MOLD EXPOSURES & POPULATION HEALTH

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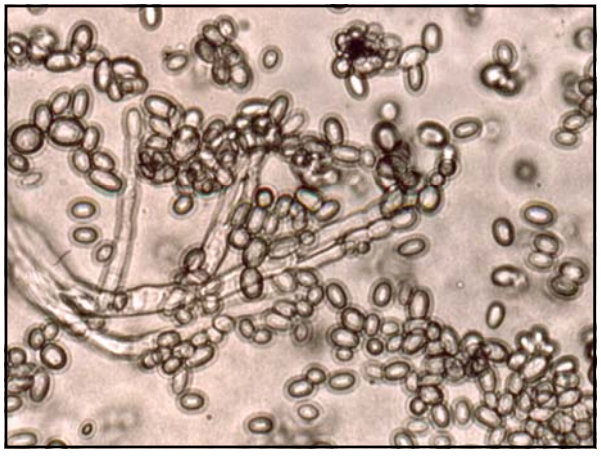
10 year Average Annual Burden of Fungal Spores in Outdoor Air at 20m the Northern Hemisphere

Cladosporium cladosporioides & C.herbarum	55%
Ascospores	19%
Basidiospores	12%
Sporobolomyces	10%
Alternaria alternata	2%
Ustilago, Erysiphe, Helminthosporium, Botrytis, Tilletiopsis, Stemphylium, Epicoccum	2%
Aspergillus/Penicillium	1%

There are Population Health Effects of Molds in Outdoor Air

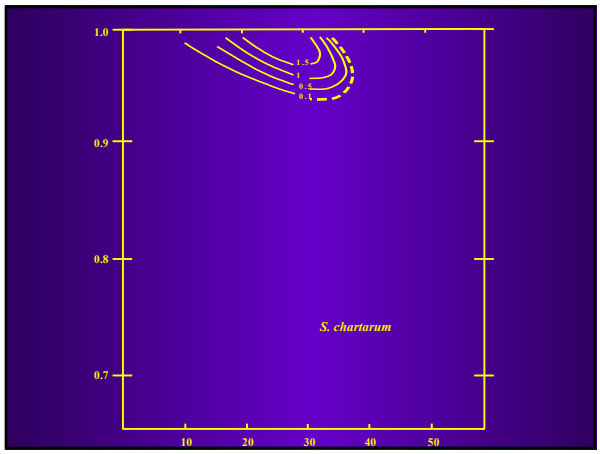
ca. 10% of Americans are allergic to *Cladosporium*

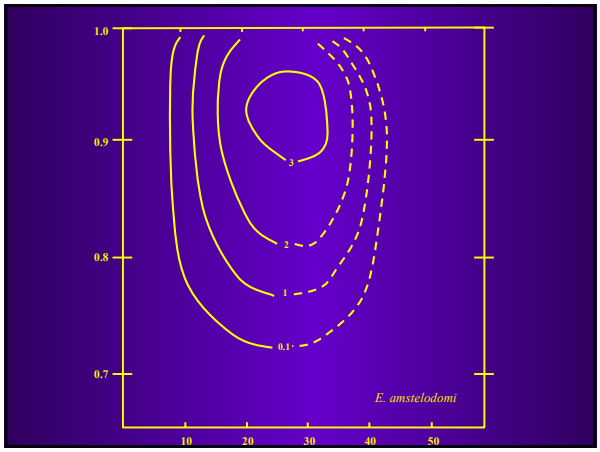
ca. 8% of emergency admissions to hospitals for asthma are associated with spores



Fungi from 2134 Wallboard Samples

Chaetomium globosum
Penicillium viridicatum
Non sporulating isolates
Eurotium herbariorum
Penicillium aurantiogriseum
Penicillium citrinum
Stachybotrys chartarum, S. chlorohalonata
Aspergillus sydowii
Penicillium chrysogenum
Penicillium commune
Non sporulating, clamp connections
Eurotrium repens
Memnoniella echinata
Aspergillus versicolor
Paecilomyces variotii
Cladosporium sphaerospermum





SECONDARY METABOLISM

- Growth unrestrained by nutrients, pH, water and gas exchange is called "balanced growth".
- In fungi, secondary metabolites are produced when one or more of nutrients become limiting; called unbalanced growth.
- This produces pools of precursors that become available for the production of secondary metabolites.

SECONDARY METABOLISM

- responsible for the biosynthesis of usually complex compounds for defense
- astounding range of compounds but all are synthesized from amino acids, acetate, mevalonic acid or glutamic acid

SECONDARY METABOLISM

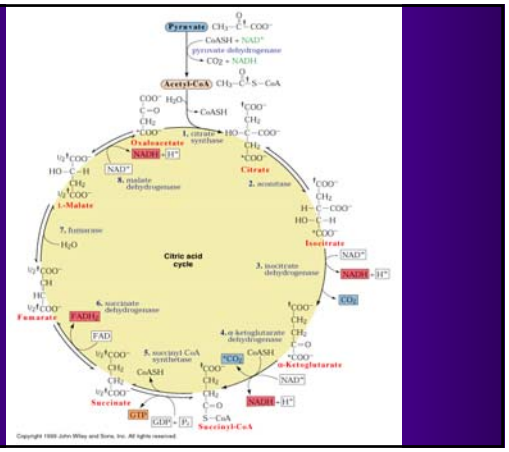
- Serious research started in the late 1930's when the need for penicillin became acute.
- Early researchers believed that these compounds had a purpose in nature. After WWII, some scientists thought that secondary metabolites were waste products or their production was a displacement activity (!).

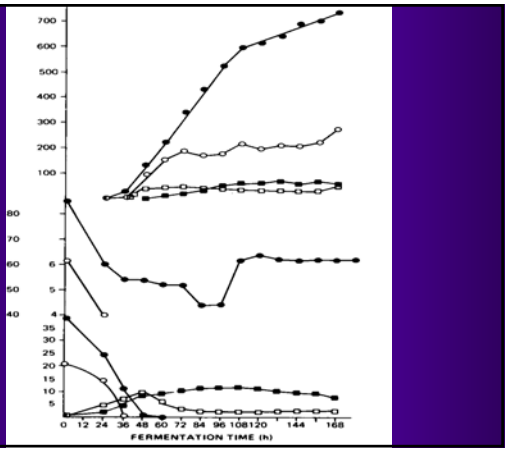
SECONDARY METABOLISM

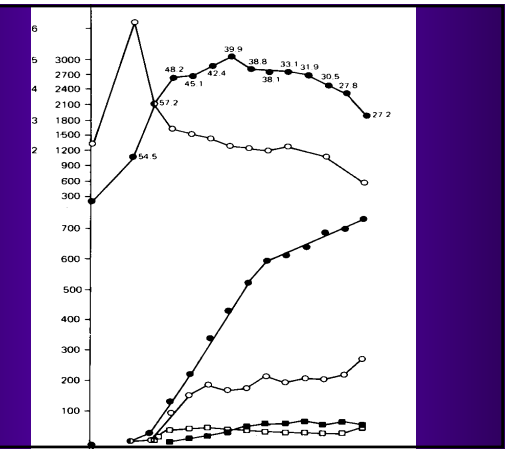
- In plants, secondary metabolites are usually tissue-specific. Needles, leaves, seeds, where the plants have male and female forms, the female forms can have more metabolite.
- Some fungi have tissue specific secondary metabolites (spores, sclerotia).

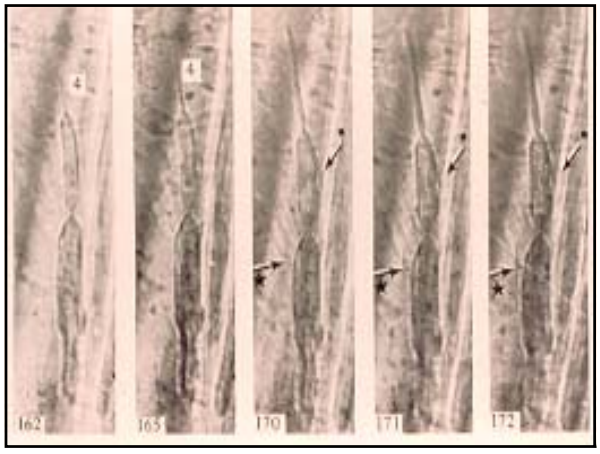
Species/ chemotype	Atranones	Dolabellanes	Tricho-dermin	Satratoxins	Roridins	Hydroxy roridin E	Pigmen-tation
chartarum/S	ND*	ND	+	+	+	+	None
chartarum/S	ND	ND	+	+	+	+	None
chartarum/S	ND	ND	+	+	+	+	Yellow
chartarum/S	ND	ND	+	+	+	+	Yellow
chartarum/S	ND	ND	+	+	+	+	Yellow
chartarum/S	ND	ND	+	+	+	+	None
chartarum/S	ND	ND	ND	+	+	+	None
chartarum/S	ND	ND	ND	+	+	+	None
chartarum/S	ND	ND	ND	+	+	+	None
chartarum/A	+	+	+	ND	ND	ND	None
chartarum/A	+	+	+	ND	ND	ND	None
chartarum/A	+	+	+	ND	ND	ND	None
chartarum/A	+	+	+	ND	ND	ND	None
chartarum/A	+	+	+	ND	ND	ND	None
chartarum/A	+	+	+	ND	ND	ND	None
chlorohalonata	+	+	+	ND	ND	ND	Green
chlorohalonata	+	+	+	ND	ND	ND	Green
chlorohalonata	+	+	+	ND	ND	ND	Green
chlorohalonata	+	+	ND	ND	ND	ND	Green
chlorohalonata	+	+	ND	ND	ND	ND	Green
chlorohalonata	+	+	ND	ND	ND	ND	Green
chlorohalonata	+	+	ND	ND	ND	ND	Green
chlorohalonata	+	+	ND	ND	ND	ND	Green
chlorohalonata	+	+	ND	ND	ND	ND	Green
chlorohalonata	ND	ND	ND	ND	ND	ND	Green

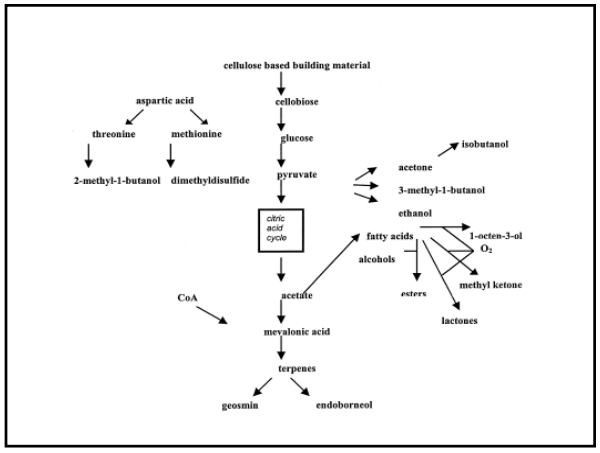
Mycologia 95:1227

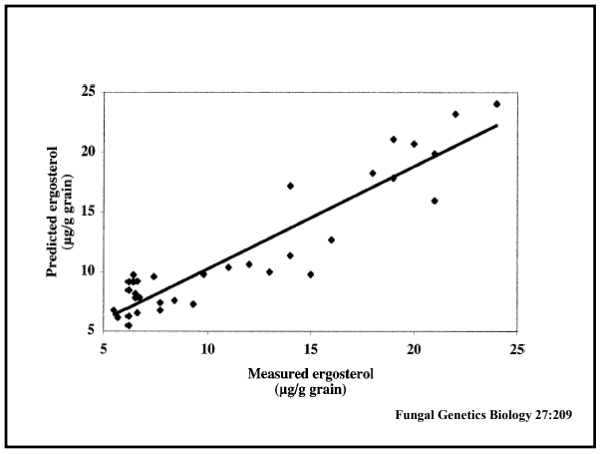

Pyruvate
Acetyl-CoA
Oxaloacetate
Citrate
Isocitrate
α-Ketoglutarate
Succinyl-CoA
Succinate
Fumarate
L-Malate
Citric acid cycle
1. citrate synthase
2. aconitase
3. isocitrate dehydrogenase
4. α-ketoglutarate dehydrogenase
5. succinyl CoA synthetase
6. succinate dehydrogenase
7. fumerase
8. malate dehydrogenase
NAD+
NADH + H+
FAD
FADH2
GTP
GDP + Pi
CoASH
CO2


FERMENTATION TIME (h)
0 12 24 36 48 60 72 84 96 108 120 144 168


39 9
38 8
38 1
33 1
31 9
30 5
27 8
27 2
48 2
45 1
42 4
57 2
54 5







Fungal Genetics Biology 27:209

SPORE GLUCAN CONTENT

Species	DG18	MEA	CMA	CZ
E. herbariorum	0.137 ± 0.001**	0.118 ± 0.006	0.115 ± 0.004	0.105 ± 0.005
P. aurantiogriseum	0.204 ± 0.002**	0.170 ± 0.004	0.168 ± 0.007	0.174 ± 0.005
S. chartarum		0.736 ± 0.012	0.714± 0.02	0.738 ± 0.01

SECONDARY METABOLITES ALWAYS PRODUCED

- if fungus grows in nature
- *a priori* species must be competitive on substrate
- need to measure the toxin for the right chemotype
- detection biomass dependent
- adequate sensitivity

Mold measures: ruler still the best

- **British Bengali (1990), Wallaceburg (1998) and Finnish studies (2002) showed that respiratory symptoms were associated with area of fungal contamination/moisture damage.**
- **Population health effects could be DETECTED at circa 1-3% visible mold per unit floor area.**

all media are selective: pure cultures

	MEA	CMA	DG18	spores
S. chartarum	1	10	1	1,000
P. aurantiogriseum	20	20	25	40
W. sebi	1	1	10	20
T. harzianum	10	10	1	40

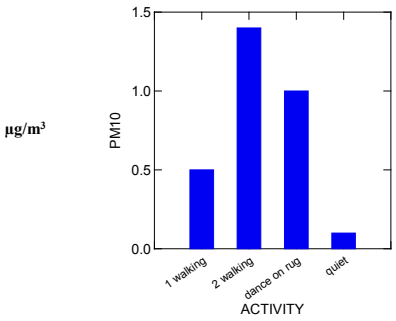
approximate half life (years)

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

Settled dust per m^2 in houses can be large:

	>300 µm (mg)	<300 to >150 µm (mg)	< 150 µm (mg)
LR	865	315	678
PBR	391	134	298
CBR	122	32	241
LR	104	64	321
PBR	274	511	477
CBR	596	675	691
LR	167	84	257
PBR	178	536	164
CBR	184	1600	1308

Mass of settled dust and room activity are the variables dominating exposure and 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

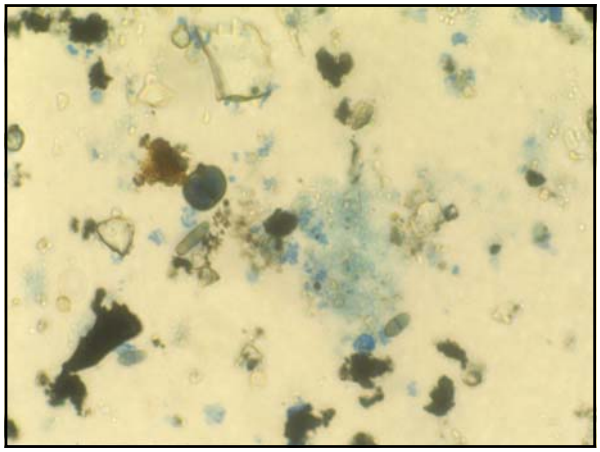
Ergosterol & duration of samples

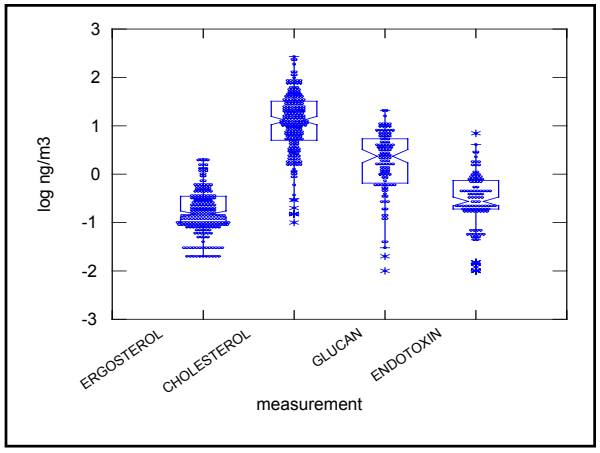
houses	% positive	mean ng/m3	median ng/m3	
401	25	0.5	(+s)	1 day
110	98	0.3	0.15	5 days

proxy for room activity and dust burden

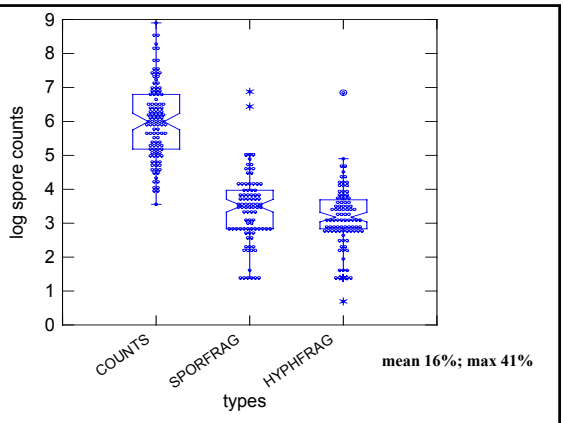
AIHAJ 58:39; Foto et al. 2004

The majority of exposure to particles indoors comes from settled dusts; personal exposure time/activity dependent.





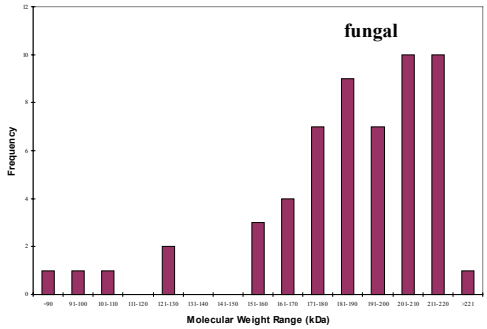
The exposure to particles indoors is much more than just fungal materials.

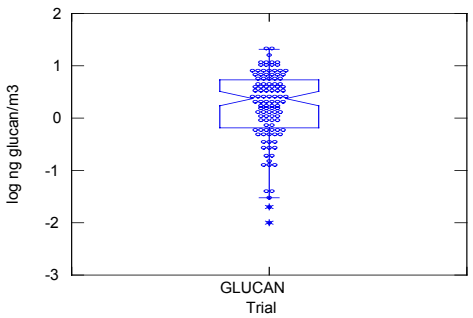


mean 16%; max 41%

110 homes; Foto et al. 2004a

Molecular weight of airborne glucans in PEI samples





Fungal materials as % of glucan

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

The fungal component of the exposure is more than to intact spores.