Hyphal Anastomosis in Phytophthora capsici

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The work was supported in part by National Science Foundation Grant GB 29283.

ABSTRACT

Anastomosis of A^1 and A^2 hyphae of *Phytophthora capsici, P. drechsleri,* and *P. infestans* was observed in cultures grown under glass cover slips in petri dishes. Anastomosis also occurred in A^1 cultures of *P. capsici.*

Phytopathology 64:149-150

Although hyphal anastomosis is common in many fungi (7), the only report of its occurrence in *Phytophthora* is that of Wilde (11). Since nuclear interchange between hyphae of different fungal races or strains could occur by means of hyphal anastomosis, it could be an important means of fungal variation.

The literature on plasticity (ability to adapt to previously resistant hosts) of *Phytophthora infestans* was reviewed by Erwin et al. (2). There has been considerable controversy whether the plasticity should be attributed to mutation or adaptive parasitism. Reddick and Mills (9) inoculated leaves of resistant potato plants with zoospores of *P. infestans* obtained from leaves of susceptible plants. After several successive passages of zoospores from resistant plants to other resistant plants, the virulence of the isolates increased. Subsequently Mills (6) noted that the potato isolate of *P. infestans* was induced to become virulent to tomato by several passages to tomato and attributed this phenomenon to adaptive parasitism. Graham et al. (3) reported that single-zoospore isolates of *P. infestans* changed from races 1.2.3.4 to 1.2.3.4.6, from 1.2.4 to 1.2.3.4, and from 1.3.4 to 1.2.3.4 following passage through susceptible and resistant varieties. He attributed these shifts to mutation. Wilde (11) isolated race 1.2.4 of *P. infestans* from potato plants previously inoculated with race 1.2 and 2.4. Since Wilde also observed hyphal anastomosis in mixed cultures of *P. infestans*, he attributed the change in race characters to parasexuality. Leach and Rich (4) reported that races 1, 2.4 and 1.2.4 were isolated from potato plants previously inoculated with races 1.4 and 2.4; and 2.4, 1.3.4 and 1.2.3.4 from plants previously inoculated with races 2.4 and 1.3.4. Since they isolated parental and recombination genotypes from a single sporangium, they interpreted this as evidence for heterokaryosis via anastomosis and parasexuality (4), as opposed to the previous interpretations implicating adaptive parasitism (6) and mutation (3). Malcomson

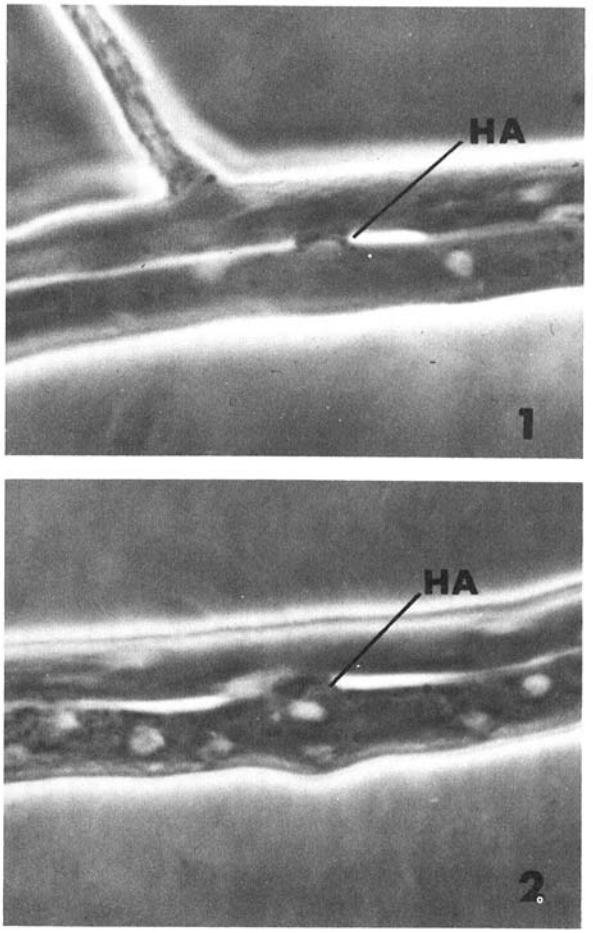

Fig. 1-2. 1) In situ whole mount of the anastomosis of hyphae of *Phytophthora capsici* (A^1 culture) as viewed with phase-contrast microscopy. **2)** Note prominent points of anastomosis (HA) between the parallel hyphae (× 2,460).

(5) isolated races 1.2.3.4.7 and 1.2.3.4.7.10 from sporangia produced on potato leaf tissue previously inoculated with races 4 and 1.2.3.4 and races 3.4.10 and 1.2.4.7, respectively. Recently, Denward (1) isolated races 1.2.3.4 from sporangia on potato plants previously inoculated with race 1.3 and 1.4. Since only the A^1 mating type of *P. infestans* exists in Europe and in the U.S.A., these data suggested that somatic recombination of factors for pathogenicity probably occurs in *Phytophthora*. For this reason, we looked for hyphal anastomosis in several different species of *Phytophthora*.

Cultures of *Phytophthora capsici* Leonian, *Phytophthora drechsleri* Tucker, and *Phytophthora infestans* (Mont.) d By. were grown under sterile glass cover slips coated on one side with a thin layer of gelatin in wells in petri plates of cleared V-8 juice agar (5 ml/plate) as described by Stephenson and Erwin (10). Crosses of A^1 and A^2 mating types of *P. capsici* (P504 X P505S), *P. drechsleri* (P208 X P209), and *P. infestans* (P443 X P475) were made by placing A^1 and A^2 types on the agar at opposite sides of the cover slip in the well. The hyphae grew under the cover slip and were observed with a Zeiss model RA microscope equipped with a 40X Planapochromatic oil immersion phase-contrast, bright-field objective and a 2X Optivar.

In addition to formation of gamatangia and oospores, anastomosis of A^1 with A^2 hyphae in cultures of *P. capsici, P. drechsleri,* and *P. infestans* was observed. However, anastomosis of hyphae of the A^1 mating type of *P. capsici* (P504 X P504) also occurred (Fig. 1, 2). The direction of growth of the approaching hyphal tips often significantly changed so that the hyphal strands were parallel. Subsequently, between the parallel hyphae anastomosis occurred at one to several points (Fig. 1, 2).

Parasexual recombination in fungi as reported by Pontecorvo et al. (8) is a common phenomenon in many fungal species. However, its implications and importance are still not fully understood. Since parasexual recombination provides a means by which the pathogenicity and host range of a pathogen can be somatically altered, its importance to plant pathology is significant. It may also offer an explanation for the rapid breakdown of single-gene resistance in several agriculturally important crop plants.

The evidence reported here in support of hyphal anastomosis in *Phytophthora* confirms the earlier report of Wilde in which a camera lucida drawing of anastomosis of A^1 hyphae in a mixed culture of *P. infestans* was presented (11). Recombination of factors for pathogenicity in *P. infestans* (A^1 mating type alone) reported by Wilde (11), Leach and Rich (4), Malcomson (5), and Denward (1) could also be explained by hyphal anastomosis and parasexual cycle. Since hyphal anastomosis was detected in an A^1 culture of *P. capsici* and in A^1 and A^2 cultures of *P. drechsleri* and *P. infestans*, this phenomenon may also occur in other species of *Phytophthora*. These observations should encourage further research in this area.

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