

Serial IgE levels in allergic farmers related to the mite content of their hay

O. D. CUTHBERT,* W. D. BRIGHTON,†§ I. G. JEFFREY‡ and HELEN B. McNEIL‡

*General Practice, Evie, Orkney, †National Institute for Biological Standards and Control, Holly Hill, Hampsted, London, and ‡Agricultural Scientific Services, East Craigs, Edinburgh

(Received 22 August 1979; accepted for publication 4 March 1980)

Summary

Asthma and allergic rhinitis in farmers has been shown to be associated with the large numbers of 'storage mites' present in stored hay (Cuthbert *et al.*, 1979). During the year July 1977 to June 1978, studies were undertaken to compare the IgE levels to specific storage mites in the sera of five farming and one control subject, with the numbers of mites present in their hay. Samples of hay were collected at monthly intervals and the total number of mites per gram of hay in each sample recorded. Species were identified and approximate estimates of the number of two of these, *Tyrophagus longior* and *Acarus farris*, were made for two of the farms Crook and Queenalia, respectively. Blood samples were also taken at monthly intervals from all the subjects and assayed by radioallergosorbent test for specific IgE to five storage mite species and to the house-dust mite (*Dermatophagoides pteronyssinus*).

Mite numbers, both in respect of total counts and specific estimates, showed a rapid increase to a peak during the month of October with a subsequent fall in November and a partial recovery in December, after which numbers tended to even out. Only two of the farmers showed consistently raised levels of specific IgE to any of the storage mite species and these tended to follow the fluctuations of the mite numbers during the months to January 1978, after which one farmer (J.M. from Crook) showed a fall in his positive IgE titre to *T. longior*, whilst the other (W.W. of Queenalia) who was positive to *A. farris* showed a sudden rise in titre to this species. High titres to the house-dust mite (*D. pteronyssinus*) were recorded in the sera of three of the farmers.

One farmer (J.M.) whilst giving a persistently high titre of IgE to *T. longior*, gave only a low one of less than twice normal to *Tyrophagus putrescentiae*, demonstrating a specificity of sensitization to the more commonly occurring of two of the species of a single genus.

Correspondence: Dr. O. D. Cuthbert, Greystones, Evie, Orkney KW17 2PQ.

§Present address: c/o M.A.A.R.A., 93 Green Lane, Derby DE1 1RX.

Introduction

It has been shown (Manners & Ezeoke, 1973) that specific IgE to grass pollen in Hay Fever subjects tends to rise at the end of the pollen season. Farmers who suffer from 'Barn Allergy' (Cuthbert *et al.*, 1979) get most of their symptoms during the winter months when their cattle are housed and being fed hay and silage. This has been shown to be due to the inhalation of storage mites which infest the hay. Serial IgE titres were therefore measured by a radioallergosorbent test at monthly intervals in a group of farmers and compared with the mite content of hay samples (both numerically and by species) taken during the same period. Details of work being done at these times were sought by questionnaire diaries. Unfortunately, whereas co-operation in giving blood and supplying hay samples was 100%, the keeping of diaries was haphazard and largely incomplete, and the information provided, therefore, of limited value. However, it was evident that symptoms occurred both during the hay harvest, especially when stacking, and later when the cattle had been brought in and were being fed hay. The time spent in the byre feeding the cattle was approximately the same every day during the winter months (November–April) and symptoms did not vary to any extent throughout that period, except when extra time was spent on such work as threshing or bruising grain, when the symptoms would often be more severe and asthma replace rhinitis as the main complaint.

Materials and methods

Selection of subjects

Five farmers believed to suffer symptoms due to storage mites were selected from four farms. In addition, one non-atopic non-farming subject was used as a control (O.C.). Table 1 gives their ages, sex and diagnosis, and the result of skin prick tests to house-dust, and to storage mites.

Table 1. Details of selected subjects and control

Subject	Age	Sex	Farm	Diagnosis	Skin test	
					House dust mite	1–4 storage mite species
J.M.	19	M	Crook	Rhinitis (occasional asthma)	+	4+
W.W.	27	M	Queenalia	Rhinitis	+	4+
E.S.	36	M	Redland	Rhinitis & Asthma	+	4+
M.H.	31	M	Lower Ellibister	Asthma	+	3+
H.H.	53	F	Lower Ellibister	Rhinitis	—	—
O.C.	54	M	—	None	—	—

All those subjects experiencing allergic symptoms did so either solely or principally on entering barn or byre, or working with hay or grain.

Farms

Five farms were investigated with regard to the mite content of their stored hay. Four of these were farms on which the selected subjects worked (M.H. and H.H., on the same farm). One other farm (Laga), on which none of the workers is affected, but on which one of the subjects (W.W.) had worked in the past, was also sampled.

Serological investigations

Ten millilitres of blood were taken from each subject at monthly intervals from July 1977 to June 1978. The serum was removed by centrifugation and stored at -20°C .

Radioallergosorbent tests by the method of Ceska (1977) were carried out on these sera against the following allergens: (a) extracts of *Tyrophagus longior*, *Acarus farris* and *Lepidoglyphus destructor*, (b) extracts of *T. putrescentiae*, *A. siro* and *L. destructor* and (c) extracts of *Dermatophagoides pteronyssinus*.

Sera were tested against mite extracts (a) from July 1977 to June 1978; against mite extracts (b) from July 1977 to January 1978; and against mite extracts (c) from February 1978 to June 1978.

IgE titres are recorded by comparison with those of a normal negative serum run in the same assay. Results of twice this normal or greater are regarded as radioallergosorbent test (RAST) positive.

Method of sampling for mites

Handfuls of hay were taken from the inside of a number of bales at each site and placed in plastic bags. The same or adjacent bales were sampled, as far as was practicable, on each occasion.

After collection, the hay samples were placed in beakers containing alcohol and subjected to ultrasonic vibration to remove mites adhering to the hay. Mites were then counted under a low power stereoscopic microscope and later transferred onto slides for species identification.

The counts record only whole mites, living or dead, and do not take account of mite debris and excreta. The counts included all species present. In addition, approximate estimates were made of individual species on two of the farms (Crook and Queenalia) and recorded as (i) 0–5, (ii) 5–10, (iii) 10–20, (iv) 20–30 and (v) more than 30 per gram of hay.

Results

The mean values for the five farms are recorded in Fig. 1, showing the fluctuations over the 7 winter months, September to March 1977–1978.

Mite counts

The numbers of mites in the stored hay rose rapidly during the first weeks of storage, reaching a peak of between 700 and 1400 per gram of hay in October. There was then a rapid fall in numbers to less than 100 mites per gram of hay on some farms in November. The numbers then rose again in December, but not to the October level, and thereafter there was a gradual stabilization of the population around 500 mites per gram. With slight variations, the pattern is the same on all the farms studied.

Figure 2 shows the numbers of the mites *Tyrophagus longior* on Crook farm and *Acarus farris* on Queenalia. The variation in numbers over the months follows the same pattern for these individual species as that for the total mite count.

Thus over one-third of the atopics show no evidence of disease and the ratio of males to females (29.6% of males to 58.8% of females) bears out the findings of Davies

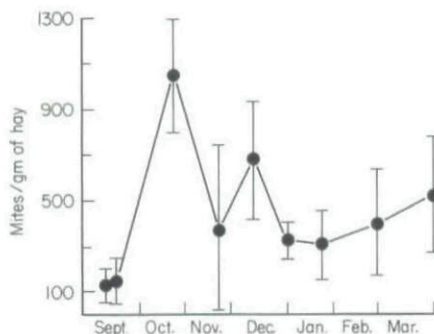


Fig. 1. The mean total mite numbers per gram of hay together with the standard deviation from five farms during the winter months 1977-1978.

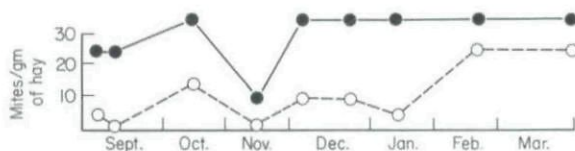


Fig. 2. The total number of mites, *T. longior*, per gram of hay on Crook farm and *A. farris*, per gram of hay on Queenalia over the winter months 1977-1978. ○—○, *T. longior*; ●—●, *A. farris*.

(1976) that more women than men are atopic without symptoms of disease. In this instance, however, the explanation may lie in the greater contact that men have with the farm dusts.

Specific IgE

All five farming subjects gave a positive RAST to at least one storage species on at least one occasion, as also did the control (O.C.). Two farmers, J.M. and W.W., consistently gave positive RAST to at least two of the storage mite species with values over the year of greater than twice the normal and W.W. gave very high titres of up to fifty-nine times normal to *Dermatophagoides pteronyssinus* (Table 2).

The IgE titres to *T. longior* in the serum of J.M. and to *A. farris* in the serum of W.W. show slight variation over the months; these variations (Fig. 3) for the first 7 months of the study (July 1977 to January 1978) follow the variations shown by both the total and specific mite counts in the hay of these individuals (Fig. 1). Subsequently their antibody levels show a different pattern of response, J.M.'s IgE titre to *T. longior* tending to fall in the spring, whilst W.W.'s IgE response to *A. farris* rises.

Comparison of the response by specific IgE titres of J.M. to *T. longior* with *T. putrescentiae* is shown in Fig. 3 and Table 3, a mean IgE titre of 8.5 to *T. longior* compared with only 1.6 to *T. putrescentiae* over the first 7 months, and a mean titre of 2.0 to *A. farris* compared with one of 0.9 to *A. siro* over the same period.

Discussion

Soon after the hay harvest the mite numbers on the stored hay rise to a peak: this is almost certainly due to the growth of fungi on the hay which provides plentiful food for the mites and allows a 'population explosion' to occur at this time. After a fall in mite numbers in November and December, the population becomes relatively stable. However, there must remain a large number of dead and disintegrating mites as well as

Table 2. Mean specific IgE titres to six mite extracts (five species) in five farming and one control subject taken monthly from July 1977 to June 1978.

Period	Mite species	Subjects					
		Farming					Control
		J.M.	W.W.	E.S.	M.H.	H.H.	O.C.
July 1977 to January 1978	(a)	2.0*	2.5*	0.8	0.9	0.8	0.9
	(b)	8.5*	1.8†	0.8	1.3	0.8	0.7
	(c)	1.2	1.4	0.7	0.8	0.7	0.8
	(d)	0.9	3.5*	1.0	1.2	1.2	1.5
	(e)	1.6	2.0*	0.8	0.8	0.6	0.7
	(f)	1.5	1.8†	1.0	1.0	1.7†	1.5†
February 1978 to June 1978	(a)	1.0	5.0*	1.5†	0.8†	0.8	1.6†
	(b)	5.8*	3.5*	1.0	0.8	0.7	1.2
	(c)	0.9	4.6*	1.4	0.7	0.6	1.4
	(g)	4.6*	34.3*	5.4*	1.0	0.8	0.7
July 1977 to June 1978	(a)	1.6†	3.5*	1.1	0.9	0.8	1.2
	(b)	7.4*	2.5*	0.9	1.1	0.7	1.0
	(c)	1.1	2.7*	1.0	0.8	0.7	1.1
Mite medium		1.2	2.3*	1.1	0.8	0.8	1.3†

* Mean IgE titre over twice normal = positive RAST.

† Mean IgE titre less than twice normal but one or more monthly values of over twice normal.

Mite species: (a), *A. farris*; (b), *T. longior*; (c) *L. destructor* (1); (d) *A. siro*; (e) *T. putrescentiae*; (f), *L. destructor* (2); (g) *T. pteronyssinus*.

Two separate strains of *L. destructor* (1) and (2) both cultured at the Pest Infestation Control Laboratories were used, strain (1) for the whole year and strain (2) for the first 7 months' samples only.

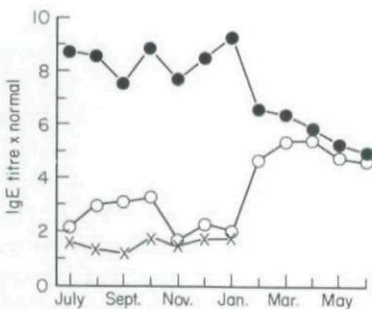
**Fig. 3.** The IgE $\times$ normal titre to *T. longior* and *T. putrescentiae* in subject J.M. and the IgE titre $\times$ normal to *A. farris* in subject W.W. estimated monthly from July 1977 to June 1978. ●, *T. longior*; ○, *A. farris*; ×, *T. putrescentiae*.

Table 3. Specific IgE titres $\times$ normal in the sera of two farming subjects to seven mite species and mite culture medium, taken at monthly intervals. Results marked * are greater than twice the normal value given by a negative serum run in the same assay and are regarded as RAST Positive.

Month	Mite species (see below)							
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
<i>I. J.M.</i>								
July 1977	1.6	8.7*	1.1	0.9	1.7	1.8		1.2
August	2.0*	8.6*	0.9	0.9	1.4	1.5		1.4
September	1.8	7.6*	1.3	0.9	1.3	1.3		1.4
October	2.1*	8.8*	1.2	0.9	1.8	1.5		1.3
November	1.8	7.7*	1.2	0.9	1.7	1.6		1.2
December	2.2*	8.5*	1.3	0.9	1.7	1.6		1.3
January 1978	2.3*	9.3*	1.4	0.9	1.9	1.2		1.5
February	1.0	6.6*	0.8				5.0*	1.0
March	1.1	6.4*	0.8				5.3*	1.0
April	1.0	5.9*	0.9				3.9*	1.0
May	1.1	5.3*	1.0				4.6*	0.9
June	0.9	5.0*	0.8				4.4*	1.0
<i>2. W.W.</i>								
July 1977	2.2*	1.7	1.3	3.7*	2.0	1.7		1.0
August	3.0*	2.4*	1.6	5.0*	2.7*	2.1		1.3
September	3.1*	1.9	1.3	3.0*	1.8	1.7		0.9
October	3.3*	1.8	1.5	3.5*	2.0*	2.0*		0.9
November	1.7	1.5	1.4	2.9*	1.8	1.8		1.0
December	2.3*	1.7	1.3	3.6*	1.8	2.1*		1.1
January 1978	2.1*	1.9	1.4	3.1*	2.0*	1.3		1.2
February	4.7*	2.8*	3.4*				23.9*	2.9*
March	5.4*	3.7*	4.2*				28.9*	4.4*
April	5.5*	4.1*	4.6*				59.6*	4.2*
May	4.8*	3.4*	5.0*				31.1*	3.9*
June	4.9*	3.5*	5.6*				27.8*	4.4*

Mite species: (a) *A. farris*; (b) *T. longior*; (c) *L. destructor* (1), (d) *A. siro*; (e) *T. putrescentiae*; (f) *L. destructor* (2), (g) *D. pteronyssinus*; (h) mite medium.

mite excreta which is as potentially allergenic as the live mites and, the particles being smaller, probably more easily inhaled.

The specific IgE titres of the two subjects (W.W. and J.M.) who are RAST-positive to one of the storage mites, follows the population peaks of those particular mites and also the mite population as a whole, especially in the period before the new year. The specific IgE rises with the mite numbers in October and falls with the mite numbers in November. If this is a true reflection of the antibody state, the IgE initially present in the serum has been depleted by contact with the early high peak of mite population rise and the antibody response takes a short time to recover and make up the shortfall. In the second half of the winter there is a marked difference in the response of the two subjects. J.M. shows a gradual falling away of specific IgE to *T. longior* until his lowest titre is reached just before the next hay harvest in June, whilst W.W.'s response to *A.*

farris (and all other species) shows a build-up to a peak in April and then only a slight falling off in the next two months (Fig. 3). This latter response is closer to that shown by hay fever sufferers and is also consistent with the high estimated numbers of *A. farris* persisting in his hay (Fig. 2).

Subject J.M. demonstrates a marked species specificity, to the two species of the genus *Tyrophagus*, namely *T. longior*, the species most commonly found in Orkney hay, to which in the seven months July 1977 to January 1978 he had a mean IgE titre of 8.5 (times normal) and *putrescentiae*, a common storage mite not found on Orkney farms, to which he had an IgE titre of 1.6 (Fig. 3). There is also a two-fold difference between his responses to two species of the genus *Acarus*, namely *A. farris*, the commoner local species with a mean seven months IgE titre of 2.0, and *A. siro*, often associated with bruised barley and grain residues, with a mean titre of 0.9. However, the latter titres are too low to be of more than marginal significance. His responses to *L. destructor* though different for the two strains, are similarly too low to be of significance (Table 3).

Finally, it is evident that of all the species, *D. pternoyssinus*, even among farmers, is the most potent sensitizer. The fact that it appears to produce fewer clinical symptoms in farmers than do some of the storage species is almost certainly due to the small numbers of this particular mite present in the farming environment when compared with the numbers of other species, such as *T. longior* and *A. farris*.

Conclusions

Mite allergy among farmers, although it may be in part the result of sensitivity to allergens common to all the acarina, is also highly specific and that specificity determined by contact with the species most commonly occurring in the farmer's environment. No definite conclusions can be drawn regarding the association of IgE levels with mite contact: in the two farmers who showed consistently raised IgE titres to a specific mite, the one, J.M., had the highest titres during the time of greatest exposure during the winter months, whilst the other, W.W., produced the highest titres at the end of the time of chief occupational exposure, just before the cattle were allowed out to grass, and therefore behaved as hay fever sufferers, following the seasonal exposure to their allergen. However, the lowest titres are found in both just prior to the hay harvest when they have been the longest time free of exposure to storage mites.

Acknowledgments

This work was helped by a grant from the Orkney Health Board. We are indebted to Mr A. M. Cunningham and Dr D. A. Griffiths for the mites in pure culture, to Dr D. G. Wraith for obtaining some of the mite extracts for us, and to Bencards for preparing them. To those farmers on the Mainland or Orkney who allowed us to take samples of their hay and blood, we are especially grateful.

References

- CESKA, H.M. (1972) Characterisation of allergic extracts by dose-response studies and by polyacrilamide gel iso-electric focussing using paper disc radioallergosorbent test as the assay method. *International Archives of Allergy and Applied Immunology*, **43**, 419.
- CUTHBERT, O. D., WRAITH, D.G., BROSTOFF, J. & BRIGHTON, W.D. (1979) 'Barn allergy': asthma and rhinitis due to storage mites. *Clinical Allergy*, **9**, 229.
- MANNER, B. & EZEKIE, A. (1973) Serum IgE levels and the use of sodium cromoglycate (BP) in hay fever; a study of forty-six patients from a single general practice. *Clinical Allergy* **3**, 311.

This document is a scanned copy of a printed document. No warranty is given about the accuracy of the copy. Users should refer to the original published version of the material.