

## LITERATURE REVIEW



### The distribution of air-borne fungi

In 1936 Feinberg and his colleague, stated that the problem of mold allergy was very much like the problem of pollen allergy. They found that Alternaria sp. was the most mold offender in Chicago area. They were able to correlate clinical symptoms with mold spore counts. (cited by Perksamer 1958).

Prince and Morrow (1942) used the plate method to survey the air-borne fungi, the area included nine states in the mid continental region of The United States extending from the great lakes to the Gulf-Coast. They found that Alternaria sp. and Hormodendrum sp. were encountered more frequently and occurred in higher number than any other molds. The seasons rather effected more than a regional trend in the case of these dominant species such as Fusarium sp. Although Aspergillus sp., Penicillium sp. and certain other species were also encountered frequently, However the number of spores were low and the occurrence is uniform throughout the year.

In 1947, Morrow presented three interesting points from his results. First, there was a "top ten" group of genera for all stations. They were Alternaria sp., Hormodendrum sp., Penicillium sp., Aspergillus sp., Pullularia sp., sterile pale species, sterile dark species, Torula sp., Fusarium sp. and Trichoderma sp. Secondly, in the top ten dominant species for all the stations there was a "big six" for each station. The third point was concerned with the occasional species of molds.

In 1948, the Research Council of the American Academy of Allergy adopted the same technique for daily mold spore counts which was previously recommended for pollen count. On the basis of these daily counts, it was possible to correlate the patients symptoms to the molds content in the air. In this way the importance of mold sensitivity as a case of seasonal allergic rhinitis and bronchial asthma in the New York was definitely established.

In 1950, Wallace et al. had studied the distribution of molds in indoor air, outdoor air and house dust from several sites in Lexington, Kentucky. Thy large number of samples were cultured on both Sabouraud and potato glucose agar. The result of this study revealed that Penicillium sp. and Aspergillus sp. were the most frequently encountered mold genera in both summer and winter from all sources of sampling. Mucor sp. was found exclusively in the indoor air. The others molds such as Monilia sp., Stemphylium sp. and Alternaria sp. were present only in the outdoor and in the house dusts. They found that the air-borne spore counts were lower during the winter than during the summer. Although the spore counts in house dust showed no change in number. There was no significant effect of any climatic condition except possibly temperature on the numbers or types of molds in the air. They also found that potato glucose agar appeared to be more satisfactory for a quantitative study than Sabouraud's agar. However Sabonraud's agar is more satisfactory in qualitative work. The finding of different species of

molds in two residences pointed to the importance of making mold determinations at the home and the surroundings of patients who suspected of being sensitive to molds.

Alvarez and Castro summarized the data on the spore loaded in the air at Havana at different seasons (1952). The culture media used was Sabouraud's agar and found that spores of detectable molds were very abundant from October to February, and in a short period in late May and early April. The principal air-borne molds detected in the study were Hormodendrum sp., Aspergillus sp. and yeasts, with many other genera being encountered occasionally. He found that the asthma and rhinitis cases under his observation with sensitivity to fungi, 69 percent of them became worse in winter.

Swaebly (1950) and his colleague at the University of Minnesota, compared whether the casein hydrolysate medium or other medium was effective to mold counts. The results indicated that Mehrlich's medium with 7.5 gm/l of sodium chloride will give a significantly higher mold count per plate than the casein hydrolysate medium. But this medium is still not the best the modified Smith-Humfeild salt agar showed a mold count almost double mold count which obtained by Mehrlich's salt agar.

Targow and Plunkett (1951) reported the atmospheric incidence of pollens and of fungal spores in the Los Angeles. The results of the fungal spore survey carried out by both plate culture and slide exposure. The predominating organisms on the plates were

Homodendrum sp., Alternaria sp. actinomycetes, Epicoccum sp., Pullularia sp., Penicillium sp., yeasts, Rhodotomla sp., Aspergillus sp<sup>1</sup>, Stemphylium sp., Helminthosporium sp. and Fusarium sp., Homodendrum sp. and Alternaria sp. were the most dominant genera. It began with a low counting in February, then increase gradually to reach a peak in May, during June and July some recession takes place, though counts still remain high, another rise then takes places to a second peak in November, recession then occurs to the winter low.

On slide method, Alternaria spores were accounted for 40 percent of the total spore count. He concluded that the predominate spore count was depended on which method of counting is used. They said that though the actinomycetes are widely distributed in the soil and in their study was the third in order of frequency in the air, most of the atmospheric surveys in the literature of allergy rarely mentioned about them.

Alvarez and Castro (1952) recognized the limitations of the culture plate method and attempted to determine quantitatively the spore count of air. From the study of air borne fungi of Havana, they concluded that the number of colonies or spores deposited on medium exposure was increased by wind velocity, but this did not mean that the actual number of fungi in a fixed volume of air is greater, because the air is the vector of the spread of spores. Hypersensitive patient were worse the days of strong wind, but

they also became worse when the actual quantity of fungi in the air was high. In Havana, the quantity of fungi in stationary air is greater at night than during the day the graph curve began to rise after 6 P.M. .

Richards and Wales (1954) studied atmospheric mold spores in and out of doors and concluded that in the houses which was observably moldy, the mold spore content of the air may be different in constitution (as well as in quantity) from that of the outside air. Culturing experiments showed that the molds growing in such houses are usually the common atmospheric contaminants, though the predominant species could vary from one house to another. The indoor trap fluctuated seasonally in size and constitution paralleled with the season fluctuations in the outdoor trap. They found that the most important source of air-borne mold spores was the outside air. This suggested that in the investigation, diagnosis, and treatment of allergy to air-borne mold spores, the most important prerequisite was a thorough understanding of the mold spore content of the air out of doors.

Collin-Williams and Ratner (1955) worked in Toronto, Canada. They reported that the most numerous molds were Alternaria sp., Hormodendrum sp. and yeasts. The peak season was from the middle of July to the middle of October. Smuts were quite prominent in July and August. They found no correlation between 10 degree drops of mean temperature and number of mold counting, and also no

correlation between mold counts and wind speed or wind direction. There was one exception when "Hurricane Hazel" struck Toronto. During the hurricane, the mold count dropped to zero and remained negligible for one week.

In 1960 a survey of the incidence of air-borne fungi in Sydney was carried out by Freg and Durie for one year by daily exposure of Petri plates containing Sabouraud's medium. They obtained information on the kinds and prevalence of molds of the air in Sydney and to correlate their seasonal fluctuation with meteorological data. They found that the fungi most commonly grown were Cladosporium sp., Alternaria sp. and Epicoccum sp. The seasonal pattern of Cladosporium sp. in Sydney appeared to be different from those that had been reported before. The pattern of incidence of Cladosporium sp. and Alternaria sp. in Sydney area displayed three peaks through the year but in different months. The occurrence of Epicoccum sp. as a predominant organism is of interest, these accounted for 51.9 % of all colonies.

Shapiro et al (1965) studied an atmospheric survey of fungi at Huntington Park, California for 2 years using Petri dishes with Wort's agar special medium. They found that Hormodendrum sp., Alternaria sp. and Epicoccum sp. were the three most important fungi found in this survey of the Los Angeles Area. No correlation was found between the plates counts and the 24 hour gravity slide counts of Alternaria sp. and Hormodendrum sp. . They found the most unexpected finding was the large number of Epicoccum sp. colonies.

Goodman et al. (1965) studied airborne fungi in the Phoenix metropolitan area, utilizing the culture plate technique for trapping spores of mold through a whole year. They found that the most prevalent fungi encountered in order were: Alternaria sp., Pullularia sp., Hormodendrum sp., Aspergillus sp., Helminthosporium sp., and Penicillium sp.. An additional genus found in relatively high concentration was Bispora sp.. All of the predominant organisms showed seasonal variations at each location site. The peaks variations of these fungi were shown in different times. And for the most part, climatic conditions were apparently insignificant in influencing the number or types of fungi isolated which represented the most prevalent genera.

Al-Doory (1966) used the culture plate technique to survey the fungal flora of the air near the ground in San Antonio, Texas for a one complete year. Daily exposure of petridishes containing Littman's oxycall medium were used to survey. He found that Hormodendrum sp. and Alternaria sp. were found to be the most common fungi. He found no direct correlation between the seasonal pattern of spore counts with any single environmental condition. It seemed that all factors combined including the long summer months of the area controlled the number of viable spores in the air.

In 1967 AL-Doory made a further studies of the fungal flora of the air in San Antonio, Texas. A survey of air-borne fungi by using the plate method at the ground level as well as at 100 and 310 feet highes level in Fall season 15 weeks. He found no direct relation between the member of isolated molds and weather factors. The most prevalent fungi encountered in order of their frequency were: Hormodendrum sp., Alternaria sp., Stemphylium sp., Phomu sp. and Penicillium sp.. He also stated that Cryptococcus sp. was the most predominant yeast collected.

In 1970 AL-Doory studied a quantitative of air-borne fungi in the San Antonio area for a period of ten weeks with the Anderson sampler. He carried out his experiment at difference period of times in the morning and evening. The morning sampling gained the least number of colonies, while the evening sampling produce the highest.

Dworin (1966) reported the atmospheric content of fungal spores in Tucson, Arizona utilizing the culture plate technique for a one-year period. The most prevalent fungal spores encountered in order to their frequency were Alternaria sp., Pullularia sp., Hormodendrum sp., Aspergillus sp., Helminthosporium sp. and Penicillium sp. .

Reddi (1970) had studied a comparative survey of at mospheric pollen and fungal spores at two places twenty miles apart at Anakapalle and Visakhapatnam. The fungal spores of Cladosporium sp., Aspergillus sp., Nigrospora sp., Alternaria sp., Curmlaria sp.,



basidiospores, ascospores Periconia sp., Helminthosporium sp., uredospores and clamydospores of smut were the prevailing species. Cladosporium sp. was recognized as the dominant spore type at the two site. The comparison between the samplings obtained in 1966-1967 at Anakapalle and Visakhapatnam indicate that the incidence of pollen and fungal spores were greater at Anakapalle. The incidence of fungi were found to be related to the differences in the local vegetations.

Mishra & Srivastan presented the paper dealing with the air-borne fungi of a paddy field in India. The investigation was carried out from August to November 1967 on different kinds of media such as Martin's medium, malt extract agar medium and Czapek's agar-medium. The fungal flora continuously increased from August to November. The dominant and subdominant species varied from month to month. Aspergillus sp. and Helminthosporium sp. were dominant with Curvularia sp. and Fusarium sp. as subdominant.

In 1971. Mishra & Kamal presented a paper dealing with air fungal spora in different seasons of a year. The maximum fungal spora both in quality and quantity were obtained during the winter and diminished in hot dry months of summer. They had found that seasonal difference exhibited different dominant fungal species.

In 1972 Mishra alone had been summing up, the periodical fluctuations of some common air fungal species. He found that the species that widely distributed throughout the year were

Aspergillus sydowi, A. terreus, A. flavus, A. niger and Rhizopus sp.. The rainy season types were Mucor sp., Penicillium sp., Phoma sp., Paecilomyces sp., Curvularia sp., Nogrospora sp., Helminthosporium sp., Fusarium sp. and Myrothecium sp.. The winter types were Cladosporium sp., Alternaria sp. and A. candidus. Summer types were A. fumigatus, A. nidulans and A. versicolor.

Gravesen (1972) made an identification and quantitation of indoor airborne micro-fungi during twelve months of 44 Danish homes by the agar plate method. He planned to relate the effect of hypersensitization with the strain of a given species from the house of the patient to the effect of an analogous standard strain. He found that the frequently occurring genera were Trichosporon pullulans, Rhodotorula rubra, Cladosporium herbarum, Cladosporium macroscarpum, Botrytis cinerea, Alternaria sp., Aspergillus sp. and Penicillium sp.

Lumpkins et al., (1973) made a comparison between the incidence of fungi found indoors and outdoors. Cladosporium sp. was isolated much more frequently in outdoor plates and Alternaria sp. was the second. The indoor exposure showed a higher overall incidence of Aspergillus sp., Geotrichum sp. and Penicillium sp. in all areas than the outdoor exposures. Pullularia sp. was isolated more frequently outside than inside. Geotrichum sp. and Sporobolomyces sp. were found almost as frequently indoors as outdoors. Rhodotorula sp. and Rhizopus sp. were found only in indoor exposure in the winter. These differences might be due to the varied fungal flora in individual homes.

Sorensen et al. (1974) made a 12-month survey of atmospheric fungal spores in five climatologically sites, throughout the United States and Puerto Rico by culturing the fungi on rose bengal streptomycin agar. He assumed that the greater concentration of spores of any fungus in the air the greater the probability that the fungus would appear on any plate. Therefore, frequency of occurrence on plates should reflect the distribution of culturable spores in the air. Fungi which occurred high frequency at all sites were Cladosporium sp., Pullularia sp., Penicillium sp., Alternaria sp. and yeast. Alternaria sp. was much more common in San Antonio, Miami and Pittsburgh than in the other two sites. Yeast were cultured almost as frequently as Alternaria sp. Currularia sp. and Helminthosporium sp. occurred with much lower frequency in the northern site than in the southern site. Aspergillus sp., Cephalosporium sp. and Phoma sp. seem to be the organism that occur at fairly continuous, relatively low levels at all studied sites.

In 1975 Finegold made a two years pollen and spore survey in southeast Florida by using Durham gravity slide sampler. The mold spores he observed were Alternaria sp., Helminthosporium sp., Currularia sp., Fusarium sp. and Cladosporium sp. Cladosporium sp. were most frequently observed. He found that pollens and mold spores were found to be present in lower quantities in the temperate regions.

In Thailand a report of a survey of the air borne fungi in J. Med. Asoc. Thailand volume 57, 1974 was made by P. Phanichyakarn. He made an atmospheric pollens and molds survey in Bangkok at Ramathibodi Hospital in Bangkok by the standard Durham's gravity slide sampler. The study was carried out from January 1970 to December 1972. He found that the major and known to be significant in causing allergy were Hormodendrum sp., Helminthosporium sp., Curvularia sp., Fusarium sp., and Alternaria sp.. Hormodendrum sp. was the most dominant spore count and had the high peak shown in November, December, January and another peak during April, May, June with lesser spore counts during the rest of the year. Rust and smut appeared throughout the year. From the data of this survey, the most likely major causes of mold allergy belonged to the Class Fungi Imperfecti especially during late rainy to winter season and in the summer time.

#### Clinical aspects of mold sensitivity

Maunsell (1954), cited by Blatt in 1962, wrote a comprehensive review on mold allergy as a common cause of respiratory allergy. According to her explanation when mold sensitization takes place, the allergens from the spores are absorbed on the mucous membranes of the respiratory tract, because of the high water solubility of the antigens. She believes that the antibodies are produced in the reticulo-endothelium system and lymphoid system. They are then discharged into the blood circulation, and later become fixed to cells of the mucous membranes and skin. Most mold sensitive patients were

dependent on genetic factors. She also convinced that a high degree of humidity favored for sensitization by the fungal spores. Maunsell also reported that fungal allergy can be caused by extramural or intramural sensitization. The extramural sensitization was dependent on the fungal spore concentration of the open air. Intramural sensitization results from the spore load in dwellings and places of occupation.

In 1958 Maunsell made another study on the seasonal variation of allergic bronchial asthma in relation to the concentration of pollen and fungal spores in the year 1954, 1955 and 1956. The patients were from South London and the southern suburban areas. All patients showed positive skin test reactions to the various pollens, house dust and relative substances. The patients showed asthmatic attacks which related to the pattern of dispersal of fungal spore in the air.

The incidence of mold allergy, however, varies considerably in different sections. In Merksamer's experience (1960) most of the mold hypersensitive cases he had seen were in children. As yet he had no explanation for this. Perennial symptoms caused by molds were less common than seasonal ones. Perennial symptoms occurred mostly in patient who exposed to large quantities of molds in their homes or in their offices. These were mostly *Aspergillus* and *Penicillium* cases. These people who had mold sensitivities also had positive skin reactions.

Jilson and Adami (1955) studied 1000 patients having eczema. They believed 1 percent of the cases were due to inhalent mold spore, and emphasized the importance of advising the patient for the avoidance of molds. Desensitization should be started with extremely dilute antigens given in relatively fixed amounts and gradually increase in concentration. Desensitization therapy, they insisted, should be continued for a year or more.

In 1958 an interesting article was published by Charpin et al. this group had found that a positive test to *Candida albicans* was rather infrequent among children. Most of the cases seen in the offices of these authors were respiratory cases, such as asthma, bronchitis and vasomotor rhinitis. Good effective therapeutic results were achieved with specific desensitization.

Sclafer (1958) reported a series of 114 patients with *Candida albicans* sensitivity. There were fifty-one who showed of respiratory allergy, he pointed out that variation and frequency of their occurrence depended on places and climates. Sclafer found that the best mode of treatment in his opinion is subcutaneous desensitization with a *Candida albicans* extract. He reported that 66.6 percent of his patients were cured.

A Weiner (1960) reported an occupational bronchial asthma in a baker due to Aspergillus sp. Prior to working in a bakery, this patient never suffered from asthmatic attacks. Upon being employed in a bakery the symptom appeared. Skin that was performed

to the patient with various materials, and gave a moderate positive skin reaction to house dust and marked positive reaction to Aspergillus sp. He was desensitized with an Aspergillus mixture containing A. fumigatus, A. glaucus and A. flavus. His clinical condition was steadily improved and presently the patient tolerates well to heavy exposure.

Kesztyus and Went (1959) stated that one of the reasons responsible for our poor knowledge of the immunochemistry of molds is due to the fact that generally they have weaker antigenicity than bacteria. This weaker antigenicity may explain why so many fungus infection produce clinical manifestations slowly. Probably the relatively thick walls of the fungi effect a slow diffusion of the intracellular albumin into the tissue. It seems that the polysaccharides play the major role in determining the antigenicity of fungi.

The preparation of good fungus extracts remained a difficult task, as Van der Werff has pointed out. In his opinion, the question still remains open as to what methods to select for determining whether the allergenic fraction of different strains really differs from each other. There is also the problem whether a single generic allergen, several generic allergens, species link allergens, or strain-link allergens were involved.

Schaffer, Molomut and Center (1959) described a new synthetic medium for mold cultivation on the purpose of allergen extraction which appeared to have certain advantages over other media. The media and method described eliminates nonspecific allergen and other interfering factors which may be present in other commonly used media. By using of this method, the allergenic nature of the mold was difficult to denaturation than these prepared from Czapek's medium and extracted in the usual manner.



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