

Pseudomonas and ropogonis, P. stizolobiiおよびP.alboprecipitansの比較研究

誌名	日本植物病理學會報 = Annals of the Phytopathological Society of Japan
ISSN	00319473
著者名	後藤,正夫 Starr,M.P.
発行元	日本植物病理學會
巻/号	37巻4号
巻号補足	
掲載ページ	p. 233-241
発行年月	1971年9月

農林水産省 農林水産技術会議事務局筑波産学連携支援センター
Tsukuba Business-Academia Cooperation Support Center, Agriculture, Forestry and Fisheries Research Council
Secretariat



A Comparative Study of *Pseudomonas andropogonis*, *P. stizolobii*, and *P. alboprecipitans*

Masao GOTO* and M.P. STARR**

後藤正夫*・M.P. STARR** : *Pseudomonas andropogonis*, *P. stizolobii*
および *P. alboprecipitans* の比較研究

Abstract

Four isolates of *Pseudomonas andropogonis*, three of *P. stizolobii*, and five of *P. alboprecipitans* were studied comparatively. All the isolates of *P. andropogonis* and *P. stizolobii* are practically identical in cultural, physiological, and biochemical properties (except for one isolate of *P. andropogonis* which is different in respect to Kovacs' oxidase reaction). All isolates are pathogenic on the leaves of sorghum (producing typical red stripes) and bean (forming small brown spots). All cultures of *P. andropogonis* and one isolate of *P. stizolobii* could infect white clover, developing black spots on the leaves; the remaining strains are avirulent for this plant. Two isolates of *P. stizolobii* did not infect corn or clover. From these results, it is concluded that the two pathogens fall into a single species, and constitute pathotypes specialized with respect to host range. Thus, *Pseudomonas andropogonis* is recommended as the scientific name of the bacterium under consideration, with *P. stizolobii* as a later synonym.

The isolates of *P. alboprecipitans* obtained in Japan from corn and teosinte are different from the above mentioned bacteria in such bacteriological properties as nitrate reduction, starch hydrolysis, oxidase reaction, hydrogen sulfide production, etc. They are also different in symptoms and virulence on corn and sorghum. Taking all these factors into account, we presently recommend retention of *P. alboprecipitans* as a species separate from *P. andropogonis*; perhaps further study of the nonfluorescent phytopathogenic pseudomonads would eventually provide a different taxonomic conclusion.

(Received October 22, 1970)

Introduction

A bacterial disease of white clover (*Trifolium repens* L.) has been reported⁶⁾ to be caused in Japan by a strain of *Pseudomonas andropogonis* (E.F. Smith 1911) Stapp 1928. Isolates from clover and sorghum were shown to be identical in their bacteriological characteristics and to produce typical stripes on sorghum irrespective of the original hosts. Isolates from both plants could infect clover, developing the same leaf spot symptoms; however, the sorghum isolates were less virulent for clover than were the clover isolates. The symptoms caused on clover by the Japanese isolates, moreover, closely resembled those caused by *Pseudomonas stizolobii* (Wolf 1920), Stapp 1935²⁾. The literature^{1,2,21)} records the similarity also in biological, physiological,

* Faculty of Agriculture, Shizuoka University, Iwata, Shizuoka, Japan. 静岡大学農学部.

** Department of Bacteriology, University of California, Davis, California, U.S.A. カリフォルニア大学.

and biochemical properties, between *Pseudomonas stizolobii* and *Pseudomonas andropogonis*.

A bacterial disease, which is somewhat different in symptoms from that caused by the above bacteria, has recently been noted in Japan on corn (*Zea mays* L.) and teosinte (*Euchlaena mexicana* Schrad). Although the teosinte pathogen was identified by Tominaga¹⁸⁾ as *P. andropogonis*, the symptoms on corn and teosinte were analogous to Johnson's description⁸⁾ of the bacterial leaf blight and stalk rot of corn caused by *Pseudomonas alboprecipitans* Rosen 1922¹³⁾. The causal bacterium of the teosinte disease also closely resembled *P. alboprecipitans* in its major biological properties including the distinctive white precipitate around colonies on nutrient agar medium.

This report deals with the results of a comparative study of these three bacterial phytopathogens undertaken with the aim of clarifying their taxonomic relationships.

Materials and methods

(1) The bacteria

The isolates used in the study were obtained from the International Collection of Phytopathogenic Bacteria (ICPB: Department of Bacteriology, University of California, Davis, California) and from the Laboratory of Plant Pathology, Shizuoka University. Their histories are as follows:

- Pseudomonas andropogonis* ICPB-PA 115: Isolated from corn by Ullstrup in Indiana in 1958.
ICPB-PA 120 (NCPPB-1864): Isolated from sweet corn by Wehlburg in Florida in 1961.
ICPB-PA 132 and PA 133: Isolated from sorghum and clover by Goto in Japan in 1964.
- Pseudomonas stizolobii* ICPB-PS 23 (ATCC 12636): Isolated from leaf of white clover by Burkholder in 1956.
ICPB-PS 186 (NCPPB-1024, ATCC 19309): Isolated from *Stizolobium duringianum* by Polhill in Rhodesia in 1961.
ICPB-PS 187 (NCPPB-1130): Isolated from *Bougainvillea* sp. by Hayward in S. Rhodesia in 1962.
- Pseudomonas alboprecipitans* ICPB-PA 117: Isolated from corn by Ullstrup in Florida in 1958.
ICPB-PA 134 and PA 135: Isolated from corn by Goto in Japan in 1967.
ICPB-PA 136 and PA 137: Isolated from teosinte by Goto in Japan in 1967.

(2) Inoculation tests

The inoculation tests were, in most cases, made by puncturing leaves with a needle, through a bacterial suspension dropped on the surface of the leaves. Inoculum was prepared by suspending a loopful of bacterial growth from a 48-hour old agar slant into one ml of sterile water. The inoculated plants were kept under humid conditions for 24 hours by covering them with polyethylene bags. For spray inoculation, inoculum was prepared by suspending a 48-hour old agar slant culture into 20 ml of sterile water. The bacterial suspension was sprayed on the plants with a fine atomizer. The plants were kept under humid conditions for 24 hours. All inoculations were repeated three times with the same results. Controls were prepared either by puncturing leaves through sterile distilled water or by spraying sterile water on plants instead of the bacterial suspension. The plant varieties used were: Clover—white clover of an unknown variety, free from the disease, was taken from the lawn of the campus of the University of California, Davis; plants were planted in pots after all unfolded leaves were trimmed off, and newly developed leaves were used for inoculation. Sorghum—variety Double Dwarf 38, yellow

milo, provided by the Agronomy Department, University of California, Davis. Bean—variety Bountiful. Corn—variety PaG 347, double-cross hybrid.

(3) Biological properties

All methods used in this study are those described in the Manual of Microbiological Methods²⁸⁾ unless otherwise noted. The oxidase test was performed by Kovacs' method⁹⁾. Poly- β -hydroxybutyric acid formation was determined by Hayward's method⁷⁾. Arginine dehydrogenase activity was scored in Thornley's medium 2A¹⁷⁾. The gluconate, lipolytic, and phenylalanine deaminase tests used are those given in Manual for the Identification of Medical Bacteria⁴⁾.

Results

(1) Pathogenicity

Clover The isolate of *P. stizolobii*, PS 23, and the clover isolate of *P. andropogonis*, PA 133, were the most virulent on clover. Small lesions with a dark green color and a water-soaked appearance developed around punctures after 3 days incubation. These spots turned dark brown and enlarged slowly (Fig. 1). This symptom was exactly like that observed in the field disease in Japan. The color finally became blackish brown, and sometimes had a yellowish halo. Infection was observed in one hundred percent of the punctures. The isolates of *P. andropogonis*, PA 115 and PA 132, produced tiny water-soaked lesions scattered around the puncture, which had a dry appearance after a week. These lesions slowly enlarged and coalesced with each other to form a lesion with the same appearance as that produced by isolate PS 23. The development of a lesion was observed on almost all punctures. These isolates increased in their virulence to clover by repeated passage through clover. Isolate PA 120 was less virulent than isolate PA 115: 10 to 14 days were needed for the appearance of the first symptom and the infection was noted in thirty to fifty percent of the punctures. Isolates PS 186 and PS 187 were avirulent on clover. The isolates of *P. alboprecipitans*, PA 117, PA 134, PA 135, PA 136, and PA 137, produced light brown to greyish white necrotic lesions around the punctures when heavy inocula were used; however, no water-soaked lesions developed from them even after one month. With light inocula of *P. alboprecipitans* on clover, no change occurred in the punctures.

Sorghum All isolates of *P. andropogonis* and *P. stizolobii* showed the same virulence to sor-

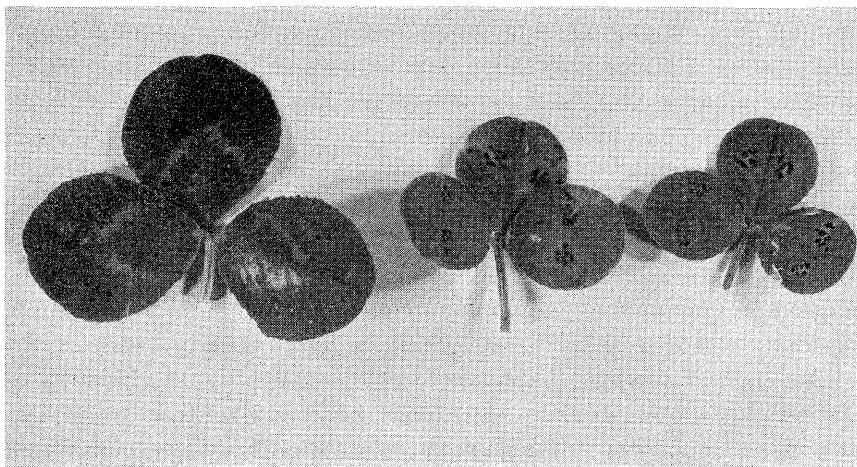


Fig. 1. Clover leaves showing symptoms resulting from the inoculation of the isolates: from left, PA 120, PA 132, and PS 23.

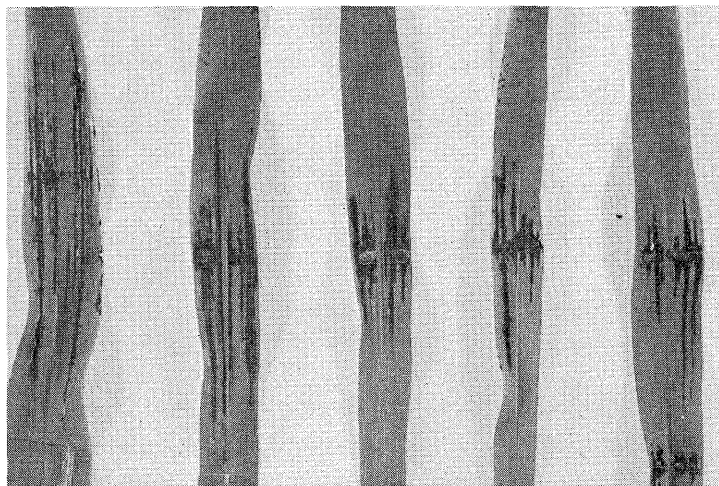


Fig. 2. Sorghum leaves showing symptoms resulting from the inoculation of the isolates: from left, PA 115a, PA 115b, PS 186, PS 187, and PS 23.

ghum. After 24 hours, small water-soaked lesions appeared around the punctures. They spread longitudinally along the veins and formed stripes 3 to 5 mm long after 2 days. The older part of the lesions soon turned red. The lesions kept elongating and formed typical red stripes 8 to 10 cm long after a week (Fig. 2). Small droplets of bacterial exudate were observed beneath the surface of the lesions. Stomatal infections occurred on young leaves when the diluted bacterial suspensions were dropped into the folded young leaves. Numerous water-soaked streaks, 2 to 4 mm in length, appeared on the leaf blade when the leaf unfolded. The lesions soon turned red and finally developed to a length of 5 to 10 cm. The virulence of isolate PA 120 was weak compared to the other isolates; the stripes produced by this isolate were only 1 cm long after 2 weeks and no stomatal infection occurred. The symptoms produced on sorghum by the isolates of *P. alboprecipitans*, PA 117, PA 134, PA 135, PA 136, and PA 137, were rather different from the above. When heavy inocula were used, round or elliptical lesions were formed around the punctures. They enlarged beyond the leaf veins without producing a water-soaked appearance at any stage and turned later greyish white with a reddish border. Long stripes restricted by veins, as in infections by *P. andropogonis* and *P. stizolobii*, were rarely formed by these isolates. When the inoculum was light, short stripes of 1 to 2 cm were formed and soon turned red. In most cases, stomatal infections resulted in red spots a few mm in diameter but not in red stripes. When these spots coalesced with each other, red stripes a few cm long developed, turning greyish white from the center.

Corn The results of inoculation tests on corn were almost the same as those on sorghum, with the exceptions of isolates PS 186 and PS 187 (which were not pathogenic on corn). On corn, the lesions produced by isolates PA 115, PS 23, PA 132, and PA 133 were water-soaked and light green at first, later turning yellowish brown and forming translucent stripes restricted by the veins. The virulence of these isolates on corn, however, was mild in comparison with that of the isolates of *P. alboprecipitans*. The symptoms produced by PA 117, PA 134, PA 135, PA 136, and PA 137 were more severe and destructive, causing bud-rot when bacterial suspensions were sprayed on the seedlings. The stripes showed a water-soaked appearance in the early stages. Later, the lesions turned greyish white and the tissue collapsed from the center outwards. The lesions coalesced very often to form extensive necrotic areas. The margin of the stripes was not

always delimited by the veins, but showed an irregular margin between the veins. These symptoms were entirely the same as those observed in field infections by *P. alboprecipitans*.

Teosinte The isolates PA 115, PA 117, PA 120, PS 23, PS 186 and PS 187 were not tested for pathogenicity on this host plant. By wound inoculation, the isolates PA 132 and PA 133 from clover and sorghum produced water-soaked dark green stripes 0.5 to 5 cm long, which later turned deep brown. When the inoculum was sprayed or injected into the leaf sheath, stripes developed which extended along the whole length of young leaves and often coalesced to form wider stripes. The corn and teosinte isolates were more virulent than those from clover and sorghum, producing heavy infection on young folded leaves which resulted in bud-rot. The separate stripes, restricted by the veins, extended from 5 cm long to the whole length of the leaves, and turned deep brown after several days. When several stripes coalesced, the lesions turned light brown from the center outwards.

Bean Inoculations were made on young trifoliate leaves. The symptoms appeared after 3 days as water-soaked, dark green spots around the pricks. They slowly enlarged and turned reddish or dark brown. No stomatal infection occurred by spraying. All isolates studied were virulent to bean. Isolate PA 115 was the most virulent, and formed lesions 2 to 3 mm in diameter after a week; the remaining isolates were slightly, but definitely virulent, and formed lesions 0.5 to 1.0 mm in diameter after 2 weeks.

(2) Bacteriological properties

All the bacteria included in this study were slender rods with round ends, occurring singly or occasionally in pairs. All isolates were Gram negative and non-sporeforming. Cells from 24-hour old nutrient agar measured $1.0\text{--}2.0\ \mu \times 0.5\text{--}0.7\ \mu$, with one or rarely two polar flagella. Sudanophilic cell inclusions were detected in all isolates. All bacteria were rather slow-growing on nutrient agar plates. After 5 days incubation at 28°C, colonies were 1.5 to 2.0 mm in diameter, white, glistening, convex, circular, and smooth. The growth of the isolates of *P. andropogonis* and *P. stizolobii* was typified by the strongly viscid nature of the colonies, although it was butyrous at the early stage of growth. It was also a characteristic of these isolates to turn the nutrient agar plates white, leaving clear zones just around the colonies. In contrast, the isolates of *P. alboprecipitans* produced colonies with a consistency which was not viscid but rather gelatinous, and the white precipitate around colonies on nutrient agar plates was much more conspicuous in these isolates than in those of *P. andropogonis* and *P. stizolobii*. Isolate PA 120 produced colonies with a rough surface and undulate margin, the consistency was viscid. On nutrient agar slants, the isolates of *P. andropogonis* and *P. stizolobii* formed filiform, white, butyrous growth, with a moderate clouding of the medium leaving a narrow clear zone around the colonies. Later, the consistency became so viscid that it was difficult to remove the growth with a needle. The growth on nutrient agar slants of the other isolates of *P. alboprecipitans* and isolate PA 120 of *P. andropogonis* was butyrous in consistency at first, then became sticky or slightly viscid. All isolates of both species, *P. alboprecipitans* and *P. andropogonis*, showed a moderate growth, forming a thin pellicle and a viscid precipitate. All isolates of *P. andropogonis* and *P. stizolobii* turned litmus milk alkaline, and often formed a soft white precipitate in the bottom after 3 to 4 weeks. Although the litmus was partially reduced, the blue color remained after a month. The isolates of *P. alboprecipitans* turned litmus milk blue in the early stages of growth followed by complete reduction of the litmus. After 3 to 4 weeks, however, a pinkish color appeared at the surface and the whole medium turned deep pink after a month with formation of curd. In Fermi's and Uschinsky's media, all the isolates of *P. alboprecipitans* and

isolate PA 120 of *P. andropogonis*, showed good growth with a white ring, pellicle, and viscid sediment, but no pigment; the growth of the other isolates of *P. andropogonis* in these media was light with neither formation of ring nor pellicle. No growth was obtained in Cohn's medium. No isolate produced a fluorescent pigment nor any other pigment on King's medium or on any of the other media used. In Hugh and Leifson's medium containing glucose, malonate, or succinate, the reaction was oxidative for all of the isolates used. No isolate liquefied gelatin. Nitrate reduction was negative for all *P. andropogonis* and *P. stizobii* cultures, but the isolates of *P. alboprecipitans* showed an evident nitrate reduction. Indole was not produced. All isolates were negative for the methyl red and Voges-Proskauer tests. All isolates were positive for catalase. All of the isolates of *P. alboprecipitans* and isolate PA 120 of *P. andropogonis* were oxidase-positive using Kovacs' method, but the other isolates of *P. andropogonis* and all isolates of *P. stizobii* were oxidase-negative. The isolates of *P. alboprecipitans* produced a little hydrogen sulfide, but the other bacteria did not form any. The arginine dihydrogenase test was positive in all of the isolates of *P. alboprecipitans* except PA 117, but negative in the other bacteria. All bacteria were nonlipolytic. Glucose, fructose, mannose, galactose, adonitol, glycerol, sorbitol, mannitol, Na-succinate, Na-citrate, and Na-malonate were utilized by all isolates as the sole source of carbon, with acid but no gas formed from the sugars and alcohols and alkali formed from the organic acids. Sucrose, maltose, raffinose, glycogen, salicin, dulcitol, and tartrate were not utilized. All isolates of *P. andropogonis* and *P. stizobii* produced a small amount of acid from lactose after 3 to 4 weeks incubation, but the isolates of *P. alboprecipitans* produced neither acid nor growth. A difference was observed also among the isolates used in the ability to utilize rhamnose and inositol. All isolates of *P. andropogonis* and *P. stizobii* were positive in the phenylalanine deaminase test in contrast to the negative reaction of the isolates of *P. alboprecipitans*. Two phages isolated from diseased teosinte leaves attacked only some isolates of *P. alboprecipitans*.

Discussion

Table 1 summarizes the differences among the isolates studied. In this table, differences which we believe to be taxonomically significant are noted between the cultures of *P. alboprecipitans* and those of the other bacteria. There are no important differences in pathogenicity nor in other properties between the isolates of *P. andropogonis* and *P. stizobii*, though variable reactions are noted in some carbohydrate utilization. The properties of these isolates were identical to the descriptions in the literature^{1,2,5,6,14,21}; except for lactose oxidation. The differences in the results for lactose oxidation undoubtedly result from the differing incubation periods, since acid production is seen only after 3 to 4 weeks; in a previous study⁹, the Japanese isolates had been observed for only 2 weeks and then discarded. Isolates PS 186 and PS 187 were different from isolate PS 23 in pathogenicity to clover and corn. Since the bacteriological properties and the pathogenicity on sorghum of PS 186 and PS 187 are identical to those of PS 23, these three isolates, PS 23, PS 186, and PS 187, are identifiable without doubt as *P. stizobii*. According to Rothwell and Hayward¹⁴, the isolates from *Bougainvillea* are not pathogenic for velvet bean; however, the host range on other leguminous plants is unknown; isolate PS 187 is one of their *Bougainvillea* strains. Thus, it is probable that there are some pathotypes with specialized host range within *P. stizobii*.

Isolate PA 120 showed less virulence on the host plants. This seems to be associated with the rough (R) colony form, since phytopathogenic bacteria of colony type R are commonly less

Table 1. Summary of the differences among the isolates of *Pseudomonas andropogonis* (PA 115, PA 120, PA 132, and PA 133), *P. stizolobii* (PS 23, PS 186, and PS 187), and *P. alboprecipitans* (PA 117, PA 134, PA 135, PA 136, and PA 137)

Property	Bacterial isolate													<i>P. andropogonis</i> ²¹⁾ (Bergey)	Tominaga's <i>P. andropogonis</i> ¹⁸⁾	Johnson's <i>P. alboprecipitans</i> ⁸⁾	Rosen's <i>P. alboprecipitans</i> ¹³⁾
	PA 115	PA 120	PS 23	PS 186	PS 187	PA 132	PA 133	PA 134	PA 135	PA 136	PA 137	PA 117					
Pathogenicity to:																	
Sorghum	3+	2+	3+	3+	3+	3+	3+	1+	1+	1+	1+	1+	+				
Clover	2+	2+	3+	—	—	2+	3+	—	—	—	—	—					
Corn	2+	2+	2+	—	—	2+	2+	3+	3+	3+	3+	2+		+	+		
Bean	2+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+					
Teosinte	?	?	?	?	?	2+	2+	3+	3+	3+	3+	?		+			
Biochemical properties:																	
Litmus milk	B	B	B	B	B	B	B	P	P	P	P	P	B	B	B	B	B
Kovacs' oxidase	—	+	—	—	—	—	—	+	+	+	+	+	—	+	+	+	+
Nitrate reduction	—	—	—	—	—	—	—	+	+	+	+	+	—	+	+	+	+
Starch hydrolysis	—	—	—	—	—	—	—	+	+	+	+	—	±	+	+	+	+
H ₂ S production	—	—	—	—	—	—	—	+	+	+	+	+	—	—	+	—	—
Phenylalanine deaminase	+	+	+	+	+	+	+	—	—	—	—	—					
Arginine dihydrogenase	—	—	—	—	—	—	—	+	+	+	+	—					
Lactose	+	+	+	+	+	+	+	—	—	—	—	—	—	—	+	—	—
Rhamnose	—	+	—	—	+	+	+	—	—	—	—	+		+, —			
Inositol	+	—	—	—	+	+	+	—	—	—	—	+					
Phage sensitivity:																	
Phage A	—	—	—	—	—	—	—	+	—	—	+	—					
Phage B	—	—	—	—	—	—	—	+	+	—	+	—					
Pathogenicity:	—No infection; 3+ Severe infection; 2+ Moderate infection; 1+ Light infection; ? Not tested.																
Litmus milk:	B=Color turned blue; P=Color turned pink.																
Reactions:	+ Positive; — Negative; ± Weakly positive.																

virulent in plant inoculation tests³⁾. It is not clear whether the seeming discrepancy in the Kovacs' oxidase test is a reflection of the colony form. Nevertheless, it is acceptable to include isolate PA 120 in *P. andropogonis*, since the other important characteristics including pathogenicity are the same as those of isolate PA 115.

Analysis of the above information leads us to conclude that the bacteria presently in the two species *P. andropogonis* and *P. stizolobii* are probably members of the same species, possibly specialized forms of a single species with respect to host range. The sorghum pathogen was named *Bacterium andropogonis* by E. F. Smith in 1911¹⁶⁾, and briefly described as follows: non-sporeforming, polarly flagellated (1-3), forming small white circular colonies, aerobic, gelatin non-liquefying, and nitrate non-reducing. Detailed descriptions of the bacteriological properties and pathogenicity were given later by Elliott and Smith⁵⁾. The velvet bean pathogen was named *Aplanobacter stizolobii* by Wolf in 1920²⁰⁾. He described the pathogenic and other properties

in detail, and most of the characterization, except motility, was confirmed by Burkholder²⁾. McCulloch¹¹⁾ demonstrated the presence of flagella and transferred this bacterium from *Aplanobacter* to *Bacterium* in 1928. The scientific name *B. andropogonis* was proposed for the sorghum pathogen nine years before *A. stizobii* was named. Although the description of the former species is rather sketchy from the standpoint of modern systematic bacteriology, it is easy to reisolate and identify the bacterium on the basis of the disease it caused in its host plant. Therefore, the present writers are inclined to recognize the priority of *Pseudomonas andropogonis*²²⁾ and to recommend that *P. stizobii* be considered as a later synonym. This bacterium causes the stripe disease of sorghum and corn, and the bacterial spot diseases of *Bougainvillea*, clover, and other leguminous plants.

The bacteria isolated in Japan from corn and teosinte are apparently identical to *P. alboprecipitans*, not only from the biological and biochemical properties but also from the symptoms on the host plants. Although there are some differences between the descriptions^{8,13)} and our results in the reactions in litmus milk, hydrogen sulfide production, and carbohydrate utilization, the general patterns of biochemical properties are clearly different from those of *P. andropogonis*. The different color reactions reported in litmus milk^{9,13,18)} might have resulted from differences in the incubation period, since the pinkish color appeared 3 to 4 weeks after inoculation. Although both pathogens are virulent on both corn and teosinte, the virulence on corn and teosinte is more severe with the *P. alboprecipitans* isolates than with the *P. andropogonis* isolates. Contrarywise, the isolates of *P. andropogonis* are more virulent on sorghum, than are the isolates of *P. alboprecipitans*, and the symptoms are also different between these two bacteria.

On the other hand, *P. andropogonis* and *P. alboprecipitans* resemble one another rather closely in the characteristic growth on agar plates, and they have many common biological and pathological properties. However, we are presently inclined to retain *P. alboprecipitans* as a species separate from *P. andropogonis* on the basis of the differences in bacteriological properties mentioned above. Perhaps, a more broadly based study of this group of nonfluorescent phytopathogenic pseudomonads (including *P. rubrisubalbicans*, which is probably a member of this group) would elicit a different taxonomic conclusion.

Acknowledgements

This study was supported by U.S. Public Health Service grants FO 5-TW-01031 and 5 RO 1-AI-08426. Mrs. Gladys Cosens performed some of the tests in Section 2 of the Results; her technical assistance is gratefully acknowledged.

Literature cited

1. Allen, R. N., Hayward, A. C., Halliday, W. J. and Fulcher, Jean, (1970). Aust. J. Biol. Sci. 23: 597-606.
2. Burkholder, W. H. (1957). Phytopathology 47: 48-50.
3. Corey, R. R. and Starr, M. P. (1957). J. Bacteriol. 74: 137-140.
4. Cowan, S. T. and Steel, K. J. (1966). Manual for the Identification of Medical Bacteria. Cambridge University Press, London.
5. Elliott, C. and Smith, E. F. (1929). J. Agr. Res. 38:1-22.
6. Goto, M. and Okabe, N. (1965). Bull. Fac. Agr. Shizuoka Univ. 15: 44-49.
7. Hayward, A. C., Forsyth, W. G. C. and Roberts, J. B. (1959). J. Gen. Microbiol. 20: 510-518.

8. Johnson, A. G., Robert, A. L. and Cash, L. (1949). J. Agr. Res. 78: 719-732.
9. Kovacs, N. (1956). Nature, Lond. 178: 703.
10. Lelliott, R. A., Billing, E. and Hayward, A. C. (1966). J. Appl. Bacteriol. 29: 470-489.
11. McCulloch, L. (1928). Phytopathology 18: 468.
12. Okabe, N. and Goto, M. (1954). Bull. Fac. Agr. Shizuoka Univ. 4: 41-60.
13. Rosen, H. H. (1922). Ann. Mo. Bot. Garden 9: 333-402.
14. Rothwell, A. and Hayward, A. C. (1964). Rhodesian J. Agr. Res. 2: 97-99.
15. Sierra, G. (1957). Antonie van Leeuwenhoek 23, 15.
16. Smith, E. F. (1911). Bacteria in Relation to Plant Disease, II. Carnegie Inst., Washington, D.C.
17. Thornley, M. J. (1966). J. Appl. Bacteriol. 23: 37-52.
18. Tominaga, T. (1967). J. Jap. Soc. Glass. Sci. 13: 156-159.
19. Ullstrup, A. J. (1960). Phytopathology 50: 906-910.
20. Wolf, F. (1920). *Ibid.* 10: 73-80.
21. Bergey's Manual of Determinative Bacteriology, 7th ed. (1957) Williams and Wilkins Co., Baltimore.
22. International Code of Nomenclature of Bacteria (1966). Int. J. Syst. Bacteriol. 16: 459-490.
23. Manual of Microbiological Methods (1957). Society of American Bacteriologists.

和文摘要

Pseudomonas andropogonis, *P. stizolobii* および *P. alboprecipitans* の比較研究

後藤正夫・M. P. STARR

Pseudomonas andropogonis 4 菌株, *P. stizolobii* 3 菌株および *P. alboprecipitans* 5 菌株を用いて病原性および細菌学的性質を比較検討した。*P. andropogonis* と *P. stizolobii* の各菌株はいずれもまったく同じ培養的・生化学的性質を示した(ただし前者の1菌株だけ Kovacs のオキシダーゼ反応で異なった)。これらの菌株はすべてモロコシに病原性を有し、赤色条斑を形成したほか、インゲンにも褐色病斑を形成した。また *P. stizolobii* の2菌株を除きトウモロコシに黄褐色条斑を形成した。これらの結果から、*P. andropogonis* と *P. stizolobii* は同一種に属し、寄主範囲において若干異なった pathotype を構成するものであると結論された。したがって先名権によって *P. andropogonis* をこのグループの細菌の学名として採用し、*P. stizolobii* を同種異名として取扱うことを提案する。

日本でトウモロコシおよびテオシントから得られた *P. alboprecipitans* は硝酸塩還元性、澱粉糖化性、オキシダーゼ反応、硫化水素産生等の性質で上記の細菌と異なるほか、トウモロコシとモロコシ上における病徴でも若干異なる。*P. andropogonis* と *P. alboprecipitans* はその他の多くの細菌学的性質および病原性における特徴を共有するが、上記の細菌学的性質の相違によって *P. alboprecipitans* を *P. andropogonis* とは異なった独立した species と考えた。