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The prevalence of positive intradermal allergy tests in 114 dogs with atopic dermatitis in the Bangkok metropolis, Thailand

Chanettee Chanthick*, Sawanya Anaman, Krissanee Buathet

Dermatology Unit, Veterinary Teaching Hospital, Faculty of Veterinary Medicine, Kasetsart University, 50 Paholyothin Road, Ladyao, Chatuchak, Bangkok 10900, Thailand

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ABSTRACT

Intradermal allergy tests using 47 selected local aero-allergens were performed on 114 dogs with atopic dermatitis. The subject animals visited the Dermatology Unit at the Veterinary Teaching Hospital of Kasetsart University or the SLV Pet Hospital with chronic pruritus and various skin lesions. Allergen extracts were composed of: 4 house dust and house dust mites, 7 household insects, 24 pollens, 11 mold spores, and Kapok. The prevalence of sensitization to various allergens were as follows: *Dermatophagoides farinae* (74.56%), *Dermatophagoides pteronyssinus* (53.51%), house dust (26.32%), American cockroach (*Periplaneta americana*) (23.68%), Para glass (21.93%) and mixed ants (20.18%). No relationship was noted between the various allergen groups and the location of the skin lesions except for those animals that reacted to pollens which appeared to have be more likely to have lesion affecting the perineum and tail area ($p = 0.022$; OR, 6.429; 95% CI, 1.003–40.292).

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1. Introduction

Canine atopic dermatitis is one of the most common skin diseases, and it is defined as an inherited tendency to produce IgE antibody and develop Type I hypersensitivity reactions to environmental aero-allergens. Aero-allergens must be antigenic, present in sufficient amounts and dispersible (Reedy et al., 1997). These clinically important aero-allergens are variable with season, climate and geographic region.

Diagnosis of canine atopic dermatitis is made by history-taking, physical examination and exclusion of other pruritic skin diseases. Intradermal allergy testing (IDT) with local allergen extracts is the procedure of choice and preferred by many veterinary dermatologists to confirm hypersensitivity reactions and identify

offending allergens (Willemse and Van Den Brom, 1982; Chalmers and Medleau, 1994; Hillier, 2002). The clinically relevant results of the IDT provide a basis for allergen avoidance and the selection of allergens that should be included in a vaccine for allergen-specific immunotherapy.

The most common clinical manifestation of canine atopic dermatitis is pruritus. The skin lesions are principally observed at site of pruritus (Griffin and DeBoer, 2001). In individual, there are differences in the sensitized allergen, skin lesion and the location of skin lesion among atopic dogs. Few data about correlation between these factors has been informed. An unpublished study has suggested that ventral involvement is more common with house dust mite allergy than other allergens (Griffin and DeBoer, 2001).

The purpose of this study is to determine the most relevant aero-allergens involved in canine atopic dermatitis in the Bangkok metropolis, Thailand. Correlation between skin reactions to each allergen group and each skin lesion location are also evaluated.

* Corresponding author. Tel.: +66 2 942 8756–9/619 6493; fax: +66 2 579 7541/619 6493.

E-mail address: fvctctc@ku.ac.th (C. Chanthick).

2. Materials and methods

2.1. Subjects

This is a retrospective study in dogs that visited the Dermatology Unit at the Veterinary Teaching Hospital of Kasetsart University or the SLV Pet Hospital from December 2004 to December 2005. The dogs presented with chronic pruritus and various skin lesions. A definitive diagnosis of canine atopic dermatitis was made using combination of compatible history, clinical signs and exclusion of other

diseases through the elimination of ectoparasitic disease, bacterial pyoderma and *Malassezia* dermatitis, dermatophytosis and cutaneous adverse food reaction. In all dogs, coat brushings, skin scrapings, skin surface cytology and a 6–10 week food trial were conducted with ectoparasite and antibiotic and antifungal therapies being used as appropriate. Before performing intradermal skin tests, medication with corticosteroids, antihistamine or omega 3 and 6 fatty acids had been withdrawn for 4 weeks.

In every dog, skin lesions were recorded descriptively and re-evaluated into 13 different areas of the body (face,

Table 1
Allergen extracts

No.	Allergen	Latin name	Concentration	Source
House dust and house dust mites				
1	Mixed mites	<i>Dermatophagoides farinae</i> , <i>Dermatophagoides pteronyssinus</i>	100 PNU/ml	Siriraj
2	<i>D. farinae</i>	<i>D. farinae</i>	100 AU/ml	ALK Abello
3	<i>D. pteronyssinus</i>	<i>D. pteronyssinus</i>	100 AU/ml	ALK Abello
4	House dust		1,000 PNU/ml	ALK Abello
Household insects				
5	Mixed ants	<i>Paratrechina longicornis</i> , <i>Camponotus</i> spp.	1,000 PNU/ml	Siriraj
6	Fire ant	<i>Solenopsis invicta</i>	1:1,000 (w/v)	ALK Abello
7	Mosquito	<i>Culex pipiens</i>	1:1,000 (w/v)	ALK Abello
8	Mixed cockroaches	<i>Periplaneta americana</i> , <i>Blattella germanica</i>	1,000 PNU/ml	Siriraj
9	American cockroach	<i>P. americana</i>	1:200 (w/v)	ALK Abello
10	German cockroach	<i>B. germanica</i>	1:200 (w/v)	ALK Abello
11	Housefly	<i>Musca domestica</i>	1,000 PNU/ml	Siriraj
Pollens (G = grass, W = weed, T = tree)				
12	Para grass (G)	<i>Urochloa mutica</i>	1,000 PNU/ml	Siriraj
13	Bermuda grass (G)	<i>Cynodon dactylon</i>	1,000 BAU/ml	ALK Abello
14	Bahia grass (G)	<i>Paspalum notatum</i>	1:200 (w/v)	ALK Abello
15	Timothy grass (G)	<i>Phleum pratense</i>	1,000 BAU/ml	ALK Abello
16	Johnson grass (G)	<i>Sorghum halepense</i>	1:200 (w/v)	ALK Abello
17	Sweet corn (G)	<i>Zea mays</i>	1:100 (w/v)	ALK Abello
18	Wheat grain (G)	<i>Triticum aestivum</i>	1:100 (w/v)	ALK Abello
19	Wild oat (G)	<i>Avena fatua</i>	1:200 (w/v)	ALK Abello
20	Sedge (W)	<i>Cyperus</i> spp.	1,000 PNU/ml	Siriraj
21	Careless weed (W)	<i>Amaranthus palmeri</i>	1:200 (w/v)	ALK Abello
22	Spiny pigweed (W)	<i>Amaranthus retroflexus</i>	1:200 (w/v)	ALK Abello
23	Common mugwort (W)	<i>Artemisia vulgaris</i>	1:200 (w/v)	ALK Abello
24	Cocklebur (W)	<i>Xanthium commune</i>	1:200 (w/v)	ALK Abello
25	Goldenrod (W)	<i>Solidago</i> spp.	1:200 (w/v)	ALK Abello
26	Typha (W)	<i>Typha angustifolia</i>	1,000 PNU/ml	Siriraj
27	Yellow dock (W)	<i>Rumex crispus</i>	1:200 (w/v)	ALK Abello
28	Sour dock (W)	<i>Rumex acetosella</i>	1:200 (w/v)	ALK Abello
29	Kochia (W)	<i>Kochia scoparia</i>	1:200 (w/v)	ALK Abello
30	Eucalyptus (T)	<i>Eucalyptus</i> spp.	1:200 (w/v)	ALK Abello
31	Queen palm (T)	<i>Cocos plumosa</i>	1:200 (w/v)	ALK Abello
32	Australian pine (T)	<i>Casuarina</i> spp.	1:200 (w/v)	ALK Abello
33	Acacia (T)	<i>Acacia</i> spp.	1:200 (w/v)	ALK Abello
34	Red mulberry (T)	<i>Morus rubra</i>	1:200 (w/v)	ALK Abello
35	White mulberry (T)	<i>Morus alba</i>	1:200 (w/v)	ALK Abello
Mold spores				
36	Mixed molds	<i>Alternaria</i> , <i>Cladosporium</i> , mixed <i>Aspergillus</i> , mixed <i>Penicillium</i>	1:100 (w/v)	ALK Abello
37	<i>Cladosporium</i>	<i>Cladosporium sphaerospermum</i>	1:100 (w/v)	ALK Abello
38	<i>Aspergillus fumigatus</i>	<i>Aspergillus fumigatus</i>	1:100 (w/v)	ALK Abello
39	Mixed <i>Aspergillus</i>	<i>Aspergillus (oryzae, rapens, niger, terreus)</i>	1:100 (w/v)	ALK Abello
40	Mixed <i>Penicillium</i>	<i>Penicillium (chrysogenum, notatum)</i>	1:100 (w/v)	ALK Abello
41	<i>Alternaria</i>	<i>Alternaria tenuis</i>	1:100 (w/v)	ALK Abello
42	<i>Acremonium</i>	<i>Acremonium strictum</i>	1:100 (w/v)	ALK Abello
43	<i>Curvularia</i>	<i>Curvularia</i> spp. (Bipolaris)	1:100 (w/v)	ALK Abello
44	<i>Drechslera</i>	<i>Drechslera sorokiniana</i>	1:100 (w/v)	ALK Abello
45	<i>Fusarium</i>	<i>Fusarium</i> spp.	1:100 (w/v)	ALK Abello
46	Yeast	<i>Saccharomyces cerevisiae</i>	1:100 (w/v)	ALK Abello
Miscellaneous				
47	Kapok		1,000 PNU/ml	Siriraj

pinna, neck, thorax, back, flank, abdomen, axillas, inguinal, limbs, feet, perineum, tail) before testing.

2.2. Intradermal allergy test

Each dog was sedated with intramuscular administration of xylazine (1.1 mg/kg) and atropine sulfate (0.04 mg/kg). An area of approximately 15 cm × 20 cm on one of lateral thoracic sites was clipped and cleaned, and a permanent marker was used to identify injection sites. Approximately 0.05 ml of each allergen and the controls were injected intradermally with 27 gauge needles. The negative control was buffered saline, the diluent of the allergen extracts. The positive control was histamine phosphate (Histatrol[®], ALK Abello, Port Washington, NY, 11050), which consisted of histamine base 1 mg/ml diluted with buffered saline into 0.1 mg/ml. The majority of stock extracts were purchased from ALK Abello (Port Washington, NY, 11050). The rest, which were local allergens, were obtained from Siriraj Medical Hospital, Faculty of Medicine, Mahidol University. All allergens were used at dilutions recommended by the manufacturer or previous report (Reedy et al., 1997), so as not to be irritant (Table 1). Diluted allergens were prepared from stock concentration and had been kept at 4 °C (for not more than 3 months).

Forty-seven allergen extracts were allocated into 5 groups (4 house dust and house dust mites, 7 household insects, 24 pollens, 11 mold spores, and Kapok) (Table 1).

Skin reactions were evaluated 15 min after injection. To be considered positive, the diameter and redness of wheal at the injection site had to be greater than or equal to the mean of the diameter and redness of wheal at histamine and buffered saline sites.

2.3. Statistical analysis

Descriptive analysis of the prevalence of positive skin reactions to individual allergens and the prevalence of skin lesions on affected dogs were analyzed as percentages.

Thirteen areas of skin lesion were grouped into 6 locations (as shown in Table 3). Correlations between skin reaction to each allergen group and each skin lesion location were analyzed using Chi-square and Fisher's exact test. A *p*-value less than 0.05 was considered significant. The chance that dogs with a positive skin reaction to each allergen group would develop a skin lesion at each location was also evaluated using odds ratios with 95% confidence intervals.

3. Results

The 114 dogs tested were 63 males and 51 females. The breeds represented in this study included Poodle (24), crossbreed (24), Golden Retriever (17), Shih Tzu (16), Labrador Retriever (6), Thai Bangkaew (6), Pug (5), Beagle (3), Chowchow (3), Bull Terrier (2), German Shepherd (2), West Highland White Terrier (2), French Bulldog (1), Akita (1), Rottweiler (1) and Thai Ridge back (1). The ages of the

Table 2

Number and percentage of atopic dogs showing positive skin reactions to individual allergen extracts

Allergen extract	Positive-IDT dogs, <i>n</i> = 114 (%)
<i>D. farinae</i>	85 (74.56%)
<i>D. pteronyssinus</i>	61 (53.51%)
House dust	30 (26.32%)
American cockroach	27 (23.68%)
Para grass	25 (21.93%)
Mixed mites	24 (21.05%)
Mixed ants	23 (20.18%)
Mosquito	18 (15.79%)
Sedge	17 (14.91%)
Yellow dock	16 (14.04%)
German cockroach	14 (12.28%)
Fire ant	13 (11.40%)
Bermuda grass	13 (11.40%)
Timothy grass	12 (10.53%)
Common mugwort	11 (9.65%)
Mixed cockroaches	11 (9.65%)
Johnson grass	10 (8.77%)
Wild oat	9 (7.89%)
Sweet corn	9 (7.89%)
Bahia grass	9 (7.89%)
Acacia	8 (7.02%)
Sour dock	7 (6.14%)
Red mulberry	7 (6.14%)
Housefly	7 (6.14%)
Goldenrod	7 (6.14%)
Careless weed	7 (6.14%)
Spiny pigweed	6 (5.26%)
Mixed <i>Penicillium</i>	6 (5.26%)
Queen palm	6 (5.26%)
Mixed molds	6 (5.26%)
Cocklebur	6 (5.26%)
Typha	5 (4.39%)
White mulberry	5 (4.39%)
Eucalyptus	5 (4.39%)
Yeast	4 (3.51%)
Australian pine	4 (3.51%)
<i>Alternaria</i>	4 (3.51%)
Wheat grain	3 (2.63%)
<i>Aspergillus fumigatus</i>	3 (2.63%)
<i>Acremonium</i>	3 (2.63%)
<i>Fusarium</i>	3 (2.63%)
Kochia	2 (1.75%)
<i>Curvularia</i>	2 (1.75%)
<i>Cladosporium</i>	2 (1.75%)
Mixed <i>Aspergillus</i>	2 (1.75%)
<i>Drechslera</i>	1 (0.88%)

dogs at the time of skin testing were between 9 months and 11 years (median 3.6 years).

3.1. Skin lesions and concurrent diseases

In this study, various skin lesions were found on individual dogs. The common skin lesions presented were erythema (67.54%), papule (48.25%), alopecia (39.47%), seborrhea (29.82%), otitis externa (28.07%), pustule (25.44%), hyperpigmentation (14.04%), lichenification (12.28%), excoriation (11.40%) and folliculitis (7.89%).

The most common areas with skin lesions were the limbs (35.96%), face (33.34%), feet (21.92%) and abdomen (21.92%). Fifty-four dogs (47.36%) showed generalized skin lesions. Ninety-one dogs (79%) had secondary infections, 61 of which (68.13%) had mixed skin infections with both bacteria and *Malassezia* spp.

Table 3

Correlations between positive skin reactions to each allergen group and each skin lesion location

Skin lesion location		Allergen group			
		HD and HDM	Pollens	Insects	Molds
Trunk (neck + thorax + back + flank)	<i>n</i>	43	32	23	8
	<i>p</i> -Value	0.914	0.834	0.658	0.959
	OR (95%CI)	1.053 (0.421–2.630)	0.922 (0.435–1.953)	0.846 (0.405–1.766)	1.027 (0.376–2.808)
Head (face + pinna)	<i>n</i>	36	24	21	7
	<i>p</i> -Value	0.811	0.233	0.719	0.813
	OR (95%CI)	1.125 (0.437–2.884)	0.626 (0.291–1.347)	1.149 (0.542–2.435)	1.135 (0.410–3.155)
Limbs	<i>n</i>	33	27	18	6
	<i>p</i> -Value	0.965	0.465	0.783	0.950
	OR (95%CI)	0.979 (0.379–2.517)	1.346 (0.611–2.958)	0.898 (0.419–1.927)	0.966 (0.341–2.757)
Ventral hairless area (abdomen + axilla + inguinal)	<i>n</i>	32	26	20	5
	<i>p</i> -Value	0.351	0.933	0.743	0.491
	OR (95%CI)	0.640 (0.254–1.612)	1.034 (0.476–2.245)	1.136 (0.533–2.425)	0.676 (0.230–2.003)
Feet	<i>n</i>	23	16	13	1
	<i>p</i> -Value	0.152 ^b	0.763	0.468	0.114 ^b
	OR (95%CI)	3.333 (0.797–13.690)	1.152 (0.466–2.840)	1.389 (0.579–3.333)	0.190 (0.031–1.197)
Perineum and tail	<i>n</i>	7	8	3	1
	<i>p</i> -Value	1.000 ^b	0.022 ^{a,b}	0.726 ^b	1.000 ^b
	OR (95%CI)	1.729 (0.258–11.221)	6.429 (1.003–40.292)	0.698 (0.175–2.800)	0.804 (0.123–5.483)

^a *p*-Value < 0.05 was considered significant;^b Fisher's Exact Test; *n*, number of affected dogs with positive skin reactions to each allergen group; OR (95% CI), odds ratio with 95% confidence intervals; HD, house dust; HDM, house dust mites.

3.2. Positive skin reactions

The prevalence of positive skin reactions to various allergens was as follows: *Dermatophagoides farinae* (74.56%), *Dermatophagoides pteronyssinus* (53.51%), house dust (26.32%), American cockroach (*Periplaneta americana*) (23.68%), Para glass (21.93%), mixed ants (20.18%) (Table 2). House dust and house dust mites were the most common allergen group to which atopic dogs yielded positive skin reactions, followed by the pollen group, the household insect group and the mold group, respectively.

3.3. Correlations between skin reaction to each allergen group and skin lesion location

Most of the skin reactions to each allergen group had no significant association with skin lesion location ($p > 0.05$) (Table 3). Only a correlation between a skin reaction to the pollens group and skin lesions of the perineum and tail area showed a significant relationship ($p = 0.022$). The dogs with positive skin reactions to pollens were 6.429 times more likely to develop skin lesions of the perineum and tail area than the dogs without positive skin reactions to pollens (OR, 6.429; 95% CI, 1.003–40.292).

The dogs with positive skin reactions to the house dust and house dust mite group were 3.333 times more prone to develop skin lesions of the feet than the dogs without positive skin reactions to the same allergen group, but this was not statistically significant ($p = 0.152$).

4. Discussion and conclusion

All of the atopic dogs had shown chronic pruritus and various skin lesions. The most common skin lesions were erythema and papule, and frequent areas of skin lesions were the limbs, face, feet and abdomen, similar to previous

reports (Saridomichelakis et al., 1999; Griffin and DeBoer, 2001; Hillier, 2002).

The prevalence of positive skin reactions to each group of allergens are defined below.

4.1. House dust and house dust mites

House dust mites are free-living arachnids of the Pyroglyphidae family. In the surveys of house dust mites in dust from bedding in various types of houses of Thailand, the most abundant species was *D. pteronyssinus* (66.30% of total mites), followed by *D. farinae* (24.40%). Other Pyroglyphid mites (i.e., *Euroglyphus maynei*, *Malayoglyphus intermedius* etc.) were also found but in very small numbers (0.5%) (Wongsathuaythong and Lakshana, 1972; Malainual et al., 1995).

In Thailand, 62–80% of asthmatic patients were found by skin testing to be sensitive to house dust mite extracts. *D. pteronyssinus* had the most prevalent positive skin reaction (Kongpanichkul et al., 1997; Sritipsukho, 2004). In our study, *D. farinae* had the most prevalent positive skin reaction (74.56%), followed by *D. pteronyssinus* (53.51%). Of dogs that were sensitized to *D. pteronyssinus*, 95% also yielded positive skin reactions to *D. farinae*. Sensitivity to *D. farinae* alone was found in 30.68% of mite-sensitized dogs.

Despite house dust mites causing the most prevalent positive skin reaction in both Thai people and dogs, the predominant *Dermatophagoides* allergen in atopic dogs (*D. farinae*) was different from the predominant *Dermatophagoides* allergen in Thai people (*D. pteronyssinus*), and it was not correlated with the most abundant mite species found in Thailand. This brought about the question whether it was true hypersensitivity to *D. farinae* or cross-reactivity to other allergens. In humid and maritime climates such as the UK, *D. pteronyssinus* was also the most abundant species, whereas *D. farinae* was the frequent allergen in

atopic dogs. The *D. pteronyssinus* mite and its allergen (Der p 1) were commonly found in dust collected from the house, bedding, skin and hair coat of dogs, whereas *D. farinae* and Der f 1 were rare in all sampling areas (Raffan et al., 2005; Jackson et al., 2005). In humans, the most important *Dermatophagoides* allergens are the low molecular weight group 1 and 2 proteins (14–25 kDa), Der p 1, Der p 2, Der f 1, Der f 2. In atopic dogs, it has been shown that the high molecular weight allergens, Der f 15 (98 kDa) and Der f 18 (60 kDa), identified as chitinase, are more important (Noli et al., 1996; Nuttall et al., 2001; McCall et al., 2001; Weber et al., 2003). Inclusion of these allergens in a survey may be useful in studying house dust mite exposure in canine atopic dermatitis.

One more thing that should not be overlooked is that storage mites are in the same order of Astigmata as house dust mites (Nuttall et al., 2006). In Thailand, a recent mite survey in which dust samples were collected from bedrooms and living rooms found incredible amounts of *Blomia tropicalis* and *Tyrophagus putrescentiae* in concurrence with *Dermatophagoides* mites (Insung and Homchan, 2004). These storage mites may play an important role in sensitizing individuals and may possibly cause cross-reaction to *Dermatophagoides* mites in sensitized dogs.

4.2. Household insects

In our atopic dogs, the American cockroach (*P. americana*) had the second most prevalent positive skin reaction after house dust mites, similar to Thai asthmatic patients. Of asthmatic Thai people, 41–60% were sensitive to the American cockroach in skin prick tests (Kongpanichkul et al., 1997; Pumhiran et al., 1997; Sritipsukho, 2004). In surveys of indoor cockroaches in some dwellings in Bangkok, cockroaches were present in 65.5% of dwellings. The highest densities of cockroaches were found in the kitchen and living room. The American cockroach (*P. americana*) was the most abundant species, having been trapped in 47.8–61.8% of various dwellings in Bangkok. The German cockroach (*Blattella germanica*) has been trapped in only 0–3.1% of private residences, but larger numbers have been trapped in storage areas such as groceries (26.7%) (Tawatsin et al., 2001; Sriwichai et al., 2002).

Atopic dogs in our study yielded positive skin reactions to American and German cockroaches in 23.68% and 12.28%, respectively. Nine of twenty-seven cockroach-sensitized dogs (33.34%) yielded positive skin reactions to both allergens.

Positive skin reactions to household insects in our atopic dogs were high compared to other reports from the UK, Japan and USA (Sture et al., 1995; Masuda et al., 2000; Zur et al., 2002). The tropical climate of Thailand might be more suitable for insect growth and replication, therefore presenting a higher concentration of allergens.

4.3. Pollens

The Bangkok metropolis is in a tropical area that is warm and humid, and most pollens are presented throughout the year (Tuchinda and Theptaranon, 1976; Bunnag et al., 1986). In an aero-allergen survey using

Rotorod samplers in Bangkok, the most common pollen grains were wild grasses (31.3%) and weeds (29.7%) (Bunnag et al., 2003). Para grass and Bermuda grass were the examples of common wild grasses in Bangkok, and the common weeds were sedge (Cyperaceae), typha (Typhaceae), careless weed and spiny pigweed (Amaranthaceae). The rest were Casaurinaceae, Myrtaceae, Fabaceae, cultivated grasses, palms and ferns, each of which was found in 0.3–1.9% of airborne pollens.

Due to low-lying land and cultivated areas around Bangkok, these wild grasses and weeds grow rapidly and produce large amounts of anemophilous (windborne) pollens. Moreover, they grow everywhere in the city, such as in flower pots, small yards along the sidewalk, etc. and are usually 1–2 feet in height. Trees are found in a lesser density, and most of them yield entomophilous (insect-borne) pollens. Anemophilous tree pollens comprise only 5% of airborne pollens found in the atmosphere (Bunnag et al., 1986).

In our study, positive skin reactions to grasses, weeds and trees in pollen-sensitized dogs were 71.43%, 61.43%, 28.57%, respectively. In this group, aero-allergens causing the most prevalent positive skin reactions were Para grass (21.93%), followed by sedge (14.91%) and yellow dock (14.04%). These results were found according to the prevalence of common pollens found in the atmosphere and common plants presented in Bangkok.

4.4. Molds

In a survey of the types and prevalence of airborne fungi found in the atmosphere in Bangkok at 1.5–2 meters above the ground, *Cladosporium* was the most common mold spore (29.0% of airborne fungi). *Penicillium* and *Aspergillus*, presented as one-cell mold spores, were the second most common mold spores (13.5%), followed by *Fusarium* (11.4%), *Curvularia* (6.0%) and *Alternaria* (5.1%) (Bunnag et al., 2003).

About 2–9% of Thai asthmatic and allergic rhinitis patients yielded positive skin reactions to mold spores. The most prevalent mold spore sensitivities in sensitized patients were *Alternaria*, *Cladosporium*, *Aspergillus*, *Penicillium*, *Fusarium* and *Curvularia* (Kongpanichkul et al., 1997; Pumhiran et al., 1997; Sritipsukho, 2004), which is in accordance with the prevalence of airborne fungi found in the atmosphere.

The prevalence of positive skin reactions to mold spores in our atopic dogs was low compared to other allergen groups. In this group, aero-allergens causing the most prevalent positive skin reactions were mixed *Penicillium* (5.26%) and mixed molds (5.26%), followed by *Alternaria* (3.51%).

4.5. Miscellaneous

The only allergen in this group was Kapok. None of our atopic dogs yielded a positive skin reaction to this allergen. In previous reports, 2–50% of atopic dogs had positive skin reactions (August, 1982; Nesbitt et al., 1984). In Thailand, 24% of allergic children had a positive skin reaction to Kapok (Sritipsukho, 2004).

Considering the aerobiology of all the above aeroallergens in Bangkok, most of them tend to be present on the floor or in an environment close to the dogs. Many reports suggest percutaneous as the favored route of allergen challenge. Impaired epidermal barrier functions of an atopic dog's skin (i.e., abnormal keratinocyte arrangement, discontinuous lipid material filled between keratinocytes, higher numbers of epidermal antigen-presenting Langerhans cells etc.) would allow allergens to penetrate the stratum corneum and conduct hypersensitivity (Inman et al., 2001; Olivry and Hill, 2001; DeBoer, 2004; Olivry et al., 2006). The oral route has also been mentioned (Marsella et al., 2006). Knowing this, it is possible that our sensitized dogs might pick up allergens via many routes, such as inhalation, oral or direct contact.

Correlations between skin reactions to each allergen group and each skin lesion location in our atopic dogs revealed that most skin lesion locations seem not to be related to skin reactions to allergen groups. It was known that the atopic dogs commonly suffer complications such as concurrent secondary infections or microbial overgrowth and chronic inflammation (Griffin and DeBoer, 2001). These might reflect the true clinical manifestations and primary skin lesion locations and cause skin lesions in similar locations that were not specific to any allergen sensitizations. It was interesting that a relationship existed between skin reactions to the pollens group and skin lesions of the perineum and tail area. In previous study, it was shown that these areas contributed to the majority of skin lesions for flea allergy dermatitis (Wilkinson et al., 2004). Moreover, the dogs with positive skin reactions to the house dust and house dust mites group were more likely to develop skin lesions of the feet (although this was not statistically significant). Because this study was not an experimental study, these observations were not enough to conclude that pollen sensitization or house dust and house dust mite sensitization caused skin lesions at these locations. Further cohort studies or clinical trials might be reasonable for studying the risk factors of skin lesions at these locations.

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