A GUIDE TO THE RECENT LITERATURE ON ASPERGILLOSIS AS CAUSED BY ASPERGILLUS FUMIGATUS, A FUNGUS FREQUENTLY FOUND IN SELF-HEATING ORGANIC MATTER

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Abstract

Spores of Aspergillus fumigatus have been found to be abundantly present in the outdoor air at a site where large scale experimental composting of sewage sludge is in progress at Beltsville, Maryland. The health significance of this finding, for that site and for others in the future, is still only incompletely understood. Further studies are in progress to characterize absolute concentrations of the spores of the fungus in air at the site, spore dispersal by air from composting operations, and background environmental spore levels in air.

The present paper contains a list of references to papers on health effects of A. fumigatus, many published in the past ten years, along with a review of the same designed to assist the reader in finding information on particular aspects of the subject in the literature. It is intended primarily as an aid to individuals interested in sludge composting and wishing to attain an insight into the A. fumigatus-composting situation, but it may also interest others concerned with other substrates which become moldy at 40–50°C. A. fumigatus has been found in great numbers in naturally and artificially heated environments such as decaying leaves, compost heaps, solar heated sloughs, cooling canals for nuclear power generators, silos, grain storage bins, boiler rooms, detritus around steam turbines and sauna baths.

The evident practical merits of sludge composting have been described elsewhere; the information presented here has its main significance in respect to requirements for choice of locations for composting sites and to process and design criteria.

Introduction

During an investigation at Beltsville into methods for composting sewage sludge, a question arose concerning the possibility that the fungal opportunist Aspergillus fumigatus Fres. might present a health hazard at and around composting operations. A preliminary and semi-quantitative examination of the air at a composting site had revealed that the organism occurred there at levels far above those found in the air at distant locations (92). Wood chips used in the process appeared to be a major source. Thus, although sludge composting is a basically useful process (33, 104), the possibility of a need for accommodations in site selection and details of the composting process in response to A. fumigatus has recently come into consideration.

The occurrence of A. fumigatus at the Beltsville composting site was not surprising, because the fungus has a history of growing and sporulating profusely on damp hay, wood chips, and other self-heating organic matter (92, 114). The magnitude of any possible consequent health problem in connection with sludge composting, however, is still incompletely known. Uncertainty on this subject derives in part from a lack of information. Data are needed on the numbers of A. fumigatus spores emitted into the air during composting, the extent of their aerial dispersal into adjacent regions, and the number already in the air of the environmental background. Air samplings on these questions are in progress. Additional uncertainty may be related to an insufficient understanding on the part of compost scientists and of responsible officials of the health implications of A. fumigatus, i.e. what adverse effects it can cause, to whom, and under what circumstances.

The writers have considered that a record of recent literature concerned with the health effects of A. fumigatus might be helpful to individuals concerned with evaluations of plans for specific compost operations. The aim of the present paper is thus to assemble references useful in aiding any interested persons in arriving at their own
independent and informed judgments on this matter and to provide a brief informational background helpful in such an endeavor. In the information provided, medical judgments generally follow closely after those of original authors.

Background to facilitate use of reference list

General comments on sources of information

The total number of published papers containing information on health effects of *A. fumigatus* in humans is not known by the writers but is obviously large, probably well in excess of 500. Papers are scattered over a wide array of journals. Attention is focussed here mainly on papers published since 1968.

An excellent overview can be found in the chapters on aspergillosis in texts on medical mycology by Rippon (118) and Emmons et al. (31). Individuals needing to make a more detailed examination of one or more aspects of the subject can find in the present paper a means of selective entry into a voluminous and rapidly increasing body of additional published information, much of it relatively recent.

The literature on aspergillosis may be located in several ways. One convenient method, in addition to the present document, is through the Review of Medical and Veterinary Mycology (6), which presents current abstracts in English from a wide range of sources in several different original languages; relevant references are segregated under the heading 'aspergillosis.' Some papers cited in the present document contain lengthy lists of additional references; computer services for reference search may be helpful. Papers were selected for citation here mainly on the basis of recency and on availability of the article in its original published form but without reference to author viewpoint.

Only brief mention is made here of direct effects of inhaled spores of *A. fumigatus* acting as an extrinsic allergen in the lung, i.e. without major growth in the body. Such allergies, while fairly common and occasionally associated with serious health effects, are also caused by spores of many other fungi and actinomycetes (8). Spasmodic bronchial response to such spores, as well as to dust, chemical vapors, and many other allergens is common among asthmatics. Among non-asthmatics, sensitization to fungal spores can occur with repeated exposure to high spore concentrations; the typical response involves a temporary episode of difficulty in breathing, nausea, and fever, beginning four to six hours after exposure (52, 168). The latter phenomenon is described in the literature under the terms ‘farmer’s lung’ and ‘extrinsic allergic alveolitis.’ Fungal infections within the ear are not considered at all here, even though *A. niger* or *A. fumigatus* may be involved; for introduction to this subject, the reader is referred to Rippon (118) and Emmons et al. (31).

Information on factors influencing distance of movement of fungus spores in air is relevant in some situations in which buffer zones between composting sites and hospitals or other health care facilities are contemplated; information on fungus spores in air has been summarized by Gregory (47).

As general background, the writers recommend a review by Lowrance (82) which contains a penetrating analysis of the subject of health risk assessment as it relates to evolving public policy. The present paper hopefully represents a useful contribution to the careful fact-finding process regarded by Lowrance as a prerequisite to risk assessment.

Early history of the study of *A. fumigatus* and aspergillosis

*Aspergillus fumigatus* was well described as a species in 1863 (114) and has been recognized for many years as a biological entity differing in its morphology and behavior from other aspergilli. Much of the early literature about the fungus deals with natural lung infections by it in wild and domestic birds and as a cause of mycotic abortion in cattle and sheep (114, pp 82–98). Study and publication on the animal disease aspect of the subject continues to the present (48, pp 88–93) but, with a few exceptions specifically noted, all further reference here is to the disease in man. The disease was first reported in man in the middle of the 19th century (31, 118) and has been the subject of a great many accounts since that time. The role of primary disease as a cause of predisposition to attack by the fungus was known in 1900, while the role of cortisone and other drugs in causing impairment of immunity to it and other opportunists has been recognized for about 30 years.

*A. fumigatus* has been observed repeatedly to occur in abundance in composts and other self-heating organic matter and other natural situations where temperatures are in the range of 40 to 50 C (7, 92, 114). It obviously enjoys a competitive advantage over other organisms in natural situations at such temperatures. Beyond this, however, detailed information on its occurrence in nature, particularly quantitative information, is very limited (114). The interested reader will find several reports on its physio-