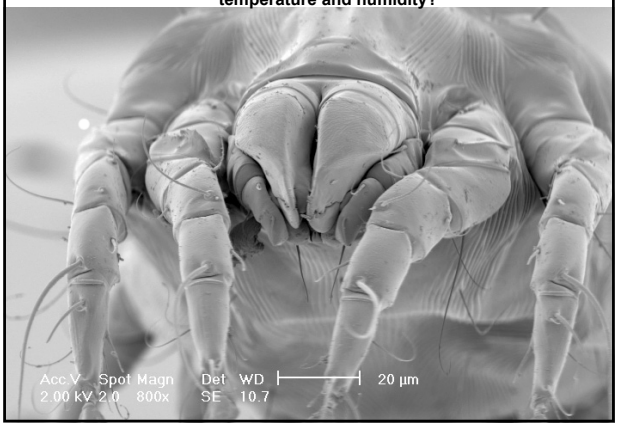
Can we get rid of house dust mites in the home by controlling temperature and humidity?



Agenda

Chair: *Prof Bill Bordass*

10:00 **Registration and Coffee**
10:30 **Living with mites:** Getting to know the enemy - *Phil Cox*
11:00 **Appropriate strategies for control:** An overview of the project - *Tadj Oreszczyn*
11:20 **The bed environment:** Results of the laboratory and field studies - *Ian Ridley*
11:40 **Modelling the bed environment:** The simple steady state model - *Stephen Pretlove*
12:00 **Modelling mite populations:** Relating population size to conditions - *David Crowther*
12:20 **Mite experiments:** Filling some of the gaps in knowledge - *Toby Wilkinson*
12.40 **Discussion**
13:00 **Lunch**
14:00 **The transient hygrothermal model:** Simulating conditions in beds - *Ian Ridley*
14:30 **The transient mite population model:** A first attempt - *David Crowther*
15:00 **The combined model**: Results and conclusions - *Tadj Oreszczyn*
15:30 **Discussion**
15:50 **Summing up** - *Bill Bordass*
16:00 **Coffee**

Appropriate strategies for control?

Tadj Oreszczyn

Appropriate strategies for control:

- What measures can be taken against mites?
- Do environmental means of control have advantages over other methods?
- An overview of the EPSRC research project

Current Methods of Control

Acaricides

Vacuuming

Microporous bedding covers

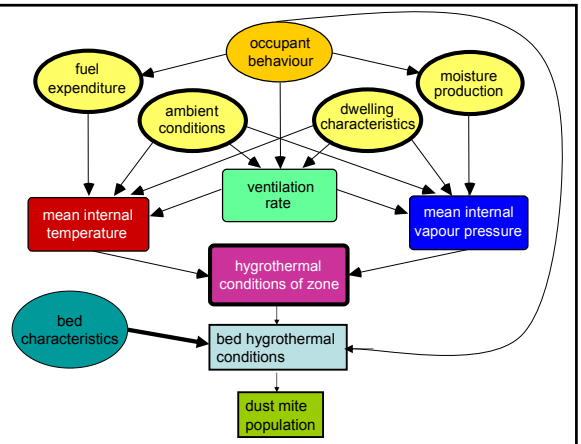
Freezing

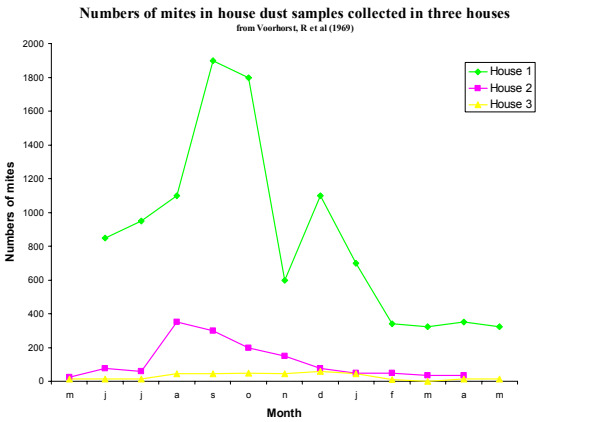
Dehumidifiers

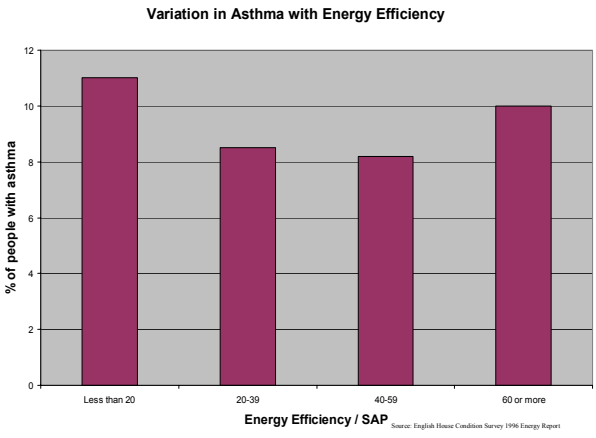
Washing at high temperatures

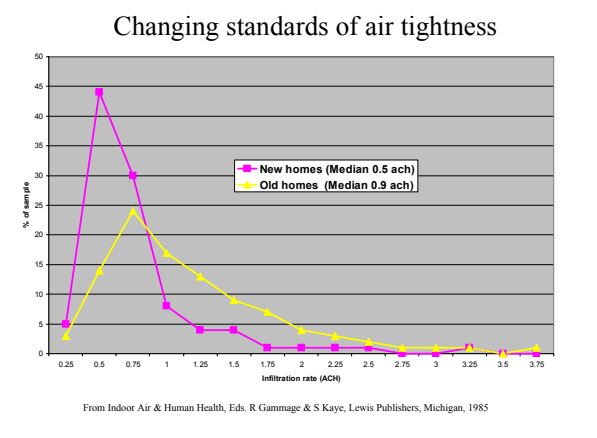
Methods of control

1. Controlling access to food - human skin scales
2. Killing mites by extreme environmental conditions or Acaricides.
3. Preventing human contact with the allergen.
4. Preventing population growth through environmental control.









From Indoor Air & Human Health, Eds. R Gammage & S Kaye, Lewis Publishers, Michigan, 1985

Engineering and Physical Sciences Research Council

South Bank University
Stephen Pretlove

Insect R&D Limited (formerly Medical Entomology Centre, Cambridge)
Phil Cox, David Thomson, John Maunder, Ian Burgess

The Bartlett, University College London
Tadj Oreszczyn, Ian Ridley

The Martin Centre, University of Cambridge
David Crowther, Nick Baker, Jane Horwood, Toby Wilkinson, Brian Leung (Department of Zoology)

Aims

- To develop a model to predict house dust mite populations in dwellings accurate enough to determine the impact of modifications to building fabric, services and occupant behaviour.

2 year project

Why model?

1. Assess a range of different options.
   - What impact does ventilating the bedroom have during the morning or taking covers back?
   - How important is the type of mattress?
   - What impact does changing insulation and ventilation systems have on the mite population
2. Examine historically what has happened
   - what impact has draught stripping and central heating had on mite populations?
3. Examine what may happen in the future as a result of climate change, regulations, etc.
4. Help understand monitored data. (VP versus RH)

‘In theory,
theory and practice are the same,
but in practice,
they’re not’

Santa Fe Institute in Factor Four

Mite is right

Sir: My husband claims to have seen a programme on TV explaining that house mites enjoy the humidity of a warm bed and, for this reason, beds should be left unmade. Bed-making is one of the few domestic chores that my husband undertakes but he now refuses to do this on the grounds that it is unhygienic. This reduction in his useful activity is clearly detrimental to his fitness and health, as well as being an added irritation to me. Can any of your readers suggest ways, or advance arguments, which might get him moving again. I wonder too, whether there is an animal rights issue here? I am thinking, of course, of the house mites.

MADGE ALSTON
Ipswich, Suffolk

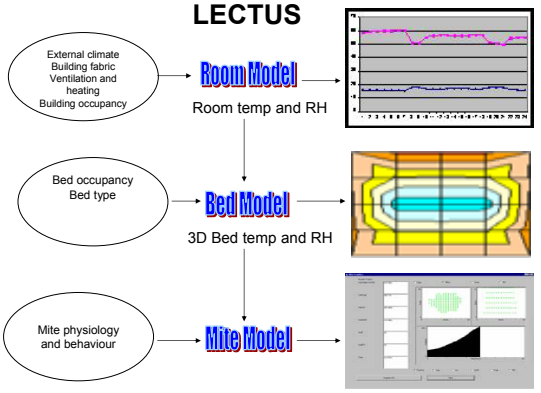
The Independent 28 March 2001

Methods

- computer modelling
- laboratory measurements in beds and environmental chambers
- field measurements in houses

Bed3 & Lectus

Name	**BED3**	**LECTUS**
Complexity	Simple	Complex
Dimensions	1 Dimensional	3 Dimensional
Time scale	Steady state Monthly	Transient (30 min)
Hygrothermal model	BREDEM 8 plus Loudon	Transient full (TAS ENERGY+)
Population model	Hygrothermal Population Equilibrium	Spatially Explicit Life Cycle model
Application	Option appraisal	Research

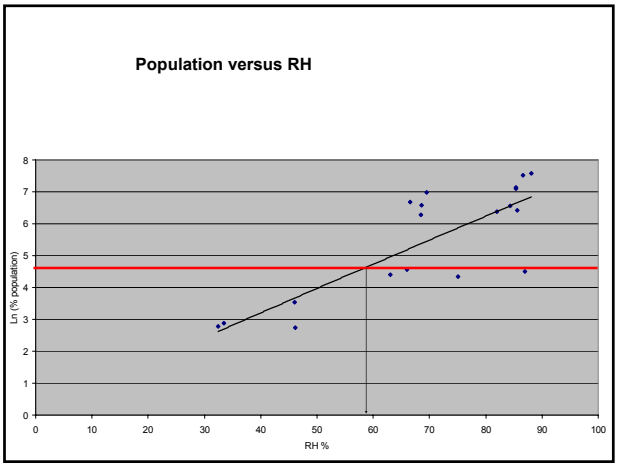


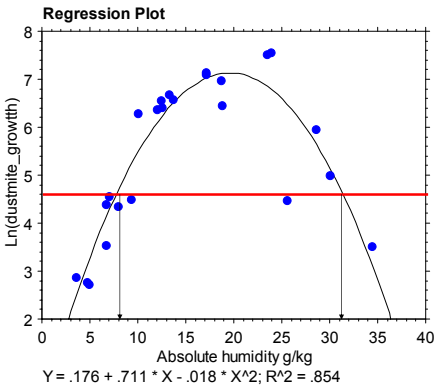
The combined hygrothermal population model:
Results and conclusions

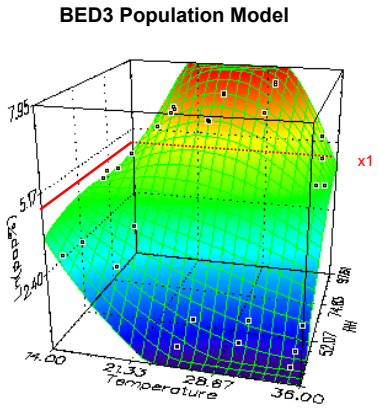
Tadj Oreszczyn

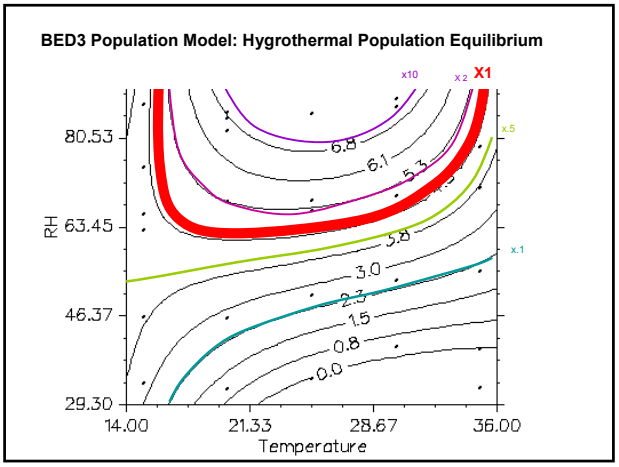
The combined model: Results and conclusions

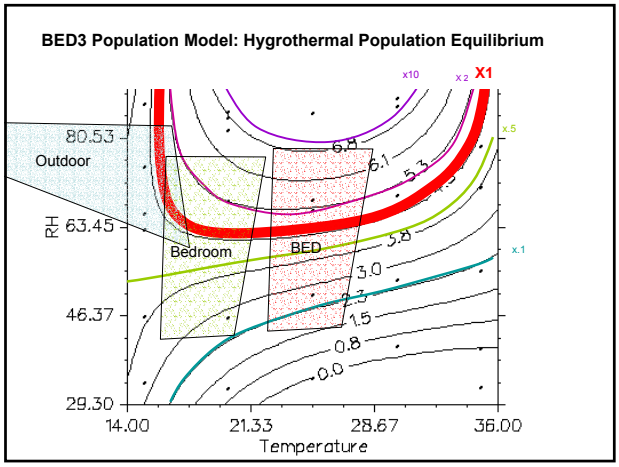
- What are the best strategies for mite control?
- What is the likely impact of climate change?
- The way forward?

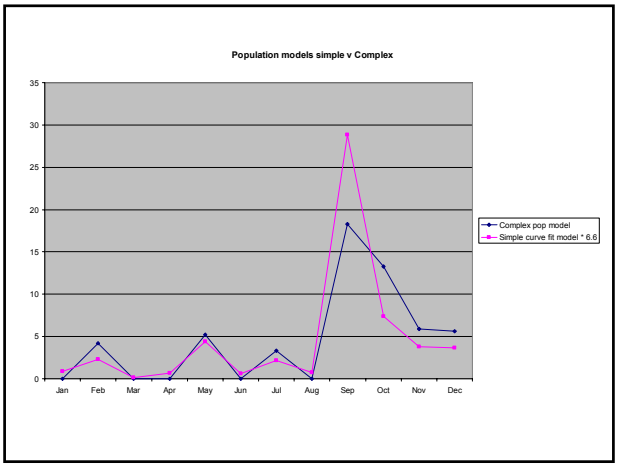


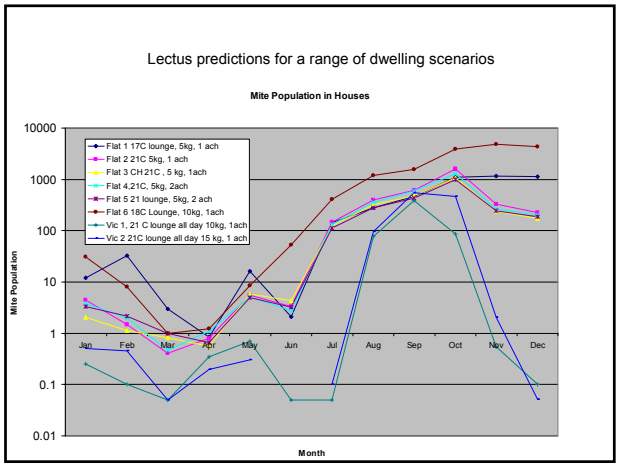


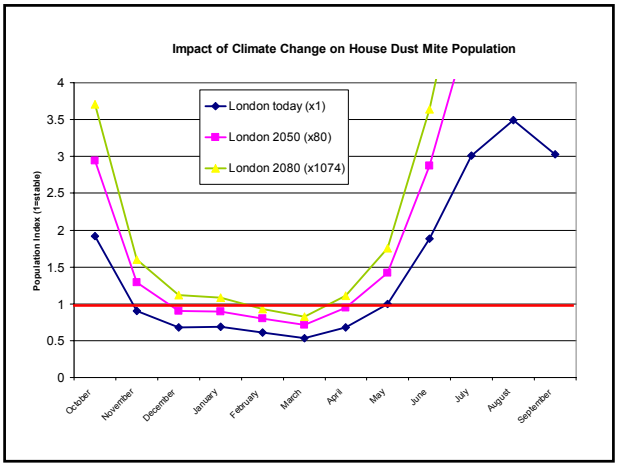






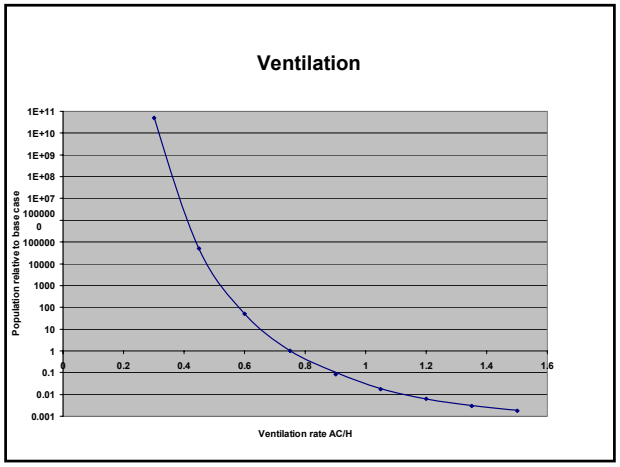


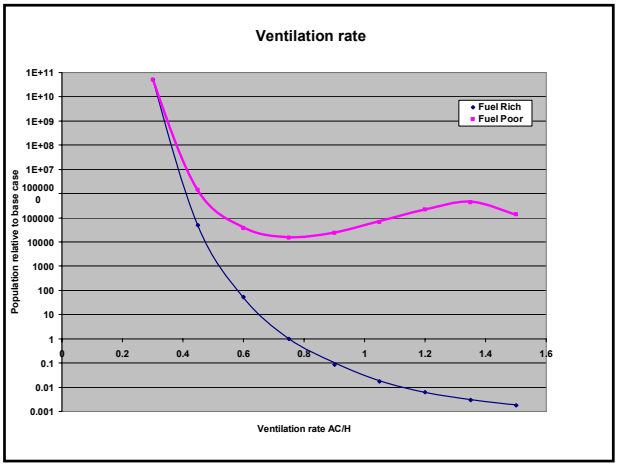




Base Case

- Semi detached modern dwelling, London,
- Heating in living room: 9 hrs/day weekdays and 16 hrs/day weekend
- Heating in bedroom: 7 hrs/day weekdays and 11 hrs/day weekends,
- Ventilation rate 0.65 ach,
- Moisture production 9 kg/day
- Occupancy 4 (2 adults and 2 children),
- Beds occupied for 7 hours each night
- Population increases over year x 2.7


Ventilation
Population relative to base case
1E+11
1E+10
1E+09
1E+08
1E+07
100000
0
100000
10000
1000
100
10
1
0.1
0.01
0.001
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
Ventilation rate AC/H


Ventilation rate
Population relative to base case
Fuel Rich
Fuel Poor
1E+11
1E+10
1E+09
1E+08
1E+07
100000
0
100000
10000
1000
100
10
1
0.1
0.01
0.001
0
0.2
0.4
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0.8
1
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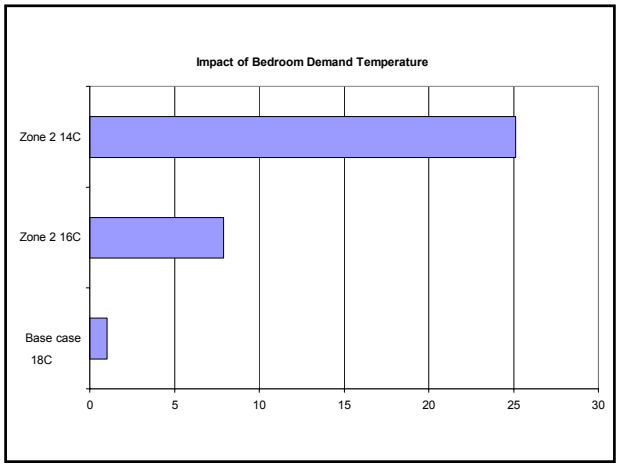
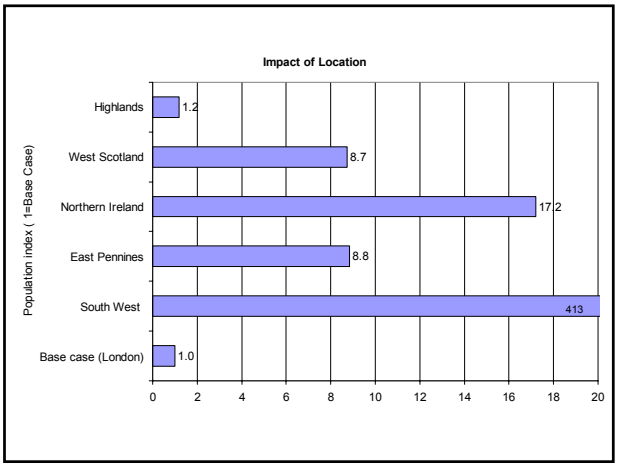
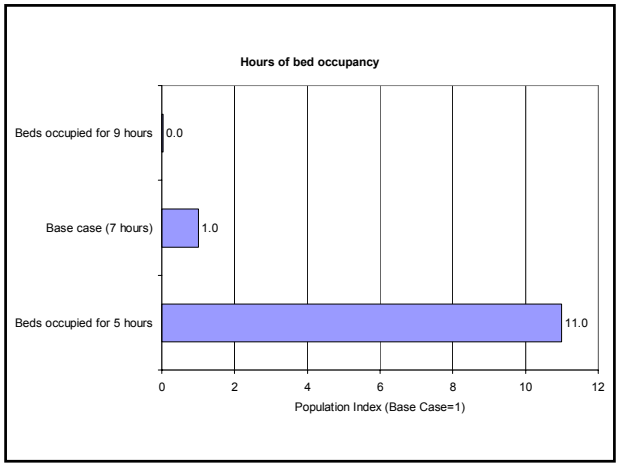
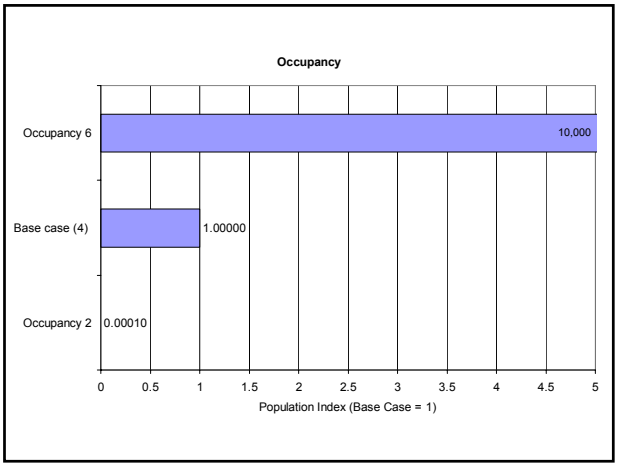
Ventilation rate AC/H


Impact of Bedroom Demand Temperature
Zone 2 14C
Zone 2 16C
Base case
18C
0
5
10
15
20
25
30


Impact of Location
Population index (1=Base Case)
Highlands
1.2
West Scotland
8.7
Northern Ireland
17.2
East Pennines
8.8
South West
413
Base case (London)
1.0
0
2
4
6
8
10
12
14
16
18
20


Hours of bed occupancy
Beds occupied for 9 hours
0.0
Base case (7 hours)
1.0
Beds occupied for 5 hours
11.0
0
2
4
6
8
10
12
Population Index (Base Case=1)


Occupancy
Occupancy 6
10,000
Base case (4)
1.00000
Occupancy 2
0.00010
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Population Index (Base Case = 1)

Conclusions from the hygrothermal modelling

1 *Hygrothermal conditions in the mite habitat are very varied*
This creates a problem since most lab mites are reared in static conditions and most of the mite physiology data relates to steady state conditions

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Partly because the bed is only occupied for 8 hrs out of 24, but even directly under the body during the night conditions vary according to room conditions

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4 *"Snapshot" room RH values are likely to be misleading*
Unfortunately this is common in major housing/health studies as an indicator of the likelihood of mite infestation.

Conclusions from the population work

1. *Mites are sensitive to both RH and temperature.*
2. *Mites can and do move to better environments*
3. *Transient environments result in different mite populations compared to steady state – even if the mean is the same*
4. *Mites are unlikely to be limited by space or food in most situations*

Project results and overall conclusions

1 *We have developed a combined hygrothermal/ population model, but it needs considerable further development*

2 *In principle it is clearer than before that we can get rid of mites from the home by controlling hygrothermal conditions*

3 *But a lot of the fine detail and really interesting questions remain unexplored, eg:*
- What are the best practice guidelines for a range of typical house types (ie. without sacrificing thermal comfort or energy efficiency)?
- Is it better to ventilate for short bursts ("purging") or a little all the time?
- Is it better to open windows at night & close them during the day (trad UK practice), or the other way round (trad Continental practice)?
- What are the implications for building regulations & public health promotion?

The Future!

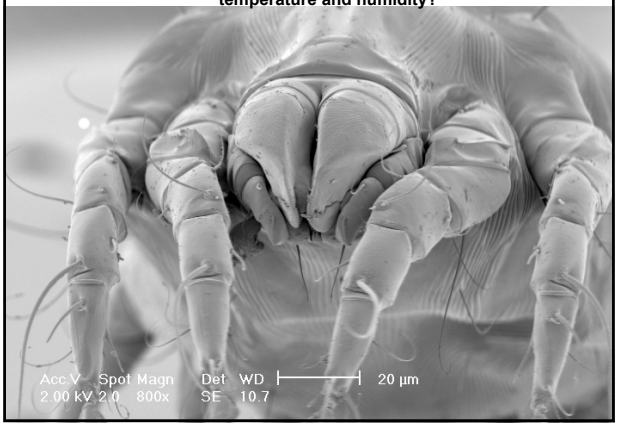
- For all relevant combinations of temperature and RH measure (for three species):
  - Rates of egg production
  - Egg to larva, larva to adult development times
  - Mortality rates for each stage
  - Mite movements

  With "real" not Royal Fanger Mites
- Measure hygrothermal properties for a greater number of beds
- Validation: Warm Front health study?

If, and only if, current model is correct?

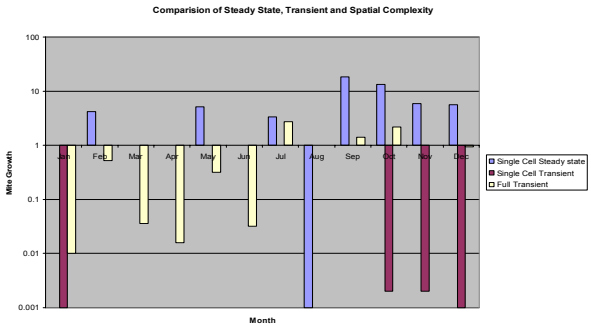
- Ventilate above 0.7 air changes per hour
- Turn the heating on
- Move to either London or the Highlands not the South West of England
- Spend more time in bed, but stay in the house alone
- Prepare to meet more mites in the future as a result of climate change

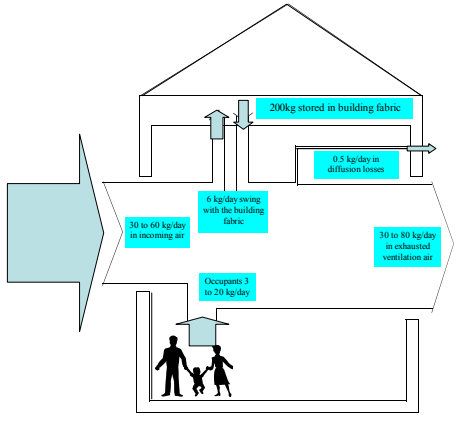
Can we get rid of house dust mites in the home by controlling temperature and humidity?



THE END

Transient, Spatial, Steady State





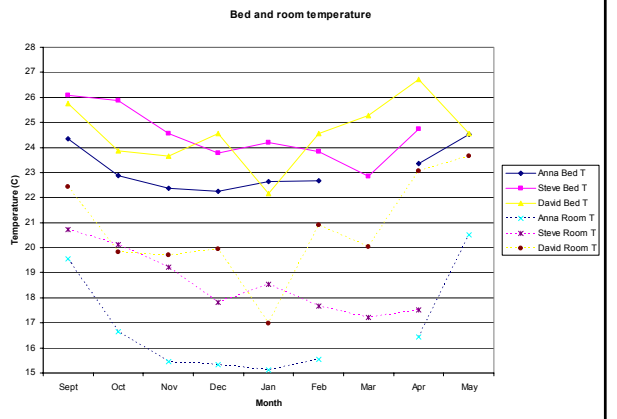
Curve fit to empirical data

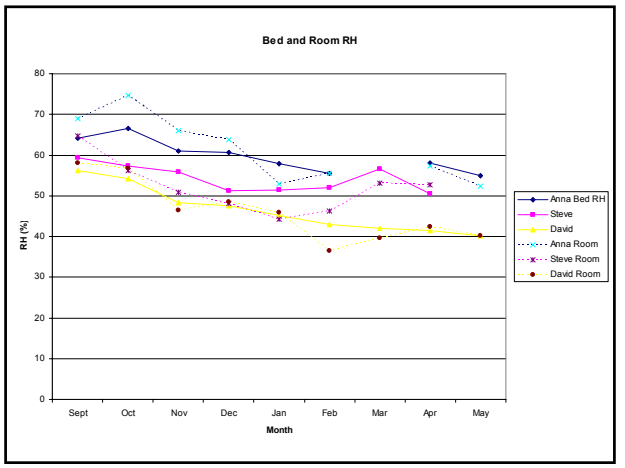
z = a + bx0y1 + cx0y2 + dx1y0 + ex1y1 + fx1y2 + gx2y0 + hx2y1 + ix2y2

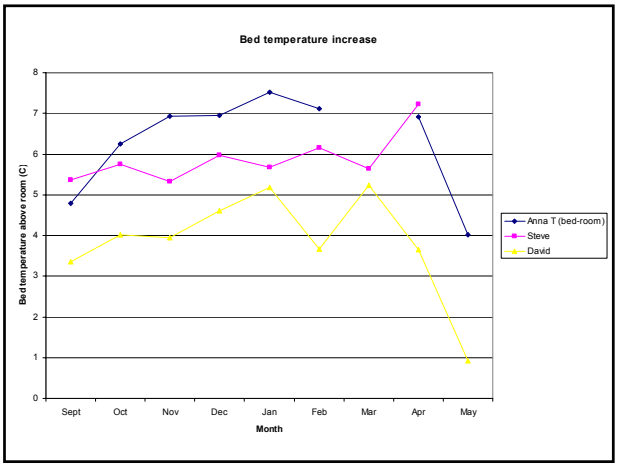
Where x is temperature, y is RH
z is Ln ([final/initiation] pop %) i.e. you get 100% if same population as before

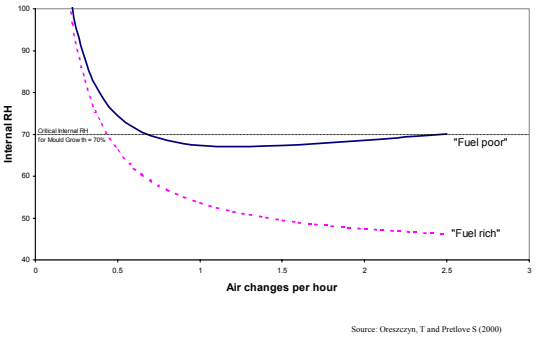
a = 2.3397246782E+01
b = -2.2105777989E-01
c = -2.4426126335E-03
d = -1.9681192296E+00
e = 2.7180575622E-02
f = 1.8004352184E-04
g = 3.0361144355E-02
h = -3.8851175984E-04
i = -4.1260780086E-06

Therefore a value of z = 4.60517 is equal to 100% i.e. after 3 weeks the population has remained stable









Source: Oreszczyn, T and Pretlove S (2000)