dust mites as they are perennial environmental aeroallergens in dust. Radon *et al*. (2008), Tsao *et al*. (2011) and Viswambhar *et al*. (2016) studied the occupation and adult onset of rhinitis in the general population. Their studies showed high collective incidence of seasonal allergic rhinitis and perennial rhinitis. Another study done by Shin *et al*. (2018) showed that local allergic rhinitis is a well-differentiated entity of rhinitis, which should be considered in patients with constant and severe symptoms without any systemic evidence of atopy. They found that most common allergens of local allergic rhinitis were house

dust mites. Similarly, the incidence of allergic rhinitis was more frequent and perennial as compared to the incidence of Asthma.

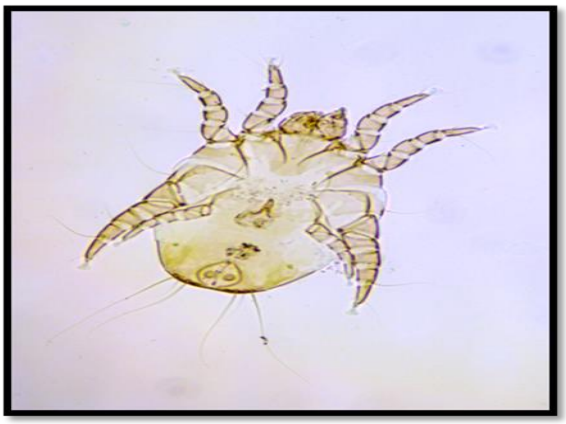

Fig. 5 A. *Dermatophagoides pteronyssinus* Troussart, 1897

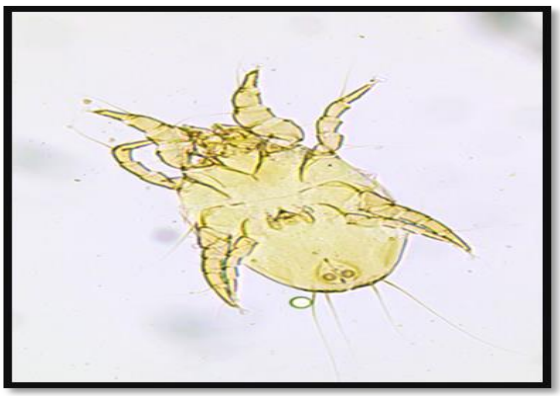

Fig. 5 B. *Dermatophagoides farinae* Hughes, 1961

Fig. 5 C. *Dermatophagoides microceras* Griffiths and Cunnington, 1971

Fig. 5 D. *Dermatophagoides aureliani* Fain, 1967

Exposure to house dust mites is a major factor for aggravating the asthma attacks. Studies by Platts-Mills and de-Weck (1989), Platts-Mills (1992), Nelson and Farnandez-Caldes (1995), Peat *et al*. (1996), Custovic *et al*., (1996), Munir (1998), Anto *et al*. (1998), Marks (1998), Pearce *et al*. (1999), Pearce *et al*. (2000), Thomas *et al*. (2004), Gill and Dehar (2006), Burgess *et al*. (2007), Tsao *et al*. (2011), Zeytun *et al*. (2015) and Miller (2018) have shown that severity of asthma varies with exposure to dust mites. More is the exposure; more will be the asthmatic attack. Same observations have been made during the present study. The patients from the homes with higher number of mites (100/gm of dust), showed more severe and frequent episodes of allergies, than the patients from the homes with a lesser number of mites. House dust mites as indoor allergens play a key role in the development of sensitization. Spieksma and Spieksma-Boezeman (1967) suggested that the mite genera *Dermatophagoides* is common in the house dust and was the main cause of its allergenicity. Studies by Zock *et al*. (1994) and Chan-Yeung *et al*. (1995) found relationship between level of house dust mite allergen in homes of children with asthma and peak airflow variability, According to Munir (1998), Dreberg (1998) and Thomas *et al*. (2004) mite allergen level >2µg/gm of dust means 100 mites in one gram of dust is considered as risk level for sensitization and for the development of asthma and many other allergies. Studies done by Munir (1998) and Dreberg (1998) showed that predisposed young children can become sensitive to house dust mites allergens at 10-100 times lower concentration. During the present study higher concentration of dust mites i.e. 172/gm of dust has been observed than those reported in studies by Platts-Mills and Chapman (1987) and Piacentini *et al.* (1993). These findings suggest the correlation between the mite concentration and different types of allergies which has also been observed during the present investigations.

Platts-Mills and de Weck (1989), Platts-Mills (1992), Korsgaard (1998), Milian and Diaz (2004), Nadchatiram (2005), El-Shazly *et al*. (2006), O' Neil *et al*. (2006), Tsao *et al*. (2011), Calderon *et al*. (2015), Jung *et al*. (2017) and Shin *et al*. (2018) reported a strong association between house dust mites with allergic respiratory diseases. From present findings, it has been observed that in houses where the dust mites are present in higher concentration, allergic patients suffered from various allergies throughout the year as compared to the houses which were having insignificant numbers of mites in their homes. These observations are in direct confirmation with the studies of Arlian (1991). According to him the mite derived allergies are present throughout the year rather than like other seasonal aeroallergens. A similar study done by Zeytun *et al*. (2015) reported the high concentration of mites in the homes of allergic asthma patients residing in Erzincan (Turkey) and these patients were more sensitive to house dust mite allergens. The patients from the homes having significantly higher number of mites per gram of dust (maximum 172/gm) showed severe allergies as

compared to the patients from the homes with significantly less number of mites per gram of dust during present study.

Yu *et al*. (2015) studied the fauna of house dust mites in Xishuangbanna Dai, a tropical rainforest region in South-West China. They showed that the house dust mites' population had its own characteristics. They further reported that this region had rich dust mite species. They found that four allergenic dust mite species viz. *Dermatophagoides farinae*, *D. pteronyssinus*, *D. siboney* and *Blomia tropicalis* were found to be co-inhabitants. In the present study, *D. pteronyssinus, D. farinae*, *D. microceras* and *D. aureliani* were found to be co-inhabitants. Present findings showed the sensitivity toward *D. pteronyssinus*, *D. farinae, D. microceras and D. aureliani* similar to the findings of Chew *et al*. (2001) that showed the sensitization of asthma and allergic rhinitis to house dust mite fauna.

Kumar and Singh (1986) found 52 species of mites from human habitation of Punjab and Himachal Pradesh, representing the three orders Astigmata, Prostigmata and Mesostigmata. Colloff (1998a) recorded thirteen species of house dust mites all over the world and six out of them are regularly found. Large numbers of other species are restricted to certain specific regions of the world. In present findings, total 756 dust samples were collected. Of these, 544 dust samples i.e. 71.96% were found to be positive for mites and 212 dust samples i.e. 28.04% were found to be negative for mites. From positive dust samples, mites belonging to order Sarcoptiformes, sub-order Oribatida and hyporder Astigmata were the most abundant and frequently found. During the study 24,704 mite specimens were collected, out of which 21,588 (87.39%) were only from hyporder Astigmata, whereas 3116 mites (12.61%) from other orders viz. Trombidiformes and Mesostigmata. We have found four species of astigmatic mites belonging to the family Pyroglyphidae viz. *Dermatophagoides pteronyssinus* (61.74%), *D. farinae* (18.33%), *D. microceras* (6.21%), *D. aureliani* (1.11%). It has been observed that higher numbers of mites were from family Pyroglyphidae and the most abundant and frequently available mite species was *Dermatophagoides pteronyssinus*. It has also been concluded that the most common cause of sensitization in allergic patients was *D. pteronyssinus* mite followed by *D. farinae*, *D. microceras* and *D. aureliani*. The above findings are in accordance with the findings of Sun *et al*. (2014), Doshi and Tripathi (2016) and Miller (2018). Study done by Miller (2018) showed that house dust mites are the main cause of atopic sensitization and allergic disorders throughout the world. He reported *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, *Euroglyphus maynei* and *Blomia tropicalis* as major allergenic dust mites. Whereas during the present observation *Dermatophagoides pteronyssinus*, was the most abundant mite followed by *D. farinae*, *D. microceras*, *D. aureliani*. *Blomia tropicalis* was altogether absent in all 544 positive dust samples. Arlian *et al*. (2002) reported that allergy causing mites are present everywhere in homes worldwide. They found that the prevalence of mites varies among humid regions, between homes within a region and between locations within a home. They suggest that the relation between climatic and biological factors influence the presence and prevalence of mites. They further suggest that relative humidity is the most important factor for the occurrence of mites. Aside from the role of relative humidity, most of these interacting factors are not understood. Mite populations are high in beds, upholstered furniture and carpets where the concentration of shed skin scales high as it serves as a good source of food. Thus, a low level of mite population is found on walls and smooth furniture. These findings are in accordance with present findings where a higher number of positive samples for mites were found on mattresses followed by carpets, upholstered furniture and floors. They also suggest that presence and prevalence of *D. pteronyssinus* and *D. farinae* in homes worldwide and reported them as parallel species. Nelson and Fernandez-Caldas (1995), O' Rourk *et al*. (1996), Arlian *et al*. (1992) have shown that surveys in the United States show that, *D. farinae* is more common than *D. pteronyssinus* in drier climates; while in humid regions *D. pteronyssinus* was found to be more common. Arlian *et al*. (1992) and Arlian *et al*. (1998) have observed that laboratory studies showed that *D. pteronyssinus* has slightly more relative humidity requirement than *D. farinae*. Both species thrive at 75% relative humidity and 22ºC temperature; However, *D. pteronyssinus* has a greater population growth rate than *D. farinae*. Arlian and Dippold (1996) reported that the difference of requirement in relative humidity alone does not explain the differential prevalence of *D. farinae* and *D. pteronyssinus*. But differences in biology of two species and influence of temperature on reproduction and survival also play a key role. For example *D. pteronyssinus* readily completes its life cycle at 16 ºC, 23 ºC, 30 ºC, and 35 ºC in 122.8, 34, 19.3, and 15.0 days respectively, at 75% relative humidity. In contrast, *D. farinae* does not develop well at 16 ºC and 35ºC. Fluctuating dynamic relative humidity and temperature conditions to each species is exposed may influence survival, duration of life cycle and formation of prolonged and desiccation resistant life stages in the life cycle. Arlian *et al*. (1990), Arlian and Dippold (1996) and Arlian *et al*. (1998) reported the difference in fecundity of the two species that may favor one species over the other in specific conditions. Therefore, this may be the reason in the present study where the number of *D. pteronyssinus* is high as compared to other 3 Co-inhabitant mite species. The housing condition may favor *D. pteronyssinus* more than other species.

V. CONCLUSION

During the study period most house dust mites were identified to belong to the order Sarcoptiformes, family Pyroglyphidae and genera *Dermatophagoides*. The most common and frequent mite species was *Dermatophagoides pteronyssinus* whereas *D. farinae D. microceras and D.*

aureliani act as Co-inhabitants. The present study first reported *Dermatophagoides pteronyssinus*, *D. farinae D. microceras and D. aureliani* as Co-inhabitants from Punjab (India).

VI. ACKNOWLEDGEMENT

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