

Comparison of intradermal and serum testing for allergen-specific IgE using a FcεRIα-based assay in atopic dogs in the UK

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Received 22 March 2002; received in revised form 12 February 2003; accepted 12 February 2003

Abstract

Atopic dermatitis in dogs is a common allergic skin disease that affects substantial numbers of dogs in the UK. The purpose of this study was to compare the results of an intradermal test (IDT) and an in vitro test in a large cohort of dogs. Dogs were intradermal tested with Greer allergens (Greer Labs Inc, Lenoir, NC, USA) using standard techniques. At the same time blood samples were drawn and submitted for evaluation by ELISA using the ALLERCEPT™ Definitive Allergen Panels for allergen-specific IgE, a commercial assay that uses a biotinylated recombinant extracellular domain of the high affinity Fc-epsilon receptor alpha chain protein (FcεRIα). The allergens used in the two tests included grass, tree and weed pollens, moulds, flea saliva/whole flea extract and house dust mite species. The optical density readings from the ELISA for each allergen were compared with the results of the IDT for 265 dogs. The prevalence of positive reactions in the ELISA was equal to or greater than the results of the IDT in the case of almost all of the allergens, but two notable exceptions were the house dust mites *Dermatophagoides farinae* and *Dermatophagoides pteronyssinus*. These two allergens were the most common positive reactions by IDT (prevalence *D. farinae* 78.9%, *D. pteronyssinus* 66.4%). The results of the two tests were significantly different (McNemar's test, $P < 0.05$) for 16 of the 22 allergens. The sensitivities of the ELISA compared to the IDT (where there were more than 3 dogs with positive reactions in both tests) varied between 19.3 and 77.1% (*D. pteronyssinus* 19.3% and *D. farinae* 67.9%) and the specificities varied between 64.2 and 96.6% (*D. pteronyssinus* 96.6% and *D. farinae* 89.3%).
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Keywords: Canine atopy; Hypersensitivity; Skin disease; ELISA; IgE; Intradermal test

1. Introduction

Canine atopic dermatitis is a well-recognised skin condition that has been defined as a genetically predisposed, inflammatory and pruritic allergic skin disease with characteristic clinical features. It is associated with immunoglobulin E (IgE) antibodies to environmental allergens (Olivry et al., 2001). The diagnosis of atopic dermatitis in the dog relies upon

Abbreviations: FcεRIα, extracellular domain of the human high affinity Fc-epsilon receptor alpha chain protein

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a careful evaluation of the owner's history and the presence of appropriate clinical signs on physical examination (Willemse, 1986; Prélard et al., 1998). The relative importance of microbial infections (*Staphylococcal pyoderma*, *Malassezia* infection), parasite infestations (e.g. fleas and sarcoptes mites) and allergic responses to food antigens have to be evaluated (Scott et al., 2001). A diagnosis of atopic dermatitis may be confirmed with in vivo or in vitro tests to demonstrate the presence of allergen-specific IgE. The results of such tests may be used to formulate allergen-specific immunotherapy to provide control of the skin condition.

The intradermal (skin) test has been the favoured method for demonstrating the presence of (mast cell-bound) canine IgE in order to establish a diagnosis of atopic dermatitis (Reedy et al., 1997; Scott et al., 2001; Hillier and DeBoer, 2001). In the past in vitro tests for canine atopic dermatitis have been associated with an unacceptable high rate of false positive results (Codner and Griffin, 1996). However, the advent of an assay using high affinity Fc-epsilon receptor alpha-chain protein (FcεRIα) enables the measurement of allergen-specific canine IgE in a highly specific manner (Wassom and Grieve, 1998; Stedman et al., 2001). In the study reported by Wassom and Grieve (1998) there was a high level of agreement between the results of an intradermal test (IDT) and an in vitro test (ALLERCEPT™ Definitive Allergen Panels). In the United Kingdom (UK) the results of IDTs have demonstrated that house dust mites are the major allergen group in atopic dogs (Sture et al., 1995; Shaw and Day, 2000). In North America both house dust mite and pollen allergens are important (DeBoer, 1989; Hill and DeBoer, 2001). A comparative study of the agreement between intradermal skin testing and the ALLERCEPT panels for dogs in the UK has not been carried out.

The aim of this study was to evaluate the agreement between test results of an IDT and the ALLERCEPT™ Definitive Allergen Panels for dogs with suspected atopic dermatitis in the UK.

2. Materials and methods

The study used data from dogs referred to two clinics (the University of Bristol Small Animal

Hospital, Langford, and the Animal Health Trust, Newmarket, UK) for the investigation of suspected atopic dermatitis. A detailed history was recorded from the owner. Cases with appropriate clinical signs for atopic dermatitis were evaluated for the presence of microbial infections and parasite burdens using standard diagnostic techniques. The role of food antigens as a cause of the skin condition was assessed using commercially available elimination diets of 6–8 weeks duration.

The dogs were sedated with medetomidine (Domitor™; Pfizer Ltd, Sandwich, UK) and an IDT performed using allergens from Greer (Greer Labs Inc, Lenoir, NC, USA); except for *Tyrophagus* (Artu Biologicals, Lelystad, The Netherlands). Prior to skin testing all anti-inflammatory drug therapy, including oral and topical glucocorticoids and anti-histamines, were discontinued for at least 3 weeks and 10 days, respectively. The IDT was carried out according to recognised criteria with *Dermatophagoides farinae* and *Dermatophagoides pteronyssinus* allergens at 1/10,000 w/v, *Tyrophagus* at 100 NU/ml, flea at 1/1000 w/v, other allergens at 1000 PNU/ml and histamine at 1/100,000 w/v. Skin test reactions were scored positive with a wheal score of 3 or 4 compared to the positive histamine control score of 4. Sedation was reversed with atipamezole (Antisedan™; Pfizer Ltd, Sandwich, UK).

At the time of skin testing, serum was collected and submitted for measurement of IgE using the ALLERCEPT™ Definitive Allergen Panels, an ELISA performed at Axiom Veterinary Laboratories, UK. The allergens used for the serum test were obtained from Center Labs, Port Washington, New York, USA and were composed of a series of indoor and common outdoor pollen allergens. The assay system used diluted dog serum, biotinylated recombinant extracellular domain of the human FcεRIα and streptavidin-horse radish peroxidase (HRP) reagents as detailed by Stedman et al. (2001). The test result was considered positive when the optical density was >350 units, although the characteristics of the tests when different cut-off values were used were also compared for two allergens (*D. farinae* and *D. pteronyssinus*). Positive and negative controls were used for each assay derived from allergen-specific IDT positive and normal dogs. Adjustments were made for interplate variation using calculations based on the positive controls for each plate.

The cutoff of 350 was determined by testing serum from a large number of normal dogs and determining a mean optical density (OD) value for this population. The cutoff was then set as +3 standard deviations from this mean.

Please note that the current commercial format of the ALLERCEPT panels uses a streptavidin-alkaline phosphatase reagent system.

The allergens that were compared between the two tests were timothy grass, cocksfoot grass, meadow grass, rye grass, sheep sorrel, plantain, nettle, lambs quarter, mugwort, alder, oak, birch, *Aspergillus*, *Penicillium*, *Cladosporium*, *Alternaria*, *Tyrophagus*, *D. farinae*, *D. pteronyssinus*, feather, cat epithelium, and flea.

The data were entered from laboratory reports into Microsoft Excel and then exported into SAS (SAS Publishing, version 6.12, ISBN: 1-55544-873-9, 1997, Cary, NC, USA) for statistical analysis using SAS-STAT. Initially data were examined using contingency tables and summary measures. The differences in test results between skin and serological tests in individual dogs were compared using McNemar's matched chi-squared test. The proportions of animals positive to any tests were compared between young and old dogs, between clinics and between genders using simple chi-squared tests. Correlations between results of different tests for reactions to flea and house dust mite antigens were assessed using Pearson's correlation coefficient.

Level of statistical significance was set at 0.05.

3. Results

The total number of dogs entered into the study was 265 (152 from Newmarket and 113 from Langford). The population was composed of 49 females, 70 neutered females, 71 males and 75 neutered male dogs. The age at presentation ranged from 6 months to 11 years. The percentage of the total population that was within the age range of 1–4 years at presentation was 72%. The most common breeds presented were boxer, German shepherd dog, Labrador, golden retriever and West Highland white terrier.

The prevalence (%) of positive reactions in the ALLERCEPT™ Definitive Allergen Panels was equal to or greater than the results for the IDT for 19 of the

22 allergens. Two notable exceptions were *D. farinae* and *D. pteronyssinus*. The difference in results of the two tests was significantly different (McNemar's test, $P < 0.05$) for 16 of the 22 allergens. When adopting the assumption that the IDT was the "gold" standard test, the sensitivities of the ALLERCEPT panels compared to IDT varied from 6.3 to 77.1% for all allergens. The specificities varied from 64.2 to 99.3% for all allergens. The data for prevalence of test reactions, the specificity and sensitivity of the ALLERCEPT panels compared with the IDT, for all of the allergens and for all of the animals tested are presented in Table 1. There were no statistically significant differences between the prevalences in different clinics, genders and different age groups (comparing less than 2 years of age with greater than 2 years age).

The dogs intradermally tested at Langford were neither tested for the individual moulds nor for *Tyrophagus*. Previous clinical studies had shown that reactions to *Tyrophagus* and mould antigens were rare. Of the 83 dogs from Newmarket that were IDT positive to *Tyrophagus* antigen, 80 of them were also positive to one or both house dust mites, and three were negative to house dust mites.

Correlations between the results of different tests to *D. farinae*, *D. pteronyssinus* and flea antigens are shown in Table 2. There was a strong and highly significant correlation between IDT to *D. farinae* and *D. pteronyssinus* and significant but less strong correlation between the ALLERCEPT panel results to *D. farinae* and *D. pteronyssinus*, whether considering the ELISA OD or the test result (positive or negative). The results of the IDT to *D. pteronyssinus* were also highly correlated with the ALLERCEPT panel results to *D. farinae* (whether considering ELISA OD or the test result). In contrast, there was not nearly such a close or significant correlation between the IDT to *D. farinae* and the ALLERCEPT panel results against *D. pteronyssinus* (whether OD or test result). There was no correlation between the flea IDT and any house dust mite test results, or any house dust mite IDT results and any flea test results, although there was a slight correlation between the ALLERCEPT panel results against flea, *D. farinae* and *D. pteronyssinus* antigens.

The basis of the ALLERCEPT panels was that all sera that reacted and had an OD of >350 units were considered positive. We examined the data to

Table 1

Specificity and sensitivity of the ALLERCEPT panels compared with intradermal testing; and proportion of dogs that tested positive for each allergen, for both tests

Allergen	Sensitivity (%)	Specificity (%)	IDT proportion positive (%)	ELISA proportion positive (%)
Timothy	69.2	82.4	4.9	20.2
Cocksfoot	44.4	83.7	6.0	18.0
Meadow grass	69.2	80.0	4.9	22.4
Rye grass	63.6	79.4	4.2	22.4
Sheep sorrel	75.0	81.1	1.5	19.8
Plantain	50.0	82.1	2.3	18.6
Nettle	33.3	88.7	2.3	11.8
Lambs quarter	60.0	84.5	3.8	17.2
Mugwort	70.0	87.3	3.8	14.9
Alder	33.3	89.1	2.3	11.5
Oak	62.5	84.3	3.1	17.2
Birch	22.2	89.4	3.4	11.0
Aspergillus	0.0	99.3	0.7	0.7
Penicillium	0.0	95.3	2.0	4.6
Cladosporium	0.0	99.3	0.7	0.7
Alternaria	0.0	97.3	0.7	2.6
<i>Tyrophagus</i>	77.1	72.2	47.0	51.0
<i>D. farinae</i>	67.9	89.3	78.9	55.8
<i>D. pteronyssinus</i>	19.3	96.6	66.4	14.0
Feather	0.0	97.7	0.4	2.3
Cat epithelium	6.3	99.2	6.1	1.1
Flea	45.8	64.2	9.1	36.7

IDT: intradermal test, and ELISA: enzyme-linked immunosorbent assay.

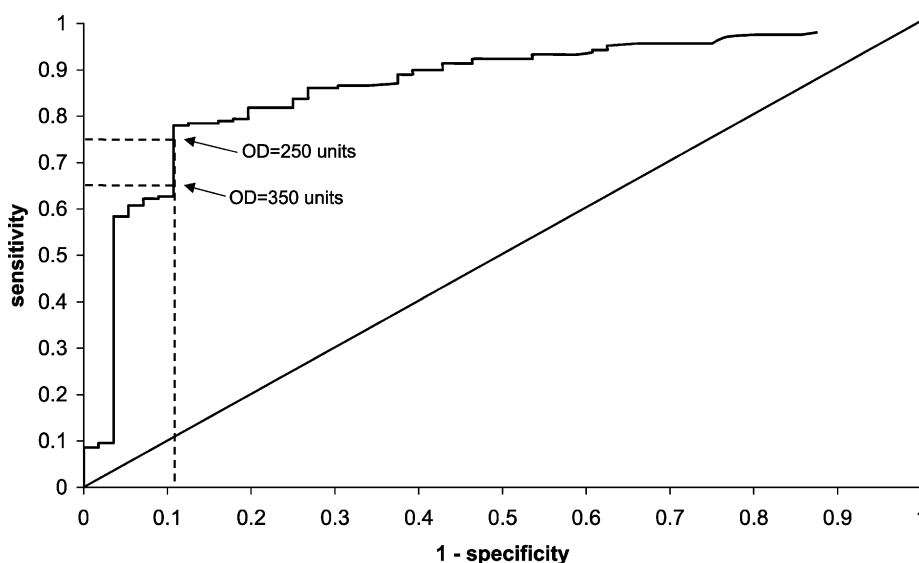


Fig. 1. ROC graph for ALLERCEPT panel characteristics of *D. farinae* compared to the IDT, demonstrating improved sensitivity, with no loss of specificity of the assay, incurred by changing OD cut-off from 350 to 250 units.

Table 2
Correlation between results of different assays for reactions to *D. farinae*, *D. pteronyssinus* and flea antigens

Allergens	DP IDT	DP ALLERCEPT OD	DP ALLERCEPT	DF IDT	DF ALLERCEPT OD	DF ALLERCEPT	Flea IDT	Flea ALLERCEPT OD	Flea ALLERCEPT
DP IDT	1.0 (0.0)	0.21 (0.0005)	0.21 (0.0004)	0.66 (<0.0001)	0.44 (<0.0001)	0.52 (<0.0001)	0.03 (0.6)	0.04 (0.5)	0.01 (0.8)
DP ALLERCEPT OD		1.0 (0.0)	0.7 (<0.001)	0.16 (0.006)	0.46 (<0.0001)	0.30 (<0.0001)	−0.07 (0.2)	0.03 (0.61)	0.04 (0.5)
DP ALLERCEPT			1.0 (0.0)	0.15 (0.01)	0.50 (<0.0001)	0.29 (<0.0001)	−0.08 (0.2)	0.12 (0.04)	0.11 (0.05)
DF IDT				1.0 (0.0)	0.36 (<0.0001)	0.47 (<0.0001)	0.03 (0.6)	0.04 (0.4)	0.01 (0.8)
DF ALLERCEPT OD					1.0 (0.0)	0.70 (<0.0001)	−0.06 (0.3)	0.18 (0.003)	0.12 (0.04)
DF ALLERCEPT						1.0 (0.0)	−0.01 (0.9)	0.11 (0.05)	0.09 (0.1)
Flea IDT							1.0 (0.0)	0.04 (0.5)	0.05 (0.3)
Flea ALLERCEPT OD								1.0 (0.0)	0.64 (<0.0001)
Flea ALLERCEPT									1.0 (0.0)

Results presented include Pearson's correlation coefficient (and statistical significance). DF: *D. farinae*, DP: *D. pteronyssinus*, IDT: intradermal test result ($\pm$), ALLERCEPT: ALLERCEPT panel result, and ALLERCEPT OD: optical density in ALLERCEPT panels.

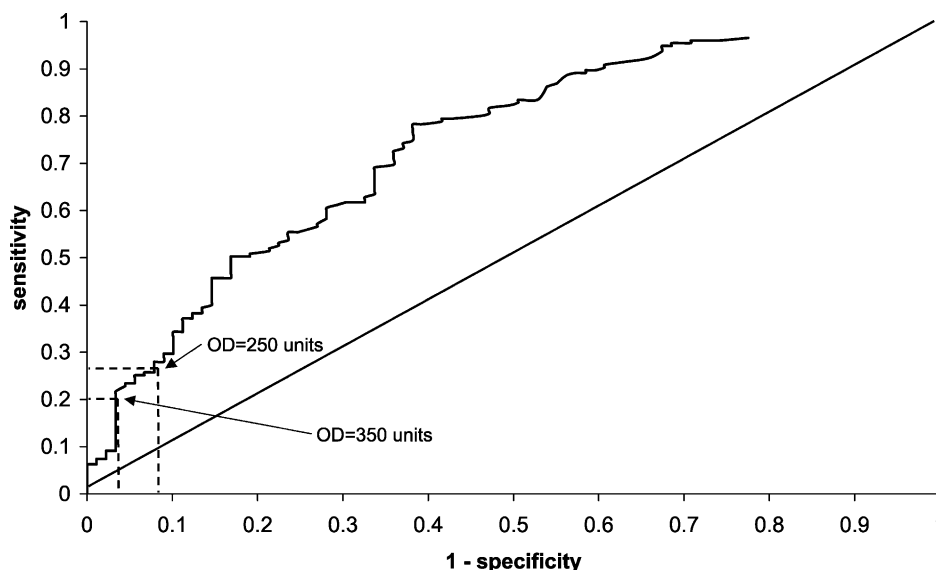


Fig. 2. ROC graph for ALLERCEPT panel characteristics of *D. pteronyssinus* compared to the IDT, demonstrating that the improved sensitivity produced by changing OD cut-off from 350 to 250 units has a deleterious effect on specificity.

determine the influence of the chosen cut-off for the *D. farinae* and *D. pteronyssinus* antigens, using receiver operator characteristic (ROC) graphs (Greiner et al., 2000). Plots of the sensitivity of the two assays against 1-specificity for *D. farinae* and *D. pteronyssinus* antigens are shown in Figs. 1 and 2. The curve in Fig. 1 shows that for *D. farinae*, by decreasing the ELISA OD cut-off from 350 to 250 units, there is a marked increase in sensitivity (to 82% from 68%) with no loss of specificity at all. The benefits of changing the ELISA OD to 250 units for *D. pteronyssinus* are not so clear. The sensitivity is increased from 19 to 26% but the specificity is reduced from 97 to 92%.

4. Discussion

The prevalence of skin test reactions is in keeping with those reported in other studies of atopic dogs in the UK and Europe (Sture et al., 1995; Shaw and Day, 2000; Reedy et al., 1997), namely the high preponderance of reactions to house dust mite allergens and the smaller contribution from pollen allergens. There have been variations reported in the skin test response to dander derived from various species—in this study the response to danders was not investigated beyond

using cat epithelium. In contrast, the reported prevalence of reactions to skin tests in dogs in North America would suggest that both house dust and pollen allergens are important groups of allergens (DeBoer, 1989; Wassom and Grieve, 1998).

To determine the potential value of the IDT as a diagnostic method there has to be consideration of the numerous factors that may influence the test results. There have been positive reactions to antigens when skin testing clinically normal dogs (August, 1982a; Willemse and Van Den Brom, 1982; Codner and Tinker, 1995; Lian and Halliwell, 1998), especially with house dust and house dust mite allergens. It is important to use an appropriate concentration of allergen to distinguish between normal and atopic dogs, and to avoid false positives and false negatives. All of the dogs in the study reported herein were considered to fulfill the criteria for a diagnosis of atopic dermatitis and yet 16.6% were IDT negative. It is difficult to comment about the likelihood that they were false negative IDT results—there is no means of determining the accuracy of the IDT such as provocative challenge. DeBoer (1989) reported up to 20% negative/equivocal IDT results in suspected atopic dermatitis cases. Hillier and DeBoer (2001) review the factors that may lead to false negative results, these

may include, amongst others, drug interference and inherent host factors. In two cases recent steroid therapy and stress were considered to have potentially influenced the results of the IDT.

The test is still considered useful and for many veterinarians is the preferred diagnostic technique (August, 1982b; Willemse and Van Den Brom, 1983; Reedy et al., 1997; Scott et al., 2001). Skin testing and serological assays measure different components of an IgE response to an antigen. The skin test reaction demonstrates IgE bound to the mast cell via the FcεRIα. An in vitro assay measures circulating serum IgE. The half-life of these antibodies varies, for example, in humans, mast cell bound IgE has a half-life of up to 14 days compared with 2.3 days for serum IgE (Ishizaka and Ishizaka, 1975). Indeed, there may be various kinds of canine IgE that have different biological properties (Peng et al., 1997; Scott et al., 2001; Halliwell and DeBoer, 2001). Consequently it would not be surprising if the results of a serological assay did not correlate highly with those of an IDT.

Another major factor to consider is that the antigens used were from different sources, consequently it is unknown how much different the test results would have been, had the same antigens been used in both tests.

In previous studies of canine atopic dermatitis there has been considerable variation in the correlation of skin test results compared with in vitro assay results. Halliwell and Kunkle (1978) and Kiembeck et al. (1989) investigated a radioallergosorbent test (RAST) and an ELISA test, respectively. Using a high cut-off point in the RAST to rule out false positives, the correlation with skin testing in atopic dogs varied with the allergen type, agreement ranging from 12.5% for dandelion to 82% for ragweed. Similar results were obtained with the ELISA system with a correlation of 43–64% according to the allergen. Some other reports suggest that a high correlation can be found between skin testing and ELISA results (Schwartzman, 1993; Halliwell, 1993). It is important to note that previous studies have used various reagents including monoclonal and polyclonal antibodies raised against canine IgE. The ALLERCEPT Definitive Allergen Panels use a biotinylated recombinant FcεRIα that binds in a highly specific manner to canine serum IgE. As ever, the methods and reagents used in this study are different from those used in other

studies, consequently making it difficult to compare this study with others that have compared the correlation between intradermal and serological methods (DeBoer and Hillier, 2001).

Another important factor that needs to be considered is that the biological reactions of the dogs to the antigens, which probably range over a continuous scale, are categorised in these testing systems as either positive or negative. We have examined the usefulness of the chosen ELISA OD cut-off using ROC methods (Greiner et al., 2000). The results of this examination suggest that there would have been the clear benefit of increased test sensitivity in changing the ELISA OD from 350 to around 250 for *D. farinae*, with no reduction in specificity. The sensitivity of the assay for *D. pteronyssinus* would have been increased by 30% of its baseline value if the OD was reduced to 250 units, but there would also have been a small reduction in test specificity (96 to 92%). These results demonstrate the importance of careful validation of new tests before introduction onto the commercial market. However, they are still dependent on comparison with a so-called “Gold Standard”, which in this situation does not actually exist. Application of detailed Bayesian statistical tools, such as Gibbs sampling, would improve the accuracy of the prevalence estimates (which are dependent currently on the results from single assays) but would not in itself improve the interpretation of single test results. Positive and negative predictive values were not included in the work as we felt that there is no true gold standard against which to compare.

The results from this study demonstrated a clear correlation between the results of IDT to *D. farinae* and *D. pteronyssinus*. There was no correlation between the IDT results to fleas and those to either house dust mite species, whereas there was a low level of correlation ($r < 0.2$) between the ALLERCEPT panel results from the different species.

The reasons for the difference in the prevalence of positive test reactions to fleas are not entirely clear, but most likely reflect differences between the antigens used. The Greer antigen is crushed whole flea (*Ctenocephalides felis*) whereas the antigen used in ALLERCEPT panels is extracted flea saliva (Frank et al., 1998). While flea allergy dermatitis was not considered to be a major factor for the pruritus in the cases studied, the prevalence of positive ALLERCEPT

panel results to flea saliva would suggest a potential role for fleas as a flare factor and suggest that flea control measures should be reconsidered where there is a positive antibody test result. Even so, a negative intradermal or serological test result does not rule out flea allergens as potentially significant because there is evidence that some dogs have delayed hypersensitivity reactions without evidence of IgE to flea antigens (Scott et al., 2001).

The ALLERCEPT panel results for pollens show little correlation with skin testing. This may in part reflect false positive assay results due to cross-reactivity of glycan epitopes present on the HRP reagent and other plant proteins. These glycans are recognised as foreign and this may lead to the production of IgG and IgE antibodies in certain individuals. In animals with a high level of such antibodies there is cross-linking of the glycans with IgG and IgE antibodies leading to non-specific binding of HRP to the assay plate (DeBoer and Hillier, 2001). Most of the dogs in this study would have had all year round signs of skin disease and a seasonal component associated with pollen allergens would not have been anticipated. Consequently the assay results for pollen allergens would be regarded as clinically insignificant. The current commercial format of ALLERCEPT Definitive Allergen Panels uses a streptavidin-alkaline phosphatase reagent system rather than HRP reagents, consequently the issue of carbohydrate cross reactivity no longer applies.

Tyrophagus is a storage mite found in stored food such as cereal grain flour, hay, straw and in urban dwellings as a component of house dust (Fernandez-Caldas, 1997; VanHageHamsten and Johansson, 1998) and is reported in rural homes in the UK (Eaton et al., 1985a; Hart and Whitehead, 1990). The positive results for skin test and serum assay suggest either exposure and possible clinical sensitivity to such mites or cross-reaction with antigens from other mites within house dust such as *Dermatophagoides* species. There is some evidence that there is such cross-reactivity between *Dermatophagoides* and *Tyrophagus* mites in serological studies of allergic human patients (Arlian et al., 1984; Fernandez-Caldas, 1997; Vander-Heide et al., 1998). Even so there may be a group of dogs with IDT positive results to *Tyrophagus* allergens without reactions to *Dermatophagoides* spp. such as those reported by Hillier (2001).

There is evidence that atopic dogs with serum antibodies (IgE and IgG) to house dust mite allergens have a greater response to *D. farinae* compared to *D. pteronyssinus* whether in Japan, The Netherlands, UK or USA (Noli et al., 1996; Day et al., 1996; Esch et al., 1997; Masuda et al., 1999; Nuttall et al., 2001). This is in contrast to the sensitivity of human patients to house dust mite allergens where *D. pteronyssinus* tends to predominate over *D. farinae* in the UK (Walshaw and Evans, 1987; Colloff, 1987; Luczynska et al., 1998). This in part is potentially due to differences in the exposure to the mite spp. since *D. pteronyssinus* tends to be more common than *D. farinae* (Eaton et al., 1985a; Smith et al., 1985; Hart and Whitehead, 1990; Arlian et al., 1992). Part of the burden of house dust mite allergens may be due to the presence of a dog in the home. For example, in one study reported from the UK pet beds were sampled for house dust mites and *D. pteronyssinus* was found in association with a variety of storage mites (Eaton et al., 1985b). In a study from two German cities the presence of a dog was a determinant factor associated with an increase in the concentration of the *Dermatophagoides* allergens Der p 1 and Der f 1 in house dust in homes (Gross et al., 2000).

It is likely that the differences between dogs and humans in terms of the serological response to house dust mites antigens reflects differences in exposure (associated with variations in microclimate) and/or the genetic ability of the immune system to recognise dust mite allergens. There is clearly a need for further investigation of the amount and type of mite allergens to be found in the environment of the dog, the dogs' immunogenetic background and the nature of their immune response to such allergens.

There were 27 dogs from Langford that were IDT negative. With the ALLERCEPT panels, the same dogs were antibody negative in 17 cases and pollen-antibody positive in seven cases. A further 3 dogs were positive to *Tyrophagus* or *D. pteronyssinus* rather than *D. farinae*. There were 17 dogs from Newmarket that were skin test negative. With the ALLERCEPT panels, 8 of them were antibody negative; four were positive for pollen antibodies; two were positive for pollen and mite antibodies; two were positive for mite antibodies only; and one was positive for mite and flea antibodies. Of the combined 265 dogs, there were 44 (16.6%) with negative IDTs, of which 8 of the 44 dogs

(18%) were ELISA positive to mites. In dogs with negative IDT results, where one suspects atopic dermatitis associated with sensitivity to indoor antigens, such as house dust mites, there may be a positive serological test in some cases.

To be of value in achieving a diagnosis of canine atopic and providing a basis for immunotherapy the results of any in vitro or in vivo test must be used in association with the history, appropriate clinical signs, exposure to allergens and elimination of other causes of pruritus. The tests are likely to vary in their correlation one to another. Even so, a positive result with either test could be used to prescribe allergen immunotherapy, especially for indoor allergens such as *Dermatophagoides* spp.

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