Erwinia chrysanthemi: A Comparative Study of Phenotypic Properties of Strains from Several Hosts and Other *Erwinia* Species

Robert S. Dickey

Professor, Department of Plant Pathology, Cornell University, Ithaca, NY 14853.
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ABSTRACT

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In a comparative study of the phenotypic properties of 421 strains of *Erwinia* species, all strains of *E. chrysanthemi* were separated from the other *Erwinia* spp. primarily by three physiological characters: production of gas from D-glucose, phosphatase production, and inability to produce acid from D-trehalose. The 322 strains of *E. chrysanthemi* were separated into five infrasubspecific subdivisions based on 12 physiological properties. All strains originally isolated from a specific host plant, regardless of geographic location, generally belonged to the same phenotypic subdivision. Strains included in subdivisions I and II had been isolated from specific or closely related hosts, whereas, the other subdivisions (III, IV, V) each included strains from diverse hosts.

Erwinia chrysanthemi Burkholder, McFadden, and Dimock was designated as a new species based on strains that had been isolated from *Chrysanthemum morifolium* (9). The host list now includes sedum (9), urn plant (10), sugar cane (12), rice (15), poinsettia (21), taro (22), nephthytis (23), carnation (25), African violet (29), pineapple (30), shasta daisy (31), aglaonema (32), philodendron (33), dieffenbachia (34), orchid (36), cyclamen (37), tomato (3), geranium (38), begonia (39), dahlia (40), corn (41), sweet potato (42), banana (43), guayule (46), potato (48), and carrot (50).

Similarities and differences in phenotypic characteristics have been noted for strains of *E. chrysanthemi* from different hosts (eg, 7,25,33,34). My preliminary studies indicated that strains isolated from the same host usually were similar even though the host plants had been collected from different locations. The latter observation suggested that the hosts of *E. chrysanthemi* may be attacked by specific types of the pathogen which might be recognizable by phenotypic characteristics. However, as the investigation was expanded, exceptions were noted which precluded the possibility of devising a method by which strains responsible for disease of a particular crop could be identified quickly.

The purpose of the study reported herein was to ascertain if there was a relationship between the phenotypic properties of strains of *E. chrysanthemi* and the original host from which they had been isolated.

MATERIALS AND METHODS

Bacterial strains. A total of 322 strains of *E. chrysanthemi* were used (Table 3). Seventy-seven strains of *E. carotovora* var. *carotovora* also were used which included one each from banana, corn, cucumber, dieffenbachia, dracaena, iris, lettuce, poinsettia, tobacco, wax plant, and zucchini, two each from caladium, carrot, cyclamen, philodendron, potato, and pothos, three from calla, four each from cabbage and tomato, six from onion, and 37 from chrysanthemum. In addition, 16 strains of *E. carotovora* var. *atroseptica*, two of *E. cypripedii*, one of *E. rhapontici*, and three of *Erwinia* sp. from sugarbeet (45,49) were included. A list of the strains that gives their sources and locations is available from the author.

Morphological, cultural, physiological, and biochemical properties. All strains were stained with the Hucker modification of the Gram stain (44). Selected strains were stained for flagella by the method of Blendon and Goldberg (5). Each strain was examined by phase contrast microscopy for cell morphology and motility. Colonial characteristics and pigment production were determined on Difco nutrient agar (NA), yeast extract-dextrose-calcium carbonate agar (YDC) (2), and modified YDC (13); all were incubated at 21 and 27 C.

Tests were made at 27 C, unless noted otherwise. The methods described by Dye (13) were used to test for: gas from glucose, hydrolysis of casein, phenylalanine deaminase (method 2), acetoin production, growth at 36 and 39 C, oxidation-fermentation, growth in 5% NaCl (also compared with 5% NaCl in nutrient broth [NB]), catalase, and H_2S from sodium thiosulfate. Indole and phosphatase production were determined as described in Bergey's manual (26); Bonnet's test (6) for indole also was used. Gelatin liquefaction was detected by the nutrient gelatin (Difco) tube method (13) and the gelatin plate method (11); final readings were made after 14 and 3 days, respectively. Potato rot and nitrate reduction tests were done according to Lelliott et al (27). Degradation of pectate was observed by the method of Beraha (4) and on medium A of Hildebrand (20). Gluconate oxidation was determined by mixing equal volumes of Benedict's qualitative solution and a 4-day shake culture in the medium of Graham and Dowson (18). β-Galactosidase was detected by ONGP differentiation disks (Difco) after 20 min and 4 hr incubation at 27 and 37 C. Decarboxylase base Moeller medium (Difco) plus 1% (w/v) L(+) arginine monohydrate was used as directed by the manufacturer. The method of Dye (13) was used for KCN tolerance; however, 2,3,5-triphenyltetrazolium chloride was not used as an aid to detect bacterial growth because some strains failed to grow when this substance was added. Deoxyribonuclease activity was tested after 2 days on DNase test agar (Difco). Urease production was detected by a change in color of urea broth (Difco) after 3, 5, 7, or 14 days. Lecithinase activity was recorded 3, 5, and 7 days after spot inoculation of McClung Toabe agar base (Difco) (44) plus egg yolk enrichment 50% (Difco). The method of Kovacs (24) was used for the oxidase test and the results were compared with those for Patho Tec-CO test paper (General Diagnostics Division, Warner-Chilcott, Morris Plains, NJ 07950). A 'basal' and 'seed' layer of NA + 1% glucose was used for the agar diffusion method to test sensitivity to Difco Antibiotic Discs containing penicillin G (two units) or erythromycin (15 μg).

Initially all strains were tested for production of acid from carbohydrates in 1% peptone water containing bromcresol purple and 1% (w/v) carbohydrate (13). The final readings were made 7

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days after inoculation of 5 ml of medium (in 18 × 150-mm test tube) with 0.1 ml of an aqueous suspension containing about 1×10^8 cells/ml from a 24-hr-old NA culture. Whenever a negative or a questionable reaction was recorded, the test was repeated in medium C (13), in peptone water with 1 ml/L of 1.6% alcoholic solution of bromthymol blue as the pH indicator, and in the medium of Ayers, Rupp, and Johnson (1). In addition, the pH of inoculated media plus carbohydrate was compared with the pH of inoculated media without the carbohydrate after incubation for 7 days, except that the pH of media containing D-sorbitol was recorded after 18–24 hr. Utilization of organic acids was tested on OY medium (13), except Simmons citrate agar (Difco) was used for sodium citrate.

RESULTS

All strains were Gram-negative, straight rods, motile (all stained strains had peritrichous flagella), facultatively anaerobic, catalase positive, and oxidase negative. All strains produced β-galactosidase, reduced nitrate, produced H_2S, and produced acid from L-(+)-arabinose, D-(−)-ribose, L-(+)-rhamnose, D-(−)-fructose, D-(+)-galactose, D-(+)-mannose, D-(+)-cellobiose, glycerol, D-mannitol, D-sorbitol, esculin, and salicin. No strains produced urease or acid from adonitol. Results for other tests are given in Table 1.

All strains grew in peptone water medium + bromcresol purple without an additional carbon source. All strains caused an increase in pH of the medium when compared with uninoculated medium 7 days after inoculation. There was a marked difference between strains, the range being 0.16 to 1.20 pH units. All strains of *E. cypripedii, E. chrysanthemi,* and *Erwinia* sp. (sugarbeet) grew poorly in Ayers, Rupp, and Johnson basal broth medium (1) without an additional carbon source. These strains caused a decrease in the pH of the medium, the range being 0.05 to 1.00 units for *E. chrysanthemi* and *Erwinia* sp. (sugarbeet) and 1.69 to 1.84 for *E. cypripedii*. The increase or decrease in pH by strains of *E. chrysanthemi* was not correlated with the host from which the strains had been isolated. No growth or only very slight growth occurred in the basal medium (1) inoculated with strains of *E. carotovora* var. *carotovora, E. carotovora* var. *atroseptica,* and *E.*

TABLE 1. Reactions of strains of *Erwinia* spp. and their varieties to physiological and biochemical tests[a]

Test	*E. rhapontici* (one strain)	*E. cypripedii* (two strains)	*E. carotovora* var. *carotovora* (77 strains)	*E. carotovora* var. *atroseptica* (16 strains)	*E.* spp. (sugarbeet) (three strains)	*E. chrysanthemi* (322 strains)
Pectate degradation	−*	−*	+	+	+	+
Potato soft rot	+	−*	+	+	+	+
Gluconate oxidation	+*	+*	−	−	−	−
Gelatin liquefaction	−*	−*	+	+	+	V
Sensitivity to erythromycin (15μg)	+	+	−*	−*	−*	+(99)
Sensitivity to penicillin G (two units)	−	−	+(90)	+(87)	−	V
KCN tolerance	−	+	+	+	−*	V
Phosphatase	+	−	−	−	−	+*
Gas from D-glucose	−	+	−(99)	−	−	+*
Growth at 36 C	−	+	+	−(87)	+	+
Growth at 39 C	−	−	−(97)	−(94)	−	V
Growth in 5% NaCl	+	+	+	+	+	+(75)
Blue pigment	−[b]	−	−	−	−	+(67)
Casein hydrolysis	−	−	+(93)	+(94)	−	+(62)
Acetoin production	+	−	+(92)	+	+	+
Indole	−	−	−(86)	−	−	V
DNase	−	−	−(91)	−(88)	−	−(96)
Lecithinase	−	−	−	−	−	V
Phenylalanine deaminase	+	+	−	−(62)	−	−(99)
Decarboxylase (L[+]arginine monohydrate)	−	−	−	−	−	V
Acid from:						
D(−) arabinose	−	−	−	−	−	V
D(+) xylose	−*	+	+	+	+	+(99)
D(+) lactose	+	−*	+	+	+	−(62)
D(+) maltose	+	+	−	+(69)	+	−
D(+) trehalose	+	+	+(90)	+	+	−*
D(+) melibiose	+	+	+(97)	+	−	V
D(+) raffinose	+	−	+(97)	+	+	V
D(+) melezitose	+*	−	−	−	−	−
starch	−	+(50)	−	−	−	−
inulin	−	−	−	−	+*	V
dextrin	+	+(50)	−	−(94)	−	−
ethanol	−	+	−(95)	−	+	+
dulcitol	+*	−	−	−	−	−
α-methyl-d-glucoside	+	−	−(97)	+	+	−
α-D-galacturonic acid	+	+	+	+	−*	+
palatinose	+	−	−(96)	+	+	−
i-inositol	+	+	+(97)	−(94)	+	+(70)
Utilization of:						
sodium citrate	−	+	+	+	−*	+(99)
sodium malonate	+	+(50)	−	−	−	+
sodium tartrate	−	+	−(99)	−	−	V

[a] Symbols: +, all strains positive; −, all strains negative; (%), percentage of strains + or −; *, may be useful as presumptive test; V, variable results, see Table 4 for details.
[b] Pink.

rhapontici; the pH change was nil or negligible. A random selection of strains was tested 5 days after inoculation of the basal medium and the strains were found to be viable.

An analysis of the tests (Table 1) for which the reactions of strains of *E. chrysanthemi* were variable showed that the strains could be subdivided into five groups by 12 tests (Table 2). The original host of the strains included in each subdivision is listed in Table 3.

TABLE 2. Physiological properties useful for the infrasubspecific subdivision of 322 strains of *Erwinia chrysanthemi*

Tests[a]	Subdivision I	II	III	IV	V
Gelatin liquefaction	+[b]	+	+	+	V
Sensitivity to penicillin G (two units)	+	V	V	V	−
KCN tolerance	+	+	−	V	−
Growth at 39 C	V	+	+	V	−[c]
Indole	+	+	+	+[d]	+
Lecithinase	+	+	+	+	V
Decarboxylase (L[+] arginine monohydrate)	−	−	−	−	V
Acid from:					
D-arabinose	+	−	V	+	−
melibiose	−[e]	+	+	+	V
raffinose	−	+	+	+	V
inulin	−	−	+	−	+
Utilization of Na tartrate	+	+	−	+	+

[a] See text for test methods.
[b] Symbols: +, all strains positive; −, all strains negative; V, all strains neither + nor −.
[c] The one strain (F) from *Daucus carota* L. var. *sativus* was positive.
[d] Nine strains (B-81, B-83, B-84, B-85, B-86, B-89, B-90, B-95, 358) from *Syngonium podophyllum* were negative.
[e] The two strains (257,258) from *Dieffenbachia* sp. 'Exotica' were positive.

DISCUSSION

Although the main thrust of this investigation was not to compare *Erwinia* species but rather to compare strains of *E. chrysanthemi*, there are some observations which should be noted. In general, there was relatively good agreement between the results reported herein and those reported by other investigators (7,14–18, 25,28,49) for the corresponding *Erwinia* spp. The discrepancies which do occur probably can be attributed to the use of different methods and strains. The value of the comparative studies for *E. rhapontici* and *E. cypripedii* certainly is limited by the number of strains which were included. These investigations indicate that three phenotypic characters (phosphatase production, gas from glucose, and lack of acid production from trehalose) can be used for the identification of *E. chrysanthemi*. All strains of *E. chrysanthemi* reported herein utilized sodium malonate. However, this phenotypic character is not considered to be useful as a presumptive test because strains of *E. chrysanthemi* from rice are unable to utilize sodium malonate (15). As seen in Table 1, the results failed to distinguish *E. carotovora* var. *carotovora* from *E. carotovora* var. *atroseptica*. However, the three strains of *Erwinia* sp. from sugarbeet displayed several distinctive characters (acid produced from inulin but not from α-D-galacturonic acid, sodium citrate not utilized, and growth inhibited by KCN) which suggests that they possibly should be designated to a specific rank. Previous results (45,49) indicate that this suggestion will have to await the results of a critical study of a larger and more representative group of strains from sugarbeet. A similar study apparently also is necessary for strains of *E. carotovora* var. *atroseptica*.

Phenotypic differences for strains of *E. chrysanthemi* which have been isolated from different hosts have been reported previously (7,19,28,32–34,36,37). These differences are supported by the results reported herein (Table 2 and 3). Studies of DNA relatedness between strains of *E. chrysanthemi* also have revealed differences among strains within the species (8,35,42,47); however, these studies do not consistently indicate larger differences between strains from two phenotypic subdivisions of Table 2 than between strains from the same subdivision. The subdivisions in Table 2

TABLE 3. Hosts from which the strains of *Erwinia chrysanthemi* for each infrasubspecific subdivision were isolated

Subdivision	Host and Strain number[a]	Isolated by	Location
I	*Dieffenbachia maculata* (Lodd.) G. Don (*D. picta* Schott)		
	28E (NCPPB 1157, PDDCC 1561), 28F (NCPPB 911)	Munnecke	California
	B-1	Knauss	Florida
	73, 98, 117 (NCPPB 2308)	Mazzucchi	Italy
	PR 40 (NCPPB 1490, PDDCC 1562)	Perez	Puerto Rico
	D1 (NCPPB 1514, PDDCC 1563)	Bortels	Germany
	Dieffenbachia amoena Hort.		
	B-1-R, B-27 (PDDCC 1569)	McFadden	Florida
	43, 68, 412	Garibaldi	Italy
	378, 379, 380	Dickey	Honduras
	Dieffenbachia sp.		
	C 760 (NCPPB 2454)	Catton	UK
	1b	Lemattre	France
	384, 385	Dickey	Honduras
	Dieffenbachia sp. 'Exotica'		
	B-14, B-15	Knauss	Florida
II	*Parthenium argentatum* A. Gray		
	NCPPB 516 (PDDCC 1547), NCPPB 1849, NCPPB 1861 (PDDCC 1842)	Campbell	USA
III	*Chrysanthemum* × *morifolium* Ramat.		
	EC16, EC16 (ATCC 11662), EC17 (ATCC 11663, NCPPB 402), EC18 (PDDCC 1555)	Burkholder	New York
	240	Nelson	Pennsylvania
	NCPPB 427 (PDDCC 1552)	Runnells	USA
	A60 (NCPPB 2028), A146a (NCPPB 2227)	Oxtoby	UK
	354 (NCPPB 2027)	Baker	UK
	A63 (NCPPB 2030)	Lelliott	UK
	NCPPB 517 (PDDCC 1553)	Hellmers	?
	Chrysantheumum superbum Bergmans ex J. Ingram (*C. maximum* Hort.)		
	138, 140, 145 (NCPPB 2039)	Mazzucchi	Italy

(continued)

TABLE 3. (continued)

Subdivision	Host and Strain number[a]	Isolated by	Location
	Dianthus caryophyllus L.		
	NCPPB 1111	Jenkins	UK
	Euphorbia pulcherrima Willd.		
	1, 2, 7, 15, 17	Hoitink	Ohio
	C188, C191, C192	Sands	Connecticut
	C664 (NCPPB 2148), C665 (NCPPB 2149)	Catton	UK
IV	*Aglaonema commutatum* Schott 'Treubii'		
	CU 243, CU 244	Knauss	Florida
	Ananas comosus (L.) Merrill		
	NCPPB 1121 (PDDCC 1829)	Dutta	Malaysia
	Chrysanthemum × *morifolium* Ramat.		
	C732 (NCPPB 2340)	Catton	UK
	Cyclamen sp.		
	3 (NCPPB 1780, PDDCC 1836), 5 (NCPPB 1791, PDDCC 1837)	Panagopoulos	Greece
	Dieffenbachia sp.		
	381	Dickey	Honduras
	Dracaena marginata Hort.		
	B-6, B-7, B-100	Knauss	Florida
	Ipomoea batatas (L.) Lam.		
	A-15, A-17, A-19	Schaad	Georgia
	Musa sp. Cavendish cultivars		
	HO-1, HO-2	Stover	Honduras
	362, 364, 365, 368, 370	Dickey	Panama
	369, 372, 373, 374	Dickey	Honduras
	NCPPB 2477	Shillingford	Jamaica
	Pelargonium capitatum L'Her. ex Ait.		
	NCPPB 898 (PDDCC 1544)	Radant	Comores
	Philodendron selloum C. Koch		
	Leaves:		
	B 110 (PDDCC 1566)	McFadden	Florida
	CU 70, NCPPB 533, 071-3272	Miller	Florida
	Z-1	Zettler	Florida
	245, 246, 247, 248, 566	Dickey	New York
	CU 241, CU 242, B-63, B-64, B-65, B-66, B-67, B-68, B-69, B-70, B-71, B-72	Knauss	Florida
	386	Dickey	Honduras
	CU 557, CU 558	Nelson	Pennsylvania
	CU 565	Nichols	Pennsylvania
	Petioles:		
	B-50, B-51, B-52, B-59, B-60, B-61, B-62	Knauss	Florida
	Hypocotyl area:		
	B-8, B-9, B-10, B-11, B-12, B-13	Knauss	Florida
	Seed pods:		
	B-22, B-23, B-24, B-25, B-26, B-46, B-47, B-48, B-59	Knauss	Florida
	Roots:		
	B-28, B-29, B-30, B-31, B-32, B-33, B-34, B-35, B-36, B-37, B-38, B-39, B-40, B-41, B-43, B-44, B-45	Knauss	Florida
	Philodendron panduriforme (HBK) Kunth.		
	151, 152, 153, 154, 155, 161, 162, 163, 164, 165	Dickey	Pennsylvania
	067-1735	Wehlburgh	Florida
	CU 156	Knauss	Florida
	387, 388	Dickey	Hondoruas
	Philodendron scandens C. Koch & Sello subsp. *oxycardium* (Schott) Bunt		
	B-101	Knauss	Florida
	Philodendron sp.		
	158, 159, 160	Dickey	Florida
	166, 167, 169, 171, 172, 173	Nelson	Pennsylvania
	525	Dickey	New York
	PH 1 (NCPPB 454, PDDCC 1565)	Miller	Florida
	Saintpaulia ionantha H. Wendl.		
	F1	Lemattre	France
	B-102, B-103, B-104, B-105, B-106, B-107, B-108, B-109	Knauss	Florida
	Syngonium podophyllum Schott		
	12B, 13A, B-73, B-74, B-75, B-76, B-77, B-78, B-79, B-80, B-81, B-82, B-83, B-84, B-85, B-86, B-87, B-88, B-89, B-90, B-95	Knauss	Florida
	357, 358, 359, 361	Dickey	Florida
	375, 376, 377	Dickey	Honduras
	Zea mays L.		
	C_1B_1 (NCPPB 1563, PDDCC 1583), C_2B_2 (NCPPB 1851, PDDCC 1359), C_6 (NCPPB 2538, PDDCC 1573), C_7, C_9 (NCPPB 2539, PDDCC 2357)	Kelman	North Carolina
	W1-1 (NCPPB 2540, PDDCC 2358), W3-20 (NCPPB 2541, PDDCC 2360)	Kelman	Wisconsin
	16 (NCPPB 1065, PDDCC 211), 16 (ICPB-EC 209), 17 (NCPPB 1066)	Sabet	Egypt
	I-1M1 (NCPPB 2542), I-3 (NCPPB 2543), I-4M4 (NCPPB 2544), I-5M5 (NCPPB 2545), I-7 (NCPPB 2546), I-8 (NCPPB 2547)	Payak	India
	NCPPB 708 (PDDCC 1548)	ITCC B55	India

(continued)

TABLE 3. (continued)

Subdivision	Host and Strain number[a]	Isolated by	Location
	NCPPB 2476	Luangthuan	Malaysia
	30-3, 30-6, 30-71, 40-1, 41-11, 41-12, 41-21, 41-22, 41-23, 41-31, 41-32	Victoria	Colombia
	221 (NCPPB 2347), 226 (NCPPB 2348), 228, 229	Mazzucchi	Italy
	NCPPB 377	Dowson	Rhodesia
	113-2, 119-14, 143-B1	Samson	France
	Zea mays L. var. *rugosa* Bonaf.		
	84, 85, 86, 88, 89, 90, 91, 92	Dickey	New York
V	*Begonia intermedia* Hort. 'Bertinii'		
	S 204-107 (NCPPB 2421)	Kamerman	Netherlands
	Dahlia pinnata Cav. [*D. variabilis* (Willd.) Desf.]		
	S59, S59 (NCPPB 1609), S62, S187-85, NCPPB 1955 (PDDCC 1843), NCPPB 1956 (PDDCC 1844)	Saaltink	Netherlands
	NCPPB 1385 (PDDCC 1387)	Lazar	Romania
	31, t	Lemattre	France
	Daucus carota L. var. *sativus* Hoffm.		
	F	Towner	Texas
	Dianthus barbatus L.		
	LO 67, 68	Garibaldi	Italy
	Dianthus caryophyllus L.		
	D-1, NCPPB 518 (PDDCC 1558), 20, 21, 98 (PDDCC 1560)	Hellmers	Denmark
	C1R, CN 25 (NCPPB 452), CN 26 (NCPPB 453)	Lelliott	UK
	NCPPB 430, NCPPB 568	Jenkins	UK
	NCPPB 429	Wilcox	UK
	300, 301, 305, 370, 372, 379, 385	Garibaldi	Italy
	309	Tramier	France
	101, 102, 103, 104, 105, 106, 107, 108	Dickey	Pennsylvania
	117	Dickey	New York
	109, 121, 122, 123, 124, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142	Nelson	Pennsylvania
	O-313, O-585-2, O-590, O-595, O-596	Tammen	Pennsylvania
	Dianthus sp.		
	81 BA	Pionnat	France
	CNBP 1354, CNPB 1355	Lemattre	Netherlands
	Lycopersicon esculentum Mill.		
	277-3	Prunier	France
	Sedum spectabile Boreau		
	CU 23	Heidrick	USA

[a] Original strain number used when known. Abbreviations: NCPPB, National Collection of Plant Pathogenic Bacteria, Harpenden, England; PDDCC, Plant Diseases Division Culture Collection, Aukland, New Zealand; ITCC, Indian Type Culture Collection of Fungi, New Delhi, India; ICPB, International Collection of Phytopathogenic Bacteria, Davis, CA; CU, Cornell University, Ithaca, NY; CNBP, Collection Nationale de Bactéries Phytopathogènes, Beaucouze 49000 Angers, France.

contain strains which have been isolated from a specific host (II), closely related hosts (I), or from a diverse group of host plants (IV) (Table 3). It is possible that further separations of the larger groups (eg, IV) could be realized by a comprehensive study of additional phenotypic characters.

Most strains isolated from a specific host, regardless of geographic location, generally belonged to the same phenotypic subdivision (Table 3). However, host range studies show that plant reactions can be demonstrated sometimes by hosts other than those from which the strains originally were isolated (11,16,19,21,23,30, 32–34,51). The implicit ability of strains to attack several hosts is important to the individual who grows several crops in a limited or confined area (eg, greenhouse) and to the person who recommends disease control measures. The practical value of in vitro studies for the assignment of strains to phenotypic subdivisions will depend upon the relation of the host range of the strains to their phenotypic properties. Several hosts currently are being tested for reactions to the strains.

The phenotypic characters of strains, coupled with results of pathogenicity tests, have been used for the designation of subspecies for *E. chrysanthemi* (26). Young et al (52) set forth a proposal that the term pathovar (pv.) be used at the infrasubspecific level and suggested that strains be designated as a pathovar if they possess a limited number of phenotypic differences and a unique host range. These authors have designated four pathovars of *E. chrysanthemi*. If the original host of the strains (Table 3) is used as a basis owing to a lack of comparative host range studies, the subdivisions in Tables 2 and 3 could be equated with the pathovar proposal as follows: I = *E. chrysanthemi* pv. *dieffenbachiae*; II = pv. *parthenii*; III = pv. *chrysanthemi*; IV = pv. *zeae*. Subdivision V includes strains that were isolated from carnation and to which Hellmers (19) ascribed the epithet, *Pectobacterium parthenii* var. *dianthicola*. Therefore, it is proposed that subdivision V could be designated as *E. chrysanthemi* pv. *dianthicola* (Hellmers 1958) comb. nov. Strain NCPPB 453 would be designated as the reference strain for pv. *dianthicola*. Confirmation of the pathovar designation for strains included in subdivision V must await the results of pathogenicity tests with carnation which currently are in progress.

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