



IAQ RADIO+

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J. David Miller, PhD

Bioaerosols Health Effects, Secondary Metabolites, Endotoxins & More

Good day and welcome to IAQ Radio+ episode 731 Blog. This week we welcomed back Dr. David Miller to discuss his chapters in the recent 2nd edition of the Bioaerosols Assessment and Control Book. In today's interview we gained behind the curtain insight Dr. Miller's chapters.

Prof. J. David Miller has focused his research on mycotoxins and damp buildings and health for the last 40 years first at Agriculture Canada and then at Carleton University in Ottawa.

Dr. Miller has published >370 papers on fungi and fungal toxins and has co-written 10 books on the public health aspects of exposures to fungi and fungal toxins and holds several patents. Miller has served on many national and international committees on the regulation of mycotoxins as well as on mold and dampness in the built environment. This includes on the American Academy of Allergy Asthma & Immunology committee that produced practice parameters for environmental allergens including fungi. He was chief editor of the American Industrial Hygiene Association "Green Book" (2008, 2020) and "Field Guide" (1996, 2005) that lay out guidelines for addressing mold and dampness in public buildings. He drafted several chapters of the recent ACGIH Bioaerosols guidelines, second edition.

In 2013, Miller was elected as a Fellow of the American Industrial Hygiene Association. In 2021, he received the inaugural Philip R. Morey award from the ACGIH for contributions to bioaerosol guidance.

Nuggets mined from today's episode:

Can you comment on why the Bioaerosol book revision took so long? It did take way too long. Cheri Marcham and Jack Springston both worked hard and nagged authors when necessary.

Dr. Miller spent a huge amount of time on his 3 chapters. Dr. Miller was the lead reviewer of the 1998 manuscript for which he offered many recommendations for improvement, he chuckled that some of his recommendations were not taken.

Chapter 2- Basis for health concerns. Virtually unknown prior to 1969, dust mites and dust mite allergies have grown exponentially due to moisture problems related to energy saving related tightening of building. Dust mites feed on skin scales and thrive in humid conditions.

Going from recognition to widespread acceptance takes time. The first epidemiology studies in North America (Harvard School of Public Health in 1989) and Canada (Health Canada in 1991) found increased risks of allergy and allergic disease occurred in damp and moldy houses. This was not accepted because there was no obvious mechanism. The past three decades have explained the reasons. Further studies made clear that when people are exposed to material mold damage for a period of time, non-atopic asthma and allergy can result. This was very well demonstrated in the NIOSH study of the occupants of the moldy Connecticut office building (e.g. Environmental Health Perspectives 113:485).

In my experience indoor environmental consultants commonly forget about dust mites, cockroaches and other common allergens when looking at buildings vs homes. Can these common home issues cause problems in larger buildings?

When complaints remain unresolved, Indoor Environmental Consultants should also consider the common indoor allergens: dust mites, cockroach, furry pets, etc. In a challenging building investigation where all the tests were clear, the late Phil Morey found high populations dust mites. In the workforce were a number that were people who very sensitive to house dust mites. Thus, dust mite allergens brought from home or that accumulated in the building soft surfaces triggered complaints. Similarly, workers with close contact to furry animals in research laboratories, pet stores, animal breeding facilities, bring allergens home.

Please tell our audience what we know about RH, temperature and viral transmission? Viral survival in air is dependent upon: RH and temperature. Each of the viruses that have been studied

over the past 80 years are somewhat different but as a generalization, around 40% RH results in lowest survival of viruses in air. That is that higher and lower RH values result in higher survival in air.

What are endotoxins? Should there be a TLV for endotoxin? Since the mid-1990s, clear evidence was obtained that people were more likely to become allergic to allergens such as house dust mites if there was more versus less endotoxin in the house dust. Endotoxin is found in the outer cell wall of gram-negative bacteria. Although we use one word, endotoxin, endotoxin has many (>250) endotoxins chemistries depending on the species of bacterium. The potency in terms of effects on lung biology after inhalation exposure can vary by two orders of magnitude depending on the mixture of endotoxins. In rural areas endotoxin in houses mainly comes from wind-blown air getting in the house being tracked in and if wood heat is being used, with the wood. In urban areas, pets and building occupants bring endotoxin indoors.

Workplace exposure to Endotoxin is also found in the air around sewage treatment plants, compost plants, animal production facilities (dairy, swine, poultry). There is no endotoxin TLV and there shouldn't be an endotoxin TLV. The potential for misunderstanding is great i.e. when one that works for swine production is used for homes or vice versa.

What is effective cleaning of porous surfaces? A well designed and executed cleaning study demonstrated that on porous surfaces (e.g. carpet) 4-6 professional cleanings with HEPA vacs were needed to reduce endotoxin and mold glucan in dust in residential homes without pets to the lowest achievable levels. The study was sufficiently sensitive to register a peak when a dog was brought into one of the homes (Indoor Built Environment 18:485).

In fire damage restoration, in conjunction with exhaust ventilation aqueous/alcohol solutions (e.g. ethanol, isopropanol) have been sprayed onto surfaces to effectively desorb odors from materials. A chapter in the 1998 Red Book mentioned the use of ethanol to detoxify and denature toxins. Would you recommend this as an addition to fungal remediation for sensitive clients? NO, remove damage material and citing the WHO considers introduction of unneeded chemistries undesirable and unnecessary. Dr. Miller added, that chemical use may provide a false sense of security.

Fungal metabolites? Dr Miller did not write the chapter in the prior book termed mycotoxins and cautioned against its inclusion in the book. Dr. Miller is very knowledgeable about fungal metabolites found both in food and from damp building fungi.

What are the key points about MVOC's that industry pros should understand? For instance, are they toxic? Are they the reason for health issues when mold is found in buildings or are they an indicator similar to how CO₂ is used to indicate lack of appropriate ventilation? Humans can detect fungal MVOCs levels below the detectability levels of the most sophisticated instruments. Mold odor is a useful signal for indication of a mold problem. Humans can detect MVOC mixtures 2-3 orders of magnitude lower than the TLVs. Radio Joe added that Just as CO₂ is an indicator of for more ventilation, mold odors are an indicator fungal amplification. Cheri Marcham and others updated the AIHA Odor Threshold Publication. <https://www.aiha.org/news/240522-editors-present-new-edition-of-aiha-odor-threshold-publication>

Testing and sampling? Since 1992, Dr. Miller has been clear that “Testing for anything should not be done until after an informed systematic inspection.” Testing isn’t always necessary. If you can see it, why test? Testing is sometimes needed for litigation or if someone wants to take the information to their clinician. Sometimes testing is necessary if all else fails in a complaint building. Dr. Miller recounted a case after visual inspection was unsuccessful in finding the source of the complaint, testing revealed fungal growth in the HVAC system. Testing is part of the repertoire. Dr. Miller advised that homeowners not do testing. Radio Joe added that schools often want to see lab results.

What is conditioned immunity? Mentioned in the 1998 version in a chapter by Dr. Harriet Ammann “Conditioned immunity”- is simultaneous exposure to an odor while the body is threatened by an allergen. In the event of future exposure to the odor without the threat; the body will think it is being threatened and react. Examples include: moving out of a moldy house and then moving back after remediation and some residual VOCs remain, removing items from a moldy home and then bringing them back. This is well understood from studies of people living downwind from an odorous farm or factory, etc.

What is fungal glucan and why is it important to understanding mold in indoor environments? Like our appendix which is evolutionarily no longer necessary, our lungs have a Dectin Receptor. The Dectin Receptor reacts to (1-3)- β -D-glucan (BDG) an abundant cell wall polysaccharide, that is

found in damp building fungi. This turns on an unattractive immunological cascade. This is the highlight. Damp building fungi make a form of this polysaccharide that turns on a receptor in our lungs that causes issues. Outdoor fungi (phylloplane fungi, mushroom spores) have a different form of glucan in their cell walls which is much less active explains a difference. Spores, fungal fragments and particles go deep into the lungs and concentrate in lung regions. Outdoor mold spores and outdoor mold spores tracked indoors remain intact. When mold grows indoors, fungal fragments and fungal particles are also present in large numbers. The majority of glucan indoors is respirable. This topic is explained in detail in Chapter 24 of the new ACGIH guide.

Allergens from common damp building fungi have been characterized but these are not available for testing by allergists. They are not the same as those from the common outdoor fungi.

Mycotoxins? For 70 years, the definition of the word “mycotoxin” refers to fungal metabolites **known** to cause human health problems. In North America, enormous effort is made to keep the important mycotoxins reaching the consumer to tolerable levels (deoxynivalenol, fumonisin, aflatoxin, zearalenone & ochratoxin). For example, when ochratoxin is found in urine by a valid test, this has come from eating wheat. If we consider *Stachybotrys*, the macrocyclic trichothecenes some strains make are very toxic. Worker exposure to *Stachybotrys* toxins in agriculture or during mold remediation is serious and dangerous. However, in an experiment with a relevant animal model at doses exposed at levels more plausible in buildings, the majority of the effect on the animals was the glucan in the spores not the toxin. Chapter 24 discusses in detail all of the known low molecular weight compounds from damp building fungi, their occurrence and impact on lung biology. In the end it’s the mold glucan that counts.

Are we ready to have OEHS pros test for fungal glucan and what do we do with the results?

Research studies in houses and some occupational environments has been done for a couple of decades. There are a number of small chamber studies where people are exposed to known concentrations of a proxy glucan as well as one powerful study where airborne exposure to beta 1, 3 D glucan was done in relation to the health of infants. Exposure to glucan is reduced by effective cleaning of porous surfaces after a mold remediation. Two methods are available to measure fungal glucan based on the same test that is used for endotoxin. Someday this testing will become commonplace and added to the repertoire. This is explained in detail in Chapter 24 (see also *J Occ Environ Hygiene* 8:540).

What is the difference between an antigen and an allergen? Allergen is a protein that raises IGE antibodies. Antigen is on the journey to becoming an allergy with sufficient exposure.

Chapter 26 Misc Allergens and Irritants is a new chapter what are the key points from this and why was it important to add it? Marijuana production work previously did not exist. The marijuana production workforce needs to be protected. The workforce in animal production facilities and university research labs with animals need to be protected.

Increases in plant related allergies is climate related. Ragweed is responsible for the largest OTC (over the counter) drug spend. Allergenic plants are moving north because of warming. Ragweed makes more allergen at higher versus lower atmospheric concentrations of CO₂ which has increased from 315 ppm at the NOAA monitor in Hawaii to 425 ppm today. When it rains, plant pollen explodes producing large numbers of small particles.

A second human case of bird flu in America is raising alarm; How close is the H5N1 outbreak to becoming the next pandemic? Sequencing work on Avian Flu virus is ongoing. Learning from history-as a species we don't think hard after the last disaster. Dr. Miller hopes that lessons learned have our government officials planning for the potential of future epidemics. Pasteurizing milk eliminates the virus. So far, the workers at greatest risk are engaged in dairy production. The flu vaccine changes annually because they mutate. Viruses are out to get us!

Z-Man signing off

Trivia:

Name the heat-stable bacterial poison responsible for the pathophysiological consequences of certain infectious diseases, that Richard Pfeiffer intellectually and experimentally conceived?

Answer: Endotoxin

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