

Barn allergy among Scottish farmers

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Summary

Previous studies have shown that allergy to storage mites is a significant contributor to allergic disease among an isolated farming community in the Orkneys. The present study was undertaken to determine the prevalence of disease due to storage mites among farmers on the mainland of Scotland. Of the 290 subjects employed on 102 randomly selected farms studied, eighty-seven (30%) reported allergic symptoms on entering barns or byres, and prick tests to storage mites were positive in 62 (21%). Rhinitis and conjunctivitis together were the more frequently reported symptoms, with less than half the subjects recording respiratory symptoms. Specific IgE antibody to storage mites was detected in 43% of subjects reporting allergic symptoms associated with hay dust. Specific IgE to storage mites was strongly associated with atopy in those subjects who reported allergic symptoms.

Introduction

Since farmer's lung was first described (Campbell, 1932), it has been the allergic condition most commonly associated with farmworkers and there have been a number of studies into its aetiology (Pepys & Jenkins, 1965; Pepys 1973) and epidemiology (Staines & Forman, 1961; Boyd, 1971). Little consideration, however, has been given to the prevalence of asthma and rhinitis (type-I allergy) (Gell & Coombes, 1968) among farmers due to hay dust, although type-I disease from grain dust (Warren, Cherniak & Tse, 1974) and from moulds at harvest time (Darke *et al.*, 1976) have been described. Moreover in one survey (Grant *et al.*, 1972) of farmer's lung on Scottish farms it was noted that 35% of the farmers examined complained of 'irritation' of the throat and nose during exposure to mouldy hay suggesting some immediate type reaction. Studies of the farming population of Orkney (Cuthbert *et al.*, 1979) have recently shown a prevalence of asthma and rhinitis chiefly associated with hay dust; skin prick test and radioallergosorbent tests (RAST) for specific IgE suggested that the

condition was due to the large numbers of non-pyroglyphid 'storage' mites present in the hay and these findings were supported by subsequent bronchial provocation tests with two of the storage-mite species, *Glycyphagus destructor* and *Tyrophagus longior* (Ingram et al., 1979). The condition has been referred to as 'barn allergy' (Cuthbert et al., 1979).

The present survey was undertaken with a view to ascertaining the extent to which 'barn allergy' was a significant contributor to allergic disease among farmworkers on the mainland of Scotland. In addition, we looked for correlations between the prevalence of allergic disease in three areas with varying climatic conditions; with the type of work undertaken by the farmworkers and with numbers of mites in their hay. Finally we compared the results of skin tests with the results of RAST to the storage mites in sensitized subjects.

Materials and methods

The three areas of Scotland chosen for study were Fife (east), Stirlingshire (central belt) and Ayrshire (west) as these cover the varying climatic conditions, particularly as regards rainfall, experienced in the country. The farms investigated were either involved in stock-raising beef cattle or dairy farming as these are the main users of stored foodstuffs which harbour the mites. From the farms in each of the three areas, thirty-four representative of the size and type in that area were selected at random. The farms were contacted by letter, or by telephone, to obtain the farmer's consent and cooperation. Out of the 102 farms contacted, only twenty-four refused to participate; these farms were replaced by others in the same area and of the same size and type.

Over 95% of the subjects on the 102 farms agreed to participate in the survey. This gave a study population of 290 (231 men, fifty-nine women) of whom 128 worked on stock raising farms and 162 on dairy farms. Each person was interviewed and a questionnaire completed which gave details of occupational history and work done on the farm. A clinical history was obtained using a modified MRC respiratory questionnaire, with subjects being asked about allergic symptoms and other respiratory conditions, including farmer's lung. Subjects reporting allergic symptoms were specifically asked about any factors which they considered provoked these symptoms.

Skin-prick tests were performed on the forearm of each subject with the Bencard allergen extracts listed in Table 1. Reactions were read after 15 min and weals of 2 mm or more after subtraction of a glycerol saline control were regarded as positive. Subjects were classified as atopic if they gave a positive reaction to one or more of the following allergens: *Aspergillus fumigatus*, mixed grasses, *D. pteronyssinus*, cat, dog, horse and cow dander. 1.25% extracts were prepared from the three storage mite species, *Glycyphagus destructor*, *Tyrophagus longior* and *Acarus farris* and also the culture media used to grow the mites. All the subjects were skin-prick tested with these extracts and weals of 2 mm or more after subtraction of any reaction to the culture media control were regarded as positive.

Blood was collected from 219 of the 290 subjects and the sera stored at -20°C . The RAST was used to measure serum-specific IgE to the storage mites, the culture media and the house-dust mite, *D. pteronyssinus*. Allergen discs were prepared by coupling 10 ml of extract to 1 gm of cyanogen-bromide-activated paper discs (Ceska, Eriksson & Vargo, 1972). IgE was measured by incubating an allergen disc with 200 μl of a 1:4

dilution of serum and detecting bound IgE with ^{125}I -labelled anti-human IgE (Pharmacia, Uppsala, Sweden). The RAST score for an allergen was expressed as:

$$\frac{\text{cpm bound to disc incubated with test serum}}{\text{cpm bound to disc incubated with known negative serum}}$$

A score of two or more was taken as indicating the presence of allergen-specific IgE.

Hay samples for determination of mite numbers and species present were taken from bales by a corer (Alexander, McGowan & Stewart, 1969). Mites were extracted from hay, counted and identified, as previously described (Ingram *et al.*, 1979).

Results

Population characteristics

One hundred and twelve (39%) of the study population reported allergic symptoms; of these forty-four (15%) had asthma, with or without other symptoms, sixty-one (21%) had rhinitis with or without conjunctivitis, and seven had conjunctivitis alone; seventy-five (26%) were classified as skin-test atopic.

Fifty percent of the subjects had never smoked, 14% were ex-smokers, and 27% were current smokers. Smoking data was not available for the remaining 9%.

Two hundred and thirty-five (81%) of the subjects described their job as general farmworker, while the remaining 19% had specific jobs on the farm. However, it was found that all subjects, with the possible exception of twelve tractor drivers, would at some time be involved in feeding cattle, and thus would be exposed to hay dust. This meant it was not possible to obtain an exposure rating for the subjects, and analysis of the data was carried out assuming all subjects were equally exposed.

Table 1. Number of positive prick-test reactions to the allergen extracts

Allergen	No. of positive reactions	% of all reactions
1.25% <i>T. longior</i> extract	74	15
1.25% <i>G. destructor</i> extract	103	21
1.25% <i>A. farris</i> extract	69	14
Bencard allergens		
B2 grass pollen	14	3
House-dust mite <i>D. pteronyssinus</i>	63	13
Dog hair	22	4
Cat fur	20	4
Horse dander	20	4
Cow dander	16	3
Sheep wool	9	2
Rat hair	6	1
Chicken feathers	4	1
<i>Aspergillus fumigatus</i>	31	6
<i>Cladosporium herbarum</i>	3	1
<i>Penicillium notatum</i>	21	4
<i>Fusarium spp.</i>	23	4
Total	498	

Table 2. Relationship between positive prick-test reactions to the storage mites and the other allergen extracts

Prick-test results		No. of subjects	% of study population
Storage mites	Other allergen extracts		
+	-	40	13.8
-	+	9	3.1
+	+	68	23.4
-	-	173	59.7

Skin-test results

Table 1 gives the number of positive skin-test reactions to the battery of allergen extracts. It is readily apparent that the largest number of reactions occurred to the house-dust and storage-mite species. However, RAST inhibition experiments showed that there was very little, if any, cross-reaction between the house-dust mite, *D. pteronyssinus*, and the storage mites, demonstrating the subjects are reacting to distinct allergens in the mite extracts. Thus, a skin-test reaction to house-dust mite is not influenced by exposure to storage mites. This finding justifies the inclusion of reactions to house-dust mite in the definition of atopy. Comparison between the number of positive prick-test reactions to the storage mites, and the relative abundance of the

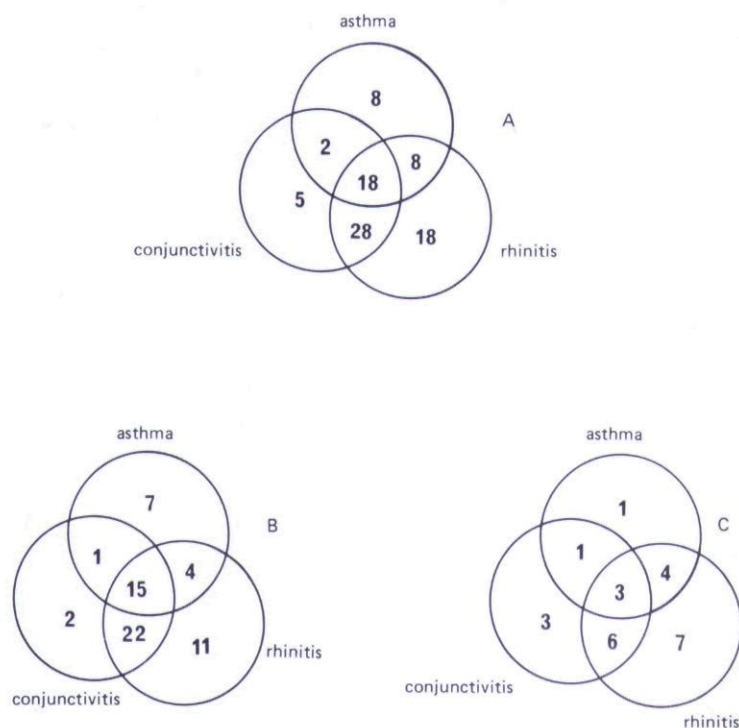
**Fig. 1.** Symptoms associated with hay dust. A, all subjects (87); B, subjects with positive prick tests to storage mites (62); C, subjects with negative prick tests to storage mites (25).

Table 3. Relationship between allergic symptoms and positive prick tests to storage mites

Allergic symptoms	Subjects		Subjects with positive prick test to storage mites		Subjects with negative prick test to storage mites	
	No.	%	No.	%	No.	%
Symptoms associated with hay dust	87	30	62	21	25	9
Symptoms not associated with hay dust	25	9	16	6	9	3
Asymptomatic	178	61	30	10	148	51
Total	290	100	108	37	182	63

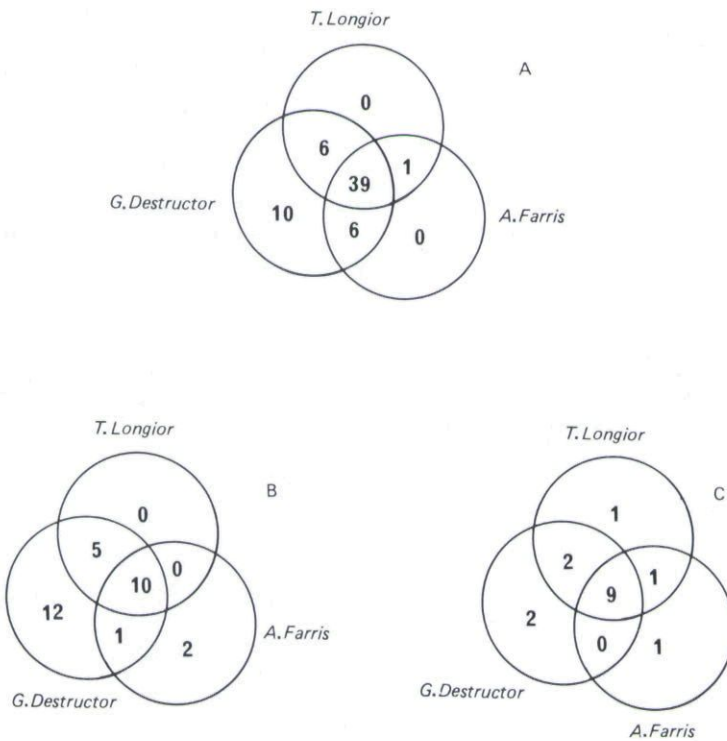


Fig. 2. Prick-test reactions to the different storage-mite species. A, subjects with allergic disease associated with hay dust (62); B, asymptomatic subjects (30); C, subjects with allergic disease not related to hay dust (16).

mites, showed that although the majority of positive prick tests occurred to *G. destructor*, *T. longior* was the most commonly occurring mite in the hay.

A total of 117 subjects gave at least one positive prick-test reaction; of these forty were positive to storage mites only, sixty-eight reacted to storage mites and at least one other allergen, and only nine reacted to other extracts and not the storage mites (Table 2).

Symptoms relating to hay dust

Eighty-seven (78%) of the 112 subjects reporting allergic symptoms, associated their symptoms with hay dust in barns or byres. Of these, sixty-two had a positive prick test to one or more of the storage-mite species. The distribution of atopy among these eighty-seven symptomatic subjects was highly skewed towards those with positive prick tests to the storage mites ($\frac{38}{62}$), whereas from the twenty-five who were negative to storage mites, only one was atopic ($\frac{1}{25}$). However, the nature of the allergic symptoms was not significantly different between the two groups (Fig. 1).

Comparison of smoking status where known and symptoms relating to hay dust showed that 33% were smokers and 13% were ex-smokers, this compares with 31 and 17% respectively, for the whole population. This suggests that smoking is not related to the development of allergic disease to hay dust.

Positive skin tests to storage mites were also observed in sixteen of the twenty-five subjects who did not relate their symptoms to hay dust, and also in thirty asymptomatic subjects (Table 3). It is noticeable that in the subjects with allergic symptoms, whether or not they were related to hay dust, reactions to all three storage mites occurred most frequently, while in the asymptomatic subjects reactions to *G. destructor* alone were the most frequent (Fig. 2).

Examination of the data according to geographical area, indicated that the prevalence of allergic disease due to hay dust, was closely similar in each of the three areas studied, Fife, Ayrshire and Stirlingshire (Table 4). Similarly, the prevalence of disease was not significantly different between dairy farming and stock raising, or between the farms of various sizes.

Mite numbers

Mean mite numbers/g of hay ranged between 157 and 254. Ayrshire farms had the lowest average with 161, followed by Stirling with 236 and Fife with 242. Dairy farms

Table 4. Effect of geographical area on the prevalence of allergic symptoms associated with hay dust

Area	No. of subjects in area	Allergic disease related to hay dust	
		+ve prick test to storage mites	-ve prick test to storage mites
Ayrshire	97	18	9
Stirlingshire	86	20	6
Fife	97	24	10
Total	290	62	25

Table 5. Relationship between allergic symptoms associated with hay dust, prick-test reactions to storage mites, and specific IgE antibody to storage mites

Allergic symptoms	No. of subjects	No. of serum samples	Positive prick test to storage mites		Negative prick test to storage mites	
			+ve RAST to storage mites	-ve RAST to storage mites	+ve RAST to storage mites	-ve RAST to storage mites
Symptoms associated with hay dust	87	65	26	23	2	14
Symptoms not associated with hay dust	25	18	4	7	0	7
Asymptomatic	178	136	6	20	0	110
Total	290	219	36	50	2	131

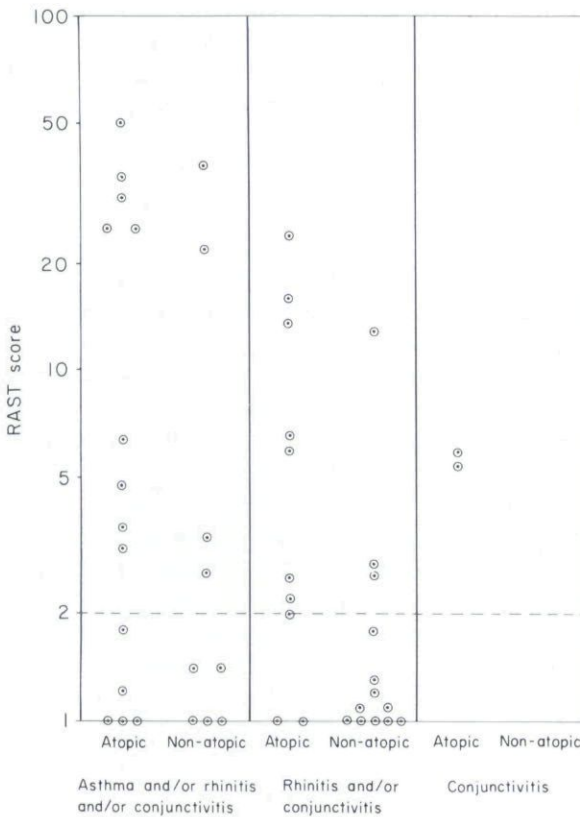


Fig. 3. RAST scores to *G. destructor* in subjects with allergic disease related to hay dust and positive prick tests to storage mites.

averaged 205 mites/g and stock raising 217. There were no significant differences in mite numbers between hay samples from large, medium or small farms in any area.

Serological results

Positive RAST scores to the mite extracts were obtained in forty-two of the 219 subjects who gave blood. Eight of these also had positive RAST scores to the media used to culture the mites, and in four subjects RAST scores to the culture media were greater than those to the mite extracts. The results from these four subjects were omitted from the analysis of the RAST data, since media is invariably present in the mite extracts, and RAST scores to the culture media higher than those to the mite extract suggests the RAST score is probably due to culture media components and not mite components.

In nearly all the subjects with positive RAST scores, scores to *G. destructor* were greater than those to *T. longior* which were greater than those to *A. farris*. The relationship between RAST scores to the mite extracts, prick tests and clinical symptoms, is shown in Table 5. It is noticeable that RAST gave fewer false positive results in asymptomatic subjects than did prick tests. However, out of the sixty-five subjects reporting allergic symptoms to hay dust, RAST was positive in twenty-eight and prick tests in forty-nine. Further examination of the data showed that positive RAST occurred most frequently in atopic subjects, in that nineteen of twenty-seven atopic subjects with hay-dust-related symptoms had positive RAST, but only nine of twenty-three non-atopic subjects. In subjects with symptoms relating to hay dust and positive prick test to storage mites, comparison of atopic status and symptoms with RAST scores to *G. destructor*, showed that the highest scores are seen in the atopic asthmatics and the lowest in non-atopic rhinitis (Fig. 3).

Discussion

We found that 21% of the study population had allergic symptoms which they associated with entering barns or byres and a positive prick test to one or more of the storage-mite species. This group of subjects represents those previously defined as having barn allergy (Cuthbert *et al.*, 1979). Although the prevalence of allergic symptoms associated with hay is high, workers in these farming communities have frequently been associated with farming all their lives, and are less likely to change employment, in contrast to industry where there is a marked tendency for subjects who become sensitized to change their job (Perks *et al.*, 1979). There was an excess of atopics in the group; however atopics were no more likely to have developed asthma than non-atopics. The RAST to storage mites was positive in 53% of the barn-allergy subjects; however RAST was associated with atopy since nineteen of the twenty-six atopics in this group were RAST positive. The findings of negative RAST in the face of positive skin test is probably due to the lower level of total IgE synthesis in these subjects, so that all the IgE is mast-cell bound, resulting in low or negligible serum levels.

In addition to barn-allergy subjects, we were able to identify a second group of subjects who were prick-test-negative to storage mites, but who nevertheless reported allergic symptoms which they associated with entering barns or byres. With the exception of two subjects, all this group were RAST negative to storage mites, and all but one were non-atopic. This group may be comparable to a group of laboratory-

animal handlers previously reported (Cockcroft *et al.*, 1981), who had symptoms relating to animal contact, and yet were skin-test-negative to animal urine; however in that group the prevalence of atopy was unchanged. In the farmers, the association between contact with hay dust and symptoms, may not be so clear as it is in the laboratory-animal workers and it is possible that the subjects have become sensitized to another allergen present in the environment. Alternatively, they may be hyper-reactive and are responding to non-specific stimuli present in the barn atmosphere. We cannot explain the absence of atopics in this group.

The prevalence of allergic disease to hay dust was not influenced by farm size or geographical location. This is not surprising since the variations in mean mite numbers/g of hay between Ayrshire (161), Stirling (236), and Fife (242) are not significantly different in terms of mite populations and are at the levels normally found in 'good' hay. Considerably greater numbers, 400–500/g are frequently found in Scottish hay (Helen B. McNeil, unpublished). These differences in levels of infestation are almost certainly due to the length of storage time when the samples were taken. Mite populations reach a peak in October or November and thereafter decline as the fungal food supply becomes exhausted. A further apparent reduction in mite numbers is due to the disintegration of dead mites over the months of storage; this means that when the hay is examined late in the storage period, actual mite counts may be low. This was very apparent in the previous studies (Ingram *et al.*, 1979), when mites/g of hay averaged 181 from September to April, but 228 during October and November on the same farms. The majority of Fife and Stirling samples were taken during the autumn when mite numbers tend to be higher; most Ayrshire samples were taken in late winter and early spring.

Finally, we suggest that farmworkers presenting with symptoms of allergic disease, should always be prick tested with storage-mite extracts, preferably *G. destructor*, since this has been shown to give the highest number of positive results in patients with allergic symptoms associated with hay dust. This is especially important if skin tests to the other common allergens have proved negative; RAST may be used as a confirmatory test but since many non-atopics give negative RAST, failure to find a positive RAST should not negate the diagnosis.

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