

## INCIDENCE OF FUNGAL SPORES AT THE HOMES OF ALLERGIC PATIENTS IN AN AGRICULTURAL COMMUNITY. III. ASSOCIATIONS WITH LOCAL CROPS

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A predominantly agricultural community in California was surveyed for prevalent fungal spores during a 12-month period. *Alternaria*, *Macrosporium* and *Stemphylium* were recovered during asparagus and strawberry harvesting times year-round. *Fusarium* and *Botrytis* were less frequently associated with the strawberry harvest and were recovered only during the first quarter of the year. *Epicoccum* was recovered in the north end of the Salinas valley in low numbers throughout the year and was strongly associated with the strawberry and artichoke harvest. *Aureobasidium* (*Pullularia*) recovery occurred in different locations according to season, correlating somewhat with the cabbage harvest as well as with the harvest of strawberries. Recovery of the pigmented yeasts showed strong correlation with the local growing season for lettuce. *Cladosporium* was prevalent year-round but did not appear to be significantly affected by changing agricultural conditions. These data have permitted the predictability of mold aeroallergens with medical applications.

"REGIONAL MOLD SURVEYS may assume an importance in the control of asthma equal to that of botanic surveys in hay fever. Especially is this true of the grain and fruit producing sections, of our country." This statement was made by Bernton in 1930.<sup>1</sup> Today regional mold surveys are perhaps more important due to increased populations and a wider recognition of allergy as a disease state.

The presence of fungi as saprobes and/or parasites on vegetation is well documented<sup>2,7</sup> and the dispersal of these fungi from their specific ecological habitat is affected by numerous climatological factors. Previous studies by us<sup>8</sup> and others<sup>9,10</sup> have shown certain associations of minimum daily temperature, prevailing winds and frank precipitation with spore recovery by aerometric devices. It is our intent to further this work by describing fungal genera recovered from the homes of persons allergic to molds and who live in the proximity of local crops. The correlation of allergenically significant fungal genera with crop growing, harvest or post-harvest times may allow more efficient prediction and management of fungal aeroallergen presence.

### Materials and Methods

The Salinas valley lies about 120 miles southeast of San Francisco, California, and is an ideal location in which to study the effects of agricultural activity on mold recovery. Climatological conditions are generally uniform throughout the 40-mile-long valley, which is bordered on each length by low mountains. The township of Gilroy is at the north end of the valley with the city of Salinas at the central and south end of the valley. Commercial agricultural activities are standardized, with specific seasons established for planting and harvesting.<sup>11,12</sup> Crops having limited growing areas with defined boundaries are as follows: artichokes, asparagus, beets, brussels sprouts, cabbage, carrots, celery, grapes, peppers, potatoes, strawberries and tomatoes. Lettuce, onions, garlic, cauliflower and broccoli are grown throughout the valley; cucumbers are grown at the south end of the valley.

In order to correlate our mold catches with crop prevalence, the calendar year was divided on the basis of agricultural seasons, which coincide with calendar year quarters, according to the University of California Agricultural Extension Service located in Salinas.

Fungal recoveries were plotted on a map of the valley according to season of recovery. The time span of this study is from November 1, 1977, to October 30, 1978. Information Obtained from recent agricultural bulletins indicates that planting patterns were essentially unchanged from the fourth quarter of 1977 and the same quarter of the same quarter of the following year. Hence it was felt that data, obtained from the fourth quarter of 1977 could be incorporated into data from 1978.

Climatological data for the period of this study was presented previously<sup>3</sup> and was gathered from official National Oceanographic and Atmospheric Administration (NOAA) records. According to these records, weather in the Salinas valley follows a predictable pattern.

Details regarding type and distribution of media used in this survey for capture and identification of fungi are presented elsewhere.<sup>8</sup>

### Results and Discussion

According to NOAA reports rainfall occurs almost entirely within the first quarter of the year and minimally and sporadically (less than 0.25 inch) the second and fourth quarters. No significant precipitation occurred during the, third quarter of the year of our survey.

Fungal recoveries were mapped by quarters, shown in Figure 1. General trends seen throughout the year include relatively infrequent recovery of *Alternaria* and *Fusarium*, as well as strongly seasonal recovery of *Epicoccum*. Pigmented yeasts such as *Sporobolomyces* and *Rhodotorula* were generally observed in large numbers throughout most of the year.

Strawberries appear to be a significant crop throughout most of this survey. The strawberry growing areas begin near Gilroy to the north and extend two-thirds of the way down the central valley toward Salinas.

During the first quarter *Alternaria*, *Stemphylium* and *Macrosporium* were recovered from areas spanning the strawberry and cabbage fields and extended south into areas of asparagus and carrot harvesting. Pigmented yeasts were recovered from areas of artichoke and cabbage harvesting. *Fusarium* and *Botrytis* were isolated near strawberry crops with occasional recoveries near brussels sprouts and artichokes. *Aureobasidium* (*Pullularia*) was captured in the southern valley near asparagus and carrot crops.

*Alternaria* was recovered at low levels most of the year. This fungus is a plant pathogen and saprobe, attacking tomatoes as well as other crops.<sup>2</sup> However, due to the low level of recoveries crop associations are difficult to make with *Alternaria* in this survey.

*Stemphylium* recovery appears to be associated with the asparagus harvest, which was in a period of activity during that quarter. In addition, *Stemphylium* was recovered in Gilroy during the second and third quarters, which coincides with the asparagus harvest underway at the north end of the valley. (Other possible associated crops include artichokes, carrots and strawberries; however, the association with these crops may be of less significant since *Stemphylium* was not recovered in other quarters of the year when these crops were harvested.)

*Fusarium* is a pathogen of potatoes, tomatoes and cereal crops<sup>2,4,5,11</sup> as well as an inhabitant of the rhizosphere of many plants.<sup>3</sup> Association of *Fusarium* with either the growing season or harvest of tomatoes was noticeably lacking. During the first quarter heavy rainfall occurred, which may account for the recovery of these spores. *Fusarium* spores are typically "slimy" and not easily dispersed by wind, so recovery might be influenced by local precipitation.<sup>4</sup>

*Botrytis* is a pathogen of onions, tomatoes, strawberries and grapes.<sup>3,4</sup> Since onions are grown valley-wide and grapes are grown at the southern end of the valley this recovery pattern suggests that local occurrence of *Botrytis* may be associated primarily with the harvesting of strawberries.

In the second quarter recovery of dematiaceous fungi was limited to an area of cabbage and strawberries, as in the first quarter, similar to the pigmented yeasts. Also associated with these crops in this quarter was *Aureobasidium*, somewhat further north than in the first quarter. During the first two

quarters *Aureobasidium* could be associated with a number of crops. However, third quarter recovery of this yeast-like fungus occurred only in the north valley and thereby suggests that strawberry or cabbage crops might be a factor in its changing distribution. Failure to recover *Aureobasidium* in the central and southern regions of the valley may be an indication that crops growing or harvested in those areas might not be harboring that yeast.

In the third quarter major recoveries of *Epicoccum*, *Aureobasidium* and all yeasts were confined nearly entirely to the north valley. *Epicoccum* was recovered every quarter of the year and always in the north end of the valley near areas of strawberries and to a lesser extent near artichokes. *Epicoccum* is pathogenic on fruit plants<sup>2</sup> and the failure to recover this mold in other than the northern valley may suggest lack of suitable plant host in other areas.

The fourth quarter showed few major recoveries. *Alternaria*, *Stemphylium* and *Macrosporium* were captured in areas of cabbage and strawberry harvesting, as was *Aureobasidium*. No pigmented yeasts were recovered anywhere in the valley during this quarter.

Pigmented yeasts appeared valley-wide the first two quarters and then were limited to the central valley the third quarter. *Sporobolomyces* is a well-known phylloplane fungus<sup>2</sup> inhabiting the protected surface of leafy plants.<sup>4,6</sup> This "shadow yeast" is not thought to be present as a saprobe but as an associate of the living plant.<sup>2</sup> Both the growing season of local lettuce and the ecology of certain pigmented yeasts<sup>6</sup> suggest that the presence of significant numbers of pigmented yeasts in this valley may be dependent upon the lettuce crop. It appears that the presence of both pigmented and nonpigmented yeasts is influenced by the local harvesting of lettuce. Some dematiaceous fungi may occur in response to the local harvest of both asparagus and strawberries; *Fusarium*, *Epicoccum* and *Aureobasidium* may also be associated with the strawberry harvest.

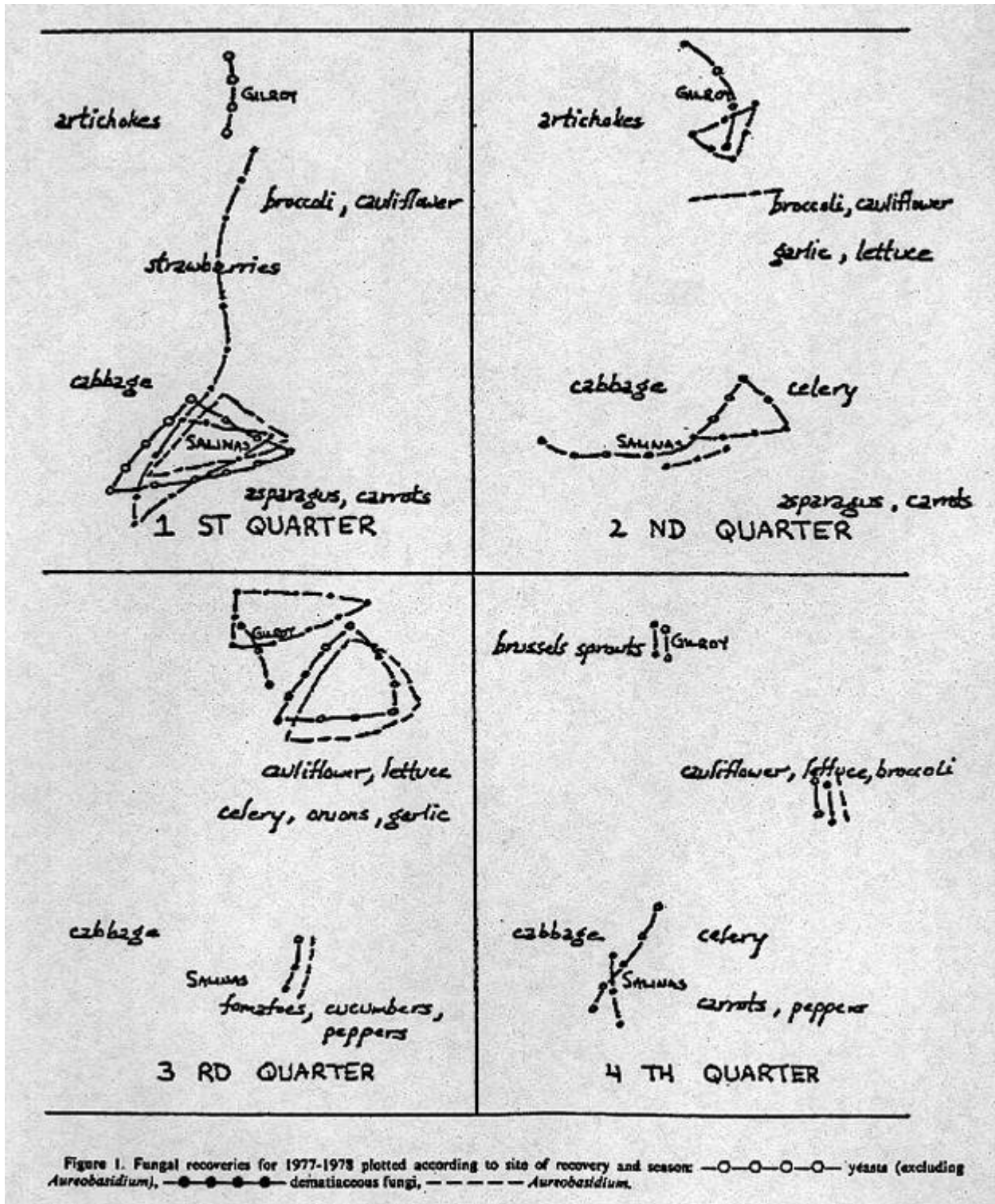
Fungi recovered in varying numbers over the entire valley were considered as a separate group, since it may be that the presence of these organisms is not due to association with a specific crop. *Aspergillus*, *Penicillium* and *Mycelia sterilia* usually were recovered throughout the valley if they were recovered at all. The latter two are known to inhabit the rhizosphere of many crop plants.<sup>4</sup>

The distribution of *Cladosporium* showed a general trend towards uniform occurrence throughout the valley, despite peaks coinciding with local precipitation.<sup>8</sup> Due to this uniformity it was felt that recoveries were not a useful index of the influence of changing agricultural conditions in the area, only changing climatological conditions. Wide variation in local crops with the seasons appeared to induce no change in the prevalence of *Cladosporium*. The ubiquity and frequency of occurrence of *Cladosporium* minimized its usefulness in this investigation and it was not considered further in regard to correlation with crops.

The presence of decaying vegetation remaining after commercial agricultural harvest may complicate the prediction of fungal spore prevalence in the Salinas valley and yet must be considered as part of the harvesting process. The practice of discing and plowing under after crop harvest undoubtedly plays a major role in fragmenting crop remnants and bringing them in full contact with the soil for attack by saprobic fungi. It is probably by this means that crops such as strawberries and post-harvest fungi including *Cladosporium*, *Botrytis*, *Epicoccum* and others become quantitatively important as aeroallergens.

As a result of our study local crops may serve to provide clues for the prediction of fungal aeroallergen presence in the Salinas valley and hence be of significant aid in the management of allergic patients in this area.

Application of these data are presently being made in the practice of allergy in Gilroy and Salinas valley and predictability of mold aeroallergen prevalence is of significant help in this management.



### Summary

The presence and frequency of certain fungi has been correlated with crop prevalence in an agricultural community. The growing, harvest and post-harvest seasons of the crops are all believed to contribute to the presence of saprobic and pathogenic fungi which serve as aeroallergens. Knowledge of area crops can lead to predictability of airborne fungi.

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