STATUS OF SYNONYMY AND PLANT
PATHOGENICITY OF PSEUDOMONAS MARGINALIS
AND P. AERUGINOSA¹

B. A. Friedman

Market Pathology Laboratory
U. S. Department of Agriculture
New York, N. Y.

A recent statement that Pseudomonas aeruginosa is a plant pathogen as well as an animal pathogen (35) and reports to be discussed below that the plant pathogen P. marginalis is identical with P. aeruginosa make it desirable to examine the question of the synonymy of these names and the role of P. aeruginosa as a plant pathogen.

Literature Survey

In 1918 N. A. Brown described P. marginalis as the cause of a marginal leaf discoloration of lettuce. The new, fluorescent species was reported to have a maximum growth temperature at 38°C; no mention was made of the formation of pyocyanin (4). In 1924 Mehta and Berridge reported one subculture of P. marginalis, originally received by S. G. Paine from N. A. Brown, as identical with P. aeruginosa. No report was made on pyocyanin production or on the maximum growth temperature. The strain of P. marginalis used differed in several respects from Brown's original description, viz., it produced a greenish discoloration on steamed potato and failed to produce acid from sucrose. A

¹The following synonymy is used (2,14): Pseudomonas aeruginosa (Schroeter) Migula (Bacterium aeruginosum Schroeter, Bacillus pyocyaneus Gessard, Pseudomonas pyocyanea Migula); Pseudomonas marginalis (Brown) Stevens (Bacterium marginale Brown, Phytomonas marginalis (Brown) Bergey et al., Phytomonas intybi Swingle); Pseudomonas polycolor Clara (Phytomonas polycolor Clara, Bacterium polycolor (Clara) Burgwitz); Pseudomonas aptata (Brown and Jamieson) Stevens (Bacterium aptatum Brown and Jamieson, Phytomonas aptata (Brown and Jamieson) Bergey et al.).

culture of P. aeruginosa, apparently not obtained from diseased plants, was pathogenic to lettuce upon inoculation (26). At the same time Paine and Branfoot stated P. aptata isolated from diseased lettuce was the same as P. aeruginosa. The lettuce isolate showed a maximum growth temperature below 37°C, and no test for pyocyanin was reported or was a comparison made with a culture of P. aeruginosa (30). St. John-Brooks et al. studied 2 cultures of P. marginalis, one labelled E. F. Smith was apyocyanogenic, the other labelled N. A. Brown was pyocyanogenic. Antiserum of P. marginalis E. F. S. did not agglutinate P. marginalis N. A. B. or 11 cultures of P. aeruginosa. P. aeruginosa antiserum did not agglutinate P. marginalis E. F. S. or any other phytopathogenic pseudomonads studied (38). From diseased tobacco Clara described P. polycolor which had a maximum growth temperature of 39°C and failed to produce pyocyanin. A culture of P. aeruginosa, apparently from a non-plant source, failed to produce infection upon inoculation of 17 different plant hosts (7, 8). Lacey reported a number of fluorescent isolates from diseased lettuce resembled P. marginalis; all showed no growth or feeble growth at 37°C with no mention made of pyocyanin formation (23). Baldacci and Ciferri reported a strain of P. aeruginosa, of human origin, caused a type of tomato infection upon inoculation (1). Desai obtained from rotting sugarcane an organism reported to resemble P. marginalis and 2 other lettuce pathogens. The sugarcane organism was believed to belong to the P. aeruginosa group. No mention was made of pyocyanin formation, the growth temperature range of the isolate, nor was it compared with a culture of P. aeruginosa. Upon inoculation it caused a weak infection of sugarcane and failed to produce disease on 7 other hosts (11). Verona and Pasinetti obtained slight infection of frost-injured lettuce upon inoculation with a culture of P. aeruginosa (40). Elrod and Braun (15) obtained plant infections with a number but not all 15 strains of P. aeruginosa tested, apparently of human, animal, water or other non-plant origin, when an excessive inoculum was used on weakened host tissue. They reported a laboratory strain of P. polycolor produced pyocyanin, and speculated, without a culture study, that P. marginalis might be synonymous with P. aeruginosa (15). Reid et al. studied 27 strains of P. aeruginosa and reported all showed good growth at 37°C, although 10 of the strains

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did not produce pyocyanin (31). Verona speculated that some saprophytes which produce proteolytic enzymes are able to cause a rot in plants which contain a large amount of nitrogen. He reported that when grown on peptonized meat agar P. aeruginosa could cause a rot of cabbage (39). Dowson stated that pyocyanogenic cultures labelled P. marginalis were considered to be P. aeruginosa while fluorescent, apocyanogenic cultures were P. marginalis (13). Friedman identified a number of fluorescent pseudomonads from diseased lettuce, escarole, and witloof chicory as P. marginalis. None of the isolates produced pyocyanin and all had no growth or weak growth at 38°C (16, 17). Haynes characterized P. aeruginosa as producing pyocyanin. Apocyanogenic strains could be identified by their ability to grow at 42°C. A laboratory culture of P. marginalis from England and P. polycolor were found to be pyocyanogenic (22). Friedman reported antiserum of P. marginalis (strain 249) showed no agglutination of 2 strains of P. marginalis (strains 136, CIBP), 5 strains of P. fluorescens or 11 named fluorescent, phytopathogenic pseudomonads, and a low titer reaction with P. aeruginosa (A.T.C.C. 10145) which indicated lack of serological identity (18). In a study of P. marginalis isolated from diseased lettuce and cabbage, Burkholder stated the ability of P. aeruginosa to produce pyocyanin and to grow at a high temperature range were not possessed by P. marginalis (5). Okabe and Goto reported 2 strains of P. aeruginosa, apparently from non-plant sources, caused a weak infection of carrot and potato but none on 15 other plant hosts. The 2 strains produced pyocyanin but other fluorescent pseudomonads, as P. marginalis, did not. P. marginalis was reported to be distinct pathologically from P. aeruginosa (28). Volcani reported a green fluorescent organism isolated with other organisms from diseased banana plants caused lesions on 6 plant hosts but not on bananas. The pseudomonad had optimum growth at 30°, grew at 43° and was fatal to mice. It was believed to be either P. polycolor or P. aeruginosa (41). Stapp reported only 1 of a number of strains of P. aeruginosa infected potato tubers; the strain was of human origin (37).

Discussion

P. marginalis as described originally (4) and similar

strains subsequently isolated from diseased plants (5, 16, 17, 21, 23, 28) have not been reported to grow at 41°C or to produce pyocyanin. On the other hand, P. aeruginosa has been characterized by its ability to grow at 41°C and to produce pyocyanin typically (2, 8, 22, 24, 31). In addition, agglutination tests indicate that P. marginalis and P. aeruginosa are serologically different (18, 38). A number of workers have reported P. marginalis to be a distinct species (2, 5, 13, 14, 16, 25).

Bacteria causing soft rot of plants produce pectolytic enzymes, and it has been shown that P. marginalis forms pectolytic enzymes in culture and ferments pectic substances (6, 19, 21, 29, 36). P. aeruginosa has not been reported to do so (36). Strains of P. marginalis which have lost their pathogenicity during the course of long laboratory cultivation or as a result of mutation resulting from ultraviolet light irradiation have been found to have lost their power to form pectolytic enzymes or to ferment pectic substances (19, 32). Such strains can be differentiated from P. aeruginosa on the basis of maximum growth temperature or pyocyanin characteristics but are distinguished with difficulty from P. fluorescens (Friedman, unpub. data).

P. marginalis has been reported repeatedly to be a virulent plant pathogen (3, 4, 5, 9, 10, 12, 16, 17, 20, 21, 23, 27, 28, 33, 34). In contradistinction, P. aeruginosa has been reported isolated from naturally diseased plants in only a relatively few instances (11, 30, 41), and in no case have the isolates been described in sufficient detail to make possible a definitive determination of the species of Pseudomonas involved or have Koch's postulates of pathogenicity been fulfilled. Most strains of P. aeruginosa, from human, animal, soil or other non-plant sources, have failed to produce infections in plants upon inoculation (9, 23, 37), but in a number of instances weak plant infections have resulted following inoculation with other strains (1, 15, 28, 40). At present it would appear that until such time as P. aeruginosa is definitely isolated from naturally diseased plants and Koch's postulates of pathogenicity fulfilled, the role of P. aeruginosa as a plant pathogen is doubtful. It should be noted that the status of P. polycolor, said to be synonymous with P. aeruginosa (15), as a species is doubtful. As far as can be determined from the literature, P. polycolor has not been reported isolated from diseased tobacco or any other source since 1930 when it was first described.

Conclusion

Pseudomonas marginalis is the correct name of a distinct species, and is not a synonym of P. aeruginosa. P. marginalis can be differentiated from the latter species by the following characteristics. It does not form pyocyanin, shows no growth or feeble growth at 37° to 39°C, produces pectolytic enzymes in cultures, ferments pectic substances, and is a virulent plant pathogen causing natural infections on a number of plant hosts. The role of P. aeruginosa as a plant pathogen is considered doubtful at present.

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