The environmental control of house dust mites: a combined hygrothermal population model

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Summary: *Allergens derived from house dust mite (HDM) faeces play a major role in allergic disease, especially asthma. It is well-known that house dust mite physiology is greatly affected by hygrothermal microclimatic conditions. Consequently, there is considerable interest in reducing mite populations in dwellings by modifying the fabric and services in a building and by changing occupant behaviour. This abstract illustrates 2 sets of combined hygrothermal population models, which are capable of predicting how room conditions affect the survival of HDM in beds. Preliminary results from fieldwork experiments indicate a satisfactory agreement between the monitored and the predicted hygrothermal conditions.*

Keywords: *house dust mites, allergy, moisture, environmental control, building design, ventilation.*

1 Introduction

Marked variations have been found in the prevalence of asthma symptoms worldwide. Environmental factors are likely to play an important role in such variations, and offer promising opportunities for prevention. Allergens derived from house dust mite (HDM) faeces play a major role in allergic disease, especially asthma. It is well-known that temperature and humidity play an important role in house dust mite physiology. The environmental (or psychrometric) control of house dust mites [1] is a method of reducing house dust mite populations and associated allergens by decreasing indoor moisture levels through the manipulation of building design, building operation and occupant behaviour.

2 Problem statement

Hygrothermal conditions in mite habitats are very variable and average values of temperature and relative humidity (RH) can be poor indicators of whether the mites are likely to prosper or not. Because of the complexity of the many interacting factors, a modelling approach is required.

A multidisciplinary UK-based team has developed two combined hygrothermal population models predicting the survival/decline in beds of *Dermatophagoides Pteronyssinus* (DP), the most common HDM species in the UK and Europe.

One of the two sets of models is a steady-state one-dimensional model combining the hygrothermal model *BED* [2] with the population model *MPI*. The main input parameters for the *BED* model are: dwelling dimensions, heating and ventilation patterns, indoor moisture production, insulation levels, climate, bed characteristics and occupant characteristics. The *BED* model predicts the average monthly temperature and RH of the bed core. This information is then used in the *MPI* model, which predicts whether a DP population in the bed core is likely to grow or decline on average each month.

The other set of combined models developed by the research team is a transient 3-dimensional model combining the hygrothermal *Lectus* model with the population model *Popmite*. Hourly room temperature and RH are the required inputs for *Lectus*, as well as the bed characteristics and the number of hours the bed is occupied. *Lectus* predicts the hourly hygrothermal conditions found in each cell of the bed. This information is then utilised in *Popmite* which - given an initial mite population - predicts the hour-by-hour population in each cell of the bed.

The results of transient experiments on wild *Dermatophagoides pteronyssinus* (DP) are currently being incorporated in the *Popmite* model. Furthermore, encapsulated live mites are being used in monitored beds, in order to validate the population model. Preliminary results from fieldwork experiments indicate a satisfactory agreement between the monitored and the predicted hygrothermal conditions. *Lectus* is currently being modified for predicting the effect of children in beds.

References

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