

Exposure assessment based on characteristics of homes in the Prince Edward Island Study

J. David Miller

**NSERC Chair
Fungal toxins and allergens**

**Carleton University
& Visiting Scientist,
Health Canada**

PEI Infant Health Study

- ~380 women recruited by Provincial perinatal health program 1997-2003.
- Follow the health of their children with help of public health nurse, administrative databases >2 years
- Very detailed investigation of their housing
- Endotoxin, allergens, long duration air samples; quantitative dust samples

Assessment of the degree of risk of exposure to saprophytic microorganisms is achieved by determining the area of contamination:

1. Current methods of sampling for saprophytic microbes do not assess exposure

2. Dales et al. (1998), Hyndman 1990; Haverinen et al. 2002

3. NYC 1993, 2000; Health Canada 1995; 2004; ISIAQ 1996; ACGIH 1999

Informed inspection

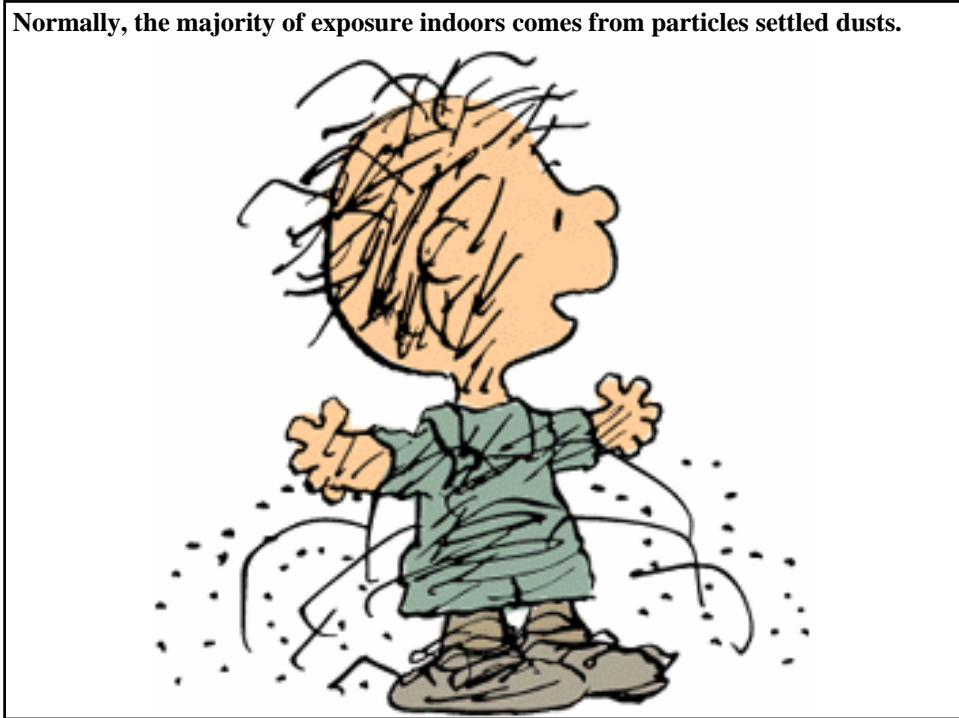
-someone with engineering, architectural expertise and of moisture problems in buildings

“investigation means the process of appropriately trained individuals entering the building to conduct inspection, sampling, documentation and production of reports” HC 2004

	Child's Bedroom	Mothers Bedroom	Living Space
Windows			
Predominant Window Covering	<input type="checkbox"/> Usually open or sheer <input type="checkbox"/> Usually covered by curtains or blinds <input type="checkbox"/> Sealed with plastic or interior storms	<input type="checkbox"/> Usually open or sheer <input type="checkbox"/> Usually covered by curtains or blinds <input type="checkbox"/> Sealed with plastic or interior storms	<input type="checkbox"/> Usually open or sheer <input type="checkbox"/> Usually covered by curtains or blinds <input type="checkbox"/> Sealed with plastic or interior storms
Floors	Room area (m ²) _____ Carpet area (m ²) _____	Room area (m ²) _____ Carpet area (m ²) _____	Room area (m ²) _____ Carpet area (m ²) _____
Appliances in Room	<input type="checkbox"/> Humidifier <input type="checkbox"/> Dehumidifier <input type="checkbox"/> Room Air Conditioner	<input type="checkbox"/> Humidifier <input type="checkbox"/> Dehumidifier <input type="checkbox"/> Room Air Conditioner	<input type="checkbox"/> Humidifier <input type="checkbox"/> Dehumidifier <input type="checkbox"/> Room Air Conditioner
Other Moisture Sources	<input type="checkbox"/> Yes <input type="checkbox"/> No _____	<input type="checkbox"/> Yes <input type="checkbox"/> No _____	<input type="checkbox"/> Yes <input type="checkbox"/> No _____
Visible Mold Growth			
Windows	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Walls	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Floors	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Ceilings	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Other	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No

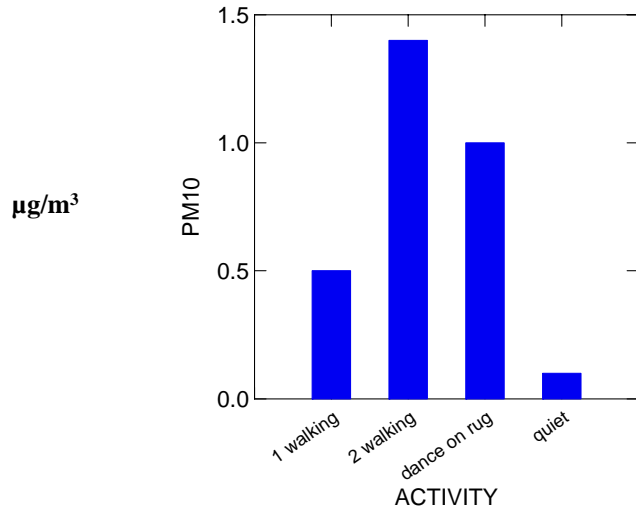
mold growth site	probable moisture source	area (cm²)	severity
	1 precipitation entering through leaks through walls, windows and roof 2 condensation on envelope elements 3 condensation on pipes or cold surfaces 4 wicking of moisture from ground 5 improperly drained surface water 6 plumbing malfunction 7 other		1 <10% of affected area 2 10-60% of affected area 3 >60% of affected area
Bedroom: infant			
Bedroom: mother			
Other rooms as necessary			

Normally, the majority of exposure indoors comes from particles settled dusts.



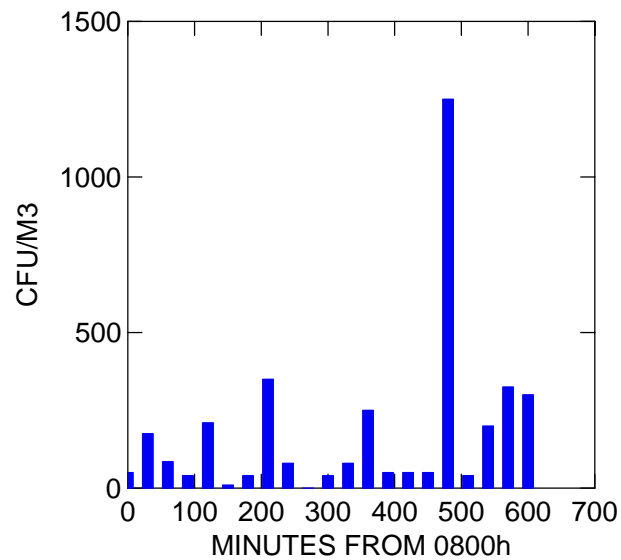
<u>>300 μm</u> (mg)	<u><300 to >150 μm</u> (mg)	<u>< 150 μm</u> (mg)
278	257	237
1551	458	1492
344	948	1563
1731	630	1535
781	268	596
243	64	482
208	128	641
547	1022	954
1191	1350	1382

Mass of settled dust and room activity are the variables dominating the results of air samples of any kind.



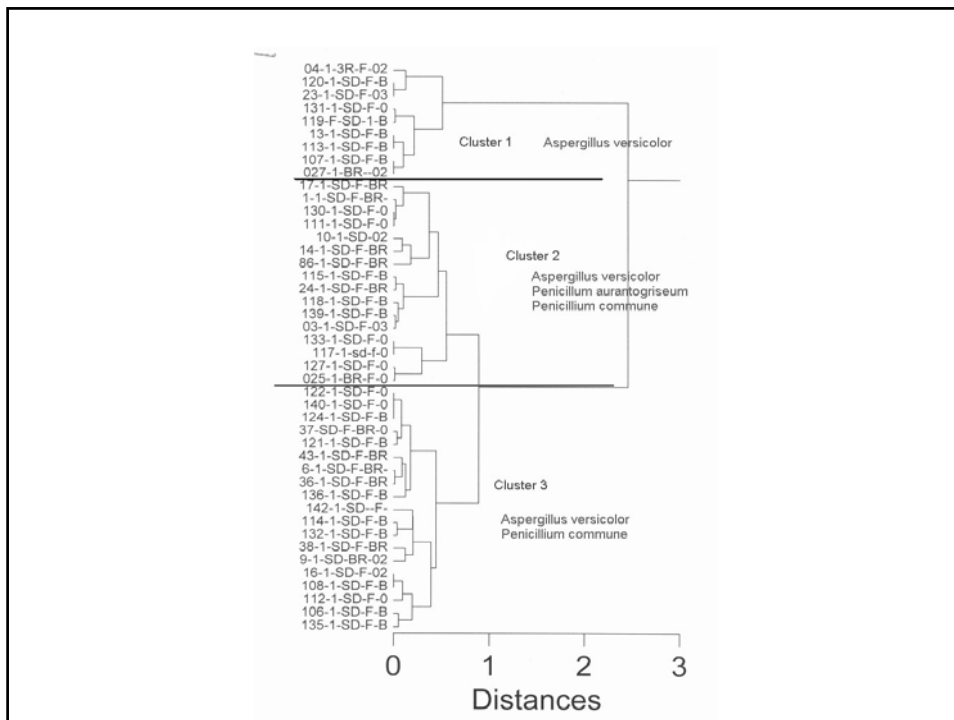
Health effects related to mass of settled dust/ m^2 in several studies

Environ Sci Technol 38:1759



Environmental variability

ASHRAE IAQ '92:147



Viability Air Sampling

- proprietary samplers tested give results without statistical difference
- environmental variability 5-10000 x
- variation in spore viability
- all media are selective
- enough outdoor air samples must be carefully taken

ASHRAE IAQ '92:147

approximate half life (years)

<i>Cladosporium cladosporioides</i>	0.1
<i>Alternaria alternata</i>	0.3
<i>Fomes annosus</i>	0.3
<i>Stachybotrys chartarum</i>	0.8
<i>Aureobasidium pullulans</i>	1
<i>Fusarium</i> sp.	>4
<i>Mucor</i> sp.	5
<i>Neosartoya fischeri</i>	>5
<i>Talaromyces luteus</i>	>6
<i>P. camemberti</i>	>6
<i>Scorulopsis brevicaulis</i>	>6
<i>Emercella nidulans</i>	>6
<i>A. niger</i>	>6
<i>A. fumigatus</i>	>7
<i>Eurotium herbariorum</i>	>7
<i>Rhizopus nigrans</i>	11
<i>Aspergillus flavus</i>	>11
<i>A. oryzae</i>	>11



Mold damage versus viable air samples

264 indoor air samples 159 outdoor samples

<u>n</u>	<u>area (m²)</u>
2	< 1
30	1.0-4.3
17	4.3-8.6
5	8.6-12.9
2	12.9-17.2
1	>17.2

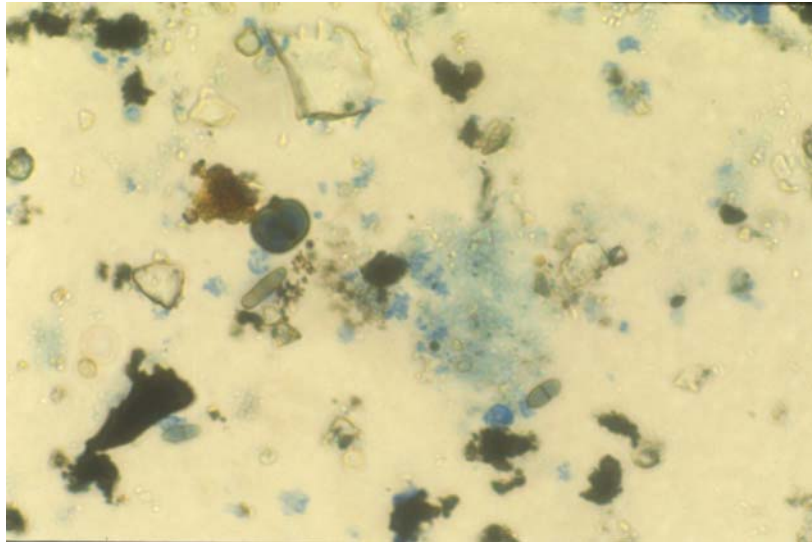
Mold damage versus viable air samples

area of fungal damage to proportion of samples different by rank order of I/O taxa

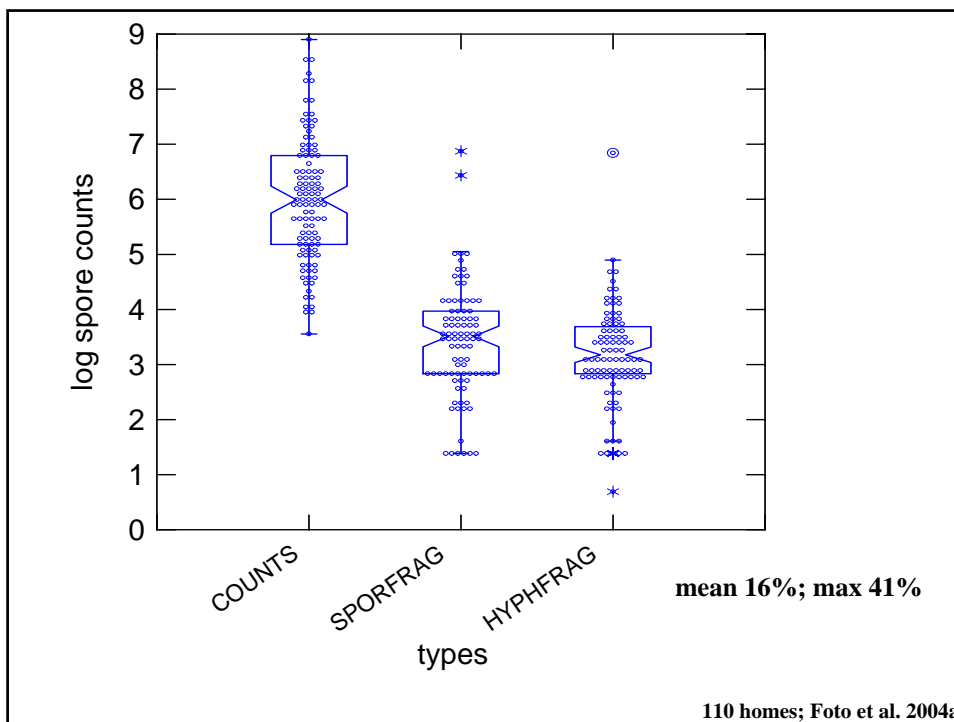
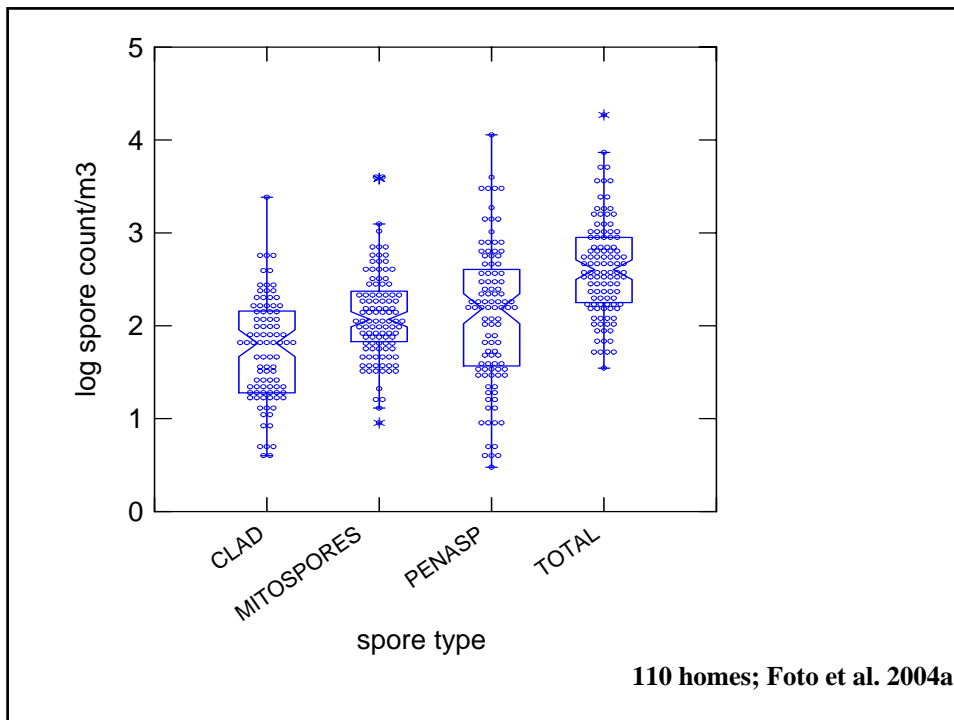
Kruskal-Wallis $p = 0.03$

ANOVA $p = 0.10$

Indoor Air 10:146



<i>Alternaria</i>	<i>Mystrospriella, Ulocladium</i>
<i>Aspergillus/Penicillium</i>	<i>Aspergillus, Penicillium, Trichoderma, Acremonium, Aphanocladium, Beauveria, Gliocladium, Paecilomyces, Phialophora Cladosporium (young spores), amerospores, basidiospores</i>
<i>Aureobasidium</i>	<i>Exophiala, Phialophora, black yeasts</i>
<i>Cladosporium</i>	<i>Cladosporium, Cladophialophora, Exophiala, Fulvia, Gonatobotryum, Mycovellosiella, Periconiella, Phaeoramularia, Septonema, Stenella</i>
<i>Stachybotrys</i>	<i>Stachybotrys, Memnoniella, Gliomastix, Periconia</i>
<i>Ulocladium</i>	<i>Ulocladium, Alternaria, Monodictys, Pithomyces</i>



Mold damage versus Air-O-Cell data

area of mold damage total counts

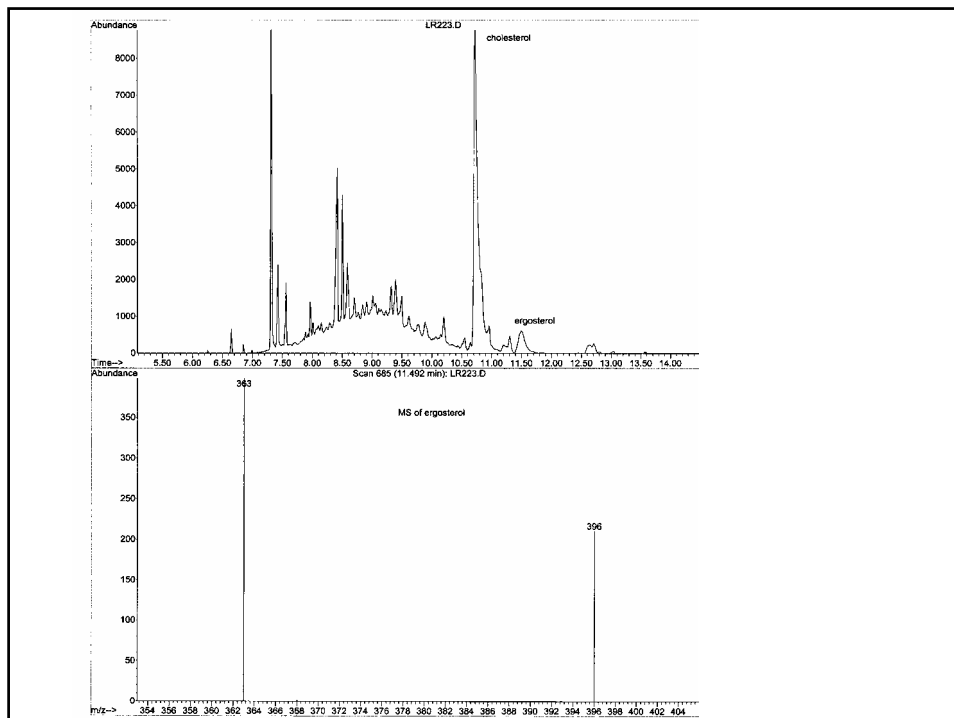
not significant

area of mold damage to proportion of Pen/Asp

not significant

110 indoor air samples

Foto et al. 2004a



area of mold damage vs 5 day airborne ergosterol

$r = 0.758, p = 0.000$ in 2000

$r = 0.873, p = 0.000$ in 2001

Foto et al.2004

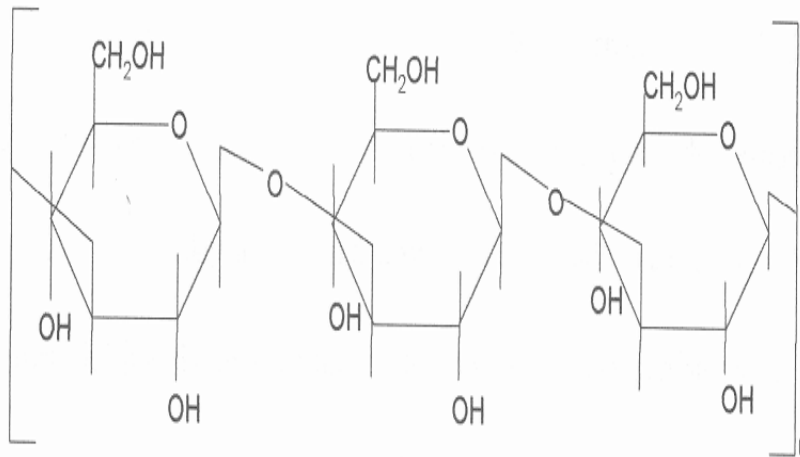
Ergosterol & duration of samples

houses	% positive	mean ng/m ³	median	
401	25	0.5	(+s)	1 day
110	98	0.3	0.15	5 days

proxy for room activity and dust burden

AIHAJ 58:39; Foto et al. 2004

Fungal glucan present in yeasts and pollen



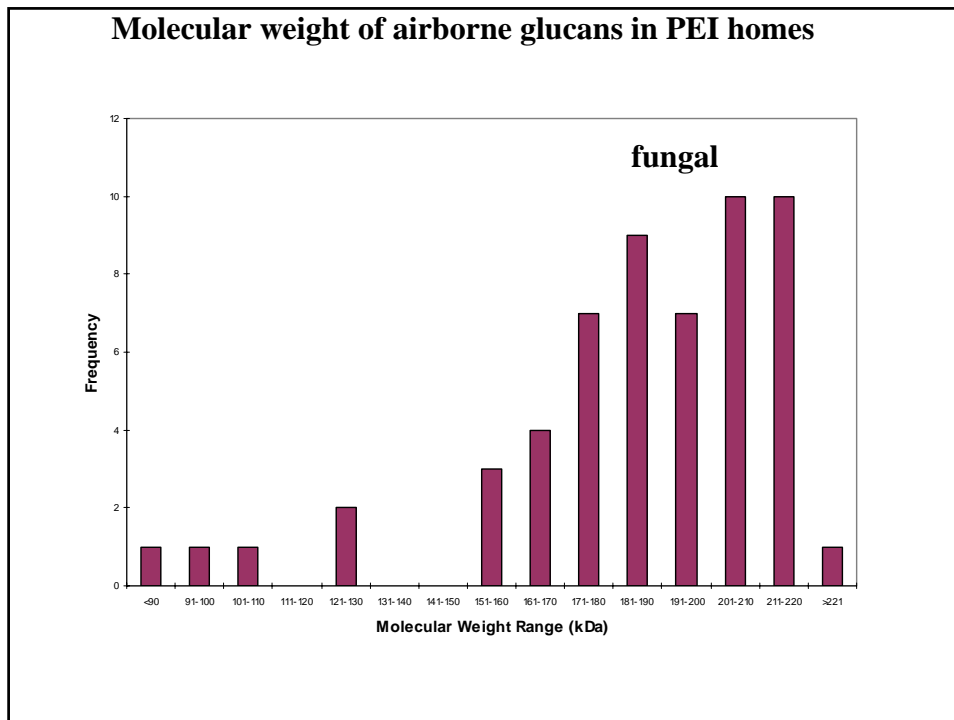
Engineering assessment of mold damage

area of mold damage versus airborne glucan

$r = 0.694, p = 0.000$ in 2000

$r = 0.763, p = 0.006$ in 2001

Foto et al.2004



Fungal materials as % of glucan

- 30% intact spores
- 30% hyphal and spore fragments
- 40% something else much smaller
 - small amount is yeast glucan

Future

- Can we begin the process of determining how much mold/dampness matters
- Exposure assessment methods being researched; human antigens
- These may lead to estimates of attributable risk for each of the contaminants that occur in housing
- Not today