# Distribution of Mycosphaerella ligulicola and Selection for Environmental Races

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Florida Agriculture Experiment Stations Journal Series Paper No. 8084.
Accepted for publication 26 April 1976.

ABSTRACT

MC COY, R. E., and J. P. BLAKEMAN. 1976. Distribution of Mycosphaerella ligulicola and selection for environmental races. Phytopathology 66: 1310-1312.

Populations of *Mycosphaerella ligulicola* in the United States and in Great Britain, although morphologically identical, are distinctly different in reproductive response to long wave ultraviolet irradiation (UV). Most American isolates require UV for induction of pycnidia, whereas all British isolates tested produced pycnidia in total darkness. By following the historical distribution of *M. ligulicola* from its type locality into areas of differing cultural environment it is possible to account for the selection and proliferation of races of the fungus that differ markedly in response to environmental stimuli.

*Additional key words: Chrysanthemum morifolium.*

Isolates of *Mycosphaerella ligulicola* Baker, Dimock, and Davis, cause of the Ascochyta blight of florists' chrysanthemum [*Chrysanthemum morifolium* (Ramat.) Hemsl.], in the United States (USA) and Great Britain are morphologically and pathologically similar, but differ greatly in environmental responses. Blakeman and Hadley (4) reported that asexual reproduction in all British isolates tested occurred readily in darkness with no signs of enhancement by exposure to light. However, McCoy et al. (12) found that the majority of *M. ligulicola* isolates from the United States were sensitive to light and in particular, required long-wave ultraviolet (UV) irradiation for initiation and development of pycnidia. A survey of isolates of *M. ligulicola* from California, Ohio, New York, Florida, and Canada revealed that only two of 34 isolates could produce pycnidia in darkness without UV stimulation (McCoy, *unpublished*). On the other hand, of 11 isolates collected throughout Great Britain, all produced pycnidia readily in darkness (Blakeman, *unpublished*).

A plausible explanation for the existence of these two distinct populations of *M. ligulicola* can be derived by considering the selective stress on the fungus during its geographic distribution. Even though florists' chrysanthemum has been grown extensively as an ornamental crop for centuries (9), *M. ligulicola* was not reported as a pathogen until 1907 (16) when it was found in North Carolina. The fungus remained generally localized in the southeastern USA until the late 1940's when reports of its first occurrence came from Maryland and California (2, 7). *Mycosphaerella ligulicola* spread rapidly throughout the rest of the USA (2, 3, 6) and the world (1, 3, 8, 10, 11, 13, 14, 15) during the next few years (Table 1). The cause of this sudden spread appears to lie in the fact that chrysanthemum production in the southeastern USA was principally for local consumption for many years. It was not until the late 1940's that the present large-scale chrysanthemum propagation industry began in Florida. With the advent of this industry, chrysanthemum cuttings were shipped throughout North

TABLE 1. Dates of first reported occurrence of *Mycosphaerella ligulicola (Ascochyta chrysanthemi)* in the United States and other areas of the world

| Date | Location | Authority |
|---|---|---|
| | United States: | |
| 1904 | North Carolina | F. L. Stevens (16) |
| 1912 | South Carolina | H. W. Barre [in (2)] |
| 1923 | Ohio | H. C. Young [in (3)] |
| 1932 | Mississippi | L. E. Miles [in (2)] |
| 1947 | Maryland | L. O. Weaver [in (2)] |
| 1948 | Florida | K. F. Baker, A. W. Dimock, and L. H. Davis (2) |
| 1949 | California | H. N. Hansen and W. C. Snyder [in (2)] |
| 1956 | New York | A. W. Dimock (6) |
| 1956 | Pennsylvania | J. Tammen [in (3)] |
| 1959 | Colorado | R. R. Baker [in (3)] |
| | Other countries: | |
| 1952 | Japan | Y. Fujioka (8) |
| 1955 | New South Wales | Anonym. (1) |
| 1959 | So. England | M. Hollings [in (3)] |
| 1961 | Germany | W. Southoff (15) |
| 1962 | Denmark | H. A. Jorgensen (11) |
| 1962 | Sweden | L. Nilsson (13) |
| 1962 | Holland | P. H. Van de Pol and P. J. Taconis (14) |
| 1963 | Italy | E. Hellmers (10) |
| 1963 | South Africa | E. Hellmers (10) |

America and the world. It is postulated that *M. ligulicola* was disseminated from Florida on these cuttings, either epiphytically on roots (5), or in the form of latent infections that were not detected by a visual inspection program.

A good proportion of the floral chrysanthemum production and most of the production of cuttings for propagation in the USA is done out-of-doors where the crop is exposed to solar UV. However, a majority of chrysanthemum production in Great Britain is done in glasshouses where filtration of solar UV by plate glass would create a selective stress against isolates requiring UV for production of pycnidia. The fact that a small portion of the American isolates tested were light-insensitive indicates that this trait was present in the population and that individual colonies with that trait were favored when placed under the appropriate environmental stress.

To determine if this environmental selection process is continuing, two British isolates, G-10 from a glasshouse crop, and O-1 from field-grown chrysanthemums were repeatedly subcultured on potato-dextrose agar at weekly intervals, either in darkness or under continuous UV irradiation (from Philips TS 40 W/B fluorescent tubes). Both isolates produced abundant pycnidia within 10 days in darkness at 21 C, although isolate O-1 produced greater numbers of pycnidia when exposed to UV than in darkness. The serial subculture of these two isolates showed that the UV response of isolate O-1 increased with continued subculture after exposure to UV and decreased with continued subculture in darkness (Fig. 1). Isolate G-10 showed no enhancement in UV response after being subcultured 15 times in either darkness or under UV exposure. In fact, isolate G-10 usually produced greater numbers of pycnidia in darkness, particularly when subcultured from dark-grown colonies. These data indicate that the UV response of some dark-sporulating isolates may be shifted by environmental manipulation. However, most American isolates could not be tested in this manner since their requirement for UV is absolute.

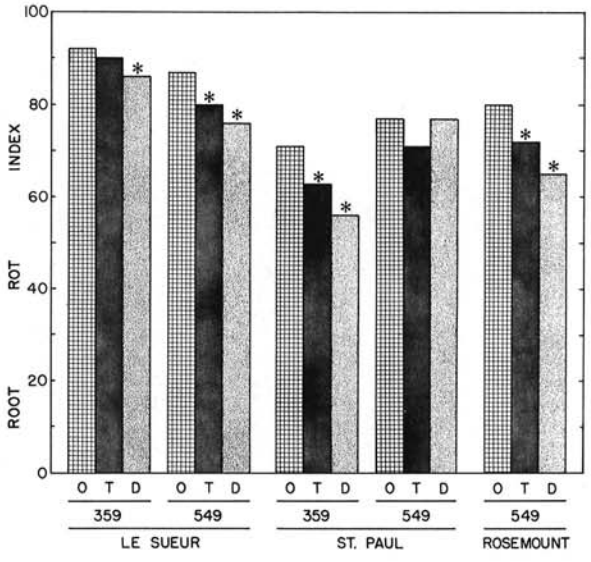


**Fig. 1.** Percent increase or decrease in numbers of pycnidia produced by two dark-sporulating isolates of *Mycosphaerella ligulicola* upon exposure to ultraviolet irradiation as compared to numbers produced in darkness after consecutive weekly subculturing from previous subcultures grown in either darkness or exposed to ultraviolet irradiation. Open circles, isolate G-10 subcultured from UV-exposed cultures ($y = 6.9 - 0.52x$, $R = -0.72$); solid circles, isolate G-10 subcultured from dark-grown cultures ($y = 55 + 1.85x$, $R = 0.72$); open triangles, isolate O-1 subcultured from UV-exposed cultures ($y = 75 + 25.2x$, $R = 0.68$); solid triangles, isolate O-1 subcultured from dark-grown cultures only ($y = 644 - 31x$, $R = -0.57$).

These two pathogen groups, one light-sensitive, the other light-insensitive, have been designated "environmental races" as defined by Waggoner and Wallin (17) since they appear morphologically and pathologically identical, yet differ markedly in environmental response. The selection of these two pathogen populations can be correlated with their historical distribution into areas of differing environmental stress.

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