NOTE

Emendation of *Pseudomonas straminea* Iizuka and Komagata 1963

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The description of *Pseudomonas straminea* Iizuka and Komagata 1963 was emended with data newly obtained. The spelling of the name of this taxon is also corrected as *Pseudomonas straminea*. Strains that were previously named '*Pseudomonas ochracea*' were identified as *P. straminea*.

Keywords: *Pseudomonas straminea*, *Pseudomonas stramineae*, *Pseudomonas*

During the study of the microflora of rice, Iizuka & Komagata (1963c, d, e) isolated large numbers of *Pseudomonas* strains from unhulled rice and rough rice. *Pseudomonas straminea* was isolated from Japanese paddies and was characterized by the production of a water-insoluble yellow pigment and a water-soluble greenish-yellow pigment (Iizuka & Komagata, 1963e). This species was validated and the specific epithet was derived from the Latin adjective *stramineus*, meaning made from straw or straw-coloured. *Pseudomonas stramineae* appeared in the Approved Lists of Bacterial Names (Skerman *et al.*, 1980), but this spelling is a misprint from the original description. *P. straminea* is monotypic and the type strain is the strain CB-7^T. Two strains of *P. straminea*, KM 501^T and KM 502^T, are available from culture collections, but they are derived from CB-7^T. In addition, Iizuka & Komagata (1963c) cited '*Pseudomonas ochracea*' (Zimmermann) Chester including strains CB-12 and CB-15 isolated from Japanese paddies, but this species was not validated. Four strains of this species are available from culture collections, but KM 503 and KM 504 are derived from CB-12 and KM 505 and KM 506 are from CB-15.

Kodama *et al.* (1985) studied Gram-negative, yellow-pigmented and oxidase-negative rods. Strains isolated from paddies and clinical specimens were named *Pseudomonas oryzihabitans* and those from clinical specimens were named *Pseudomonas luteola*. Later, Hildebrand *et al.* (1994) isolated yellow-cellular-pigment- and fluorescent-pigment-producing strains from walnut blight canker and concluded that they represented a new species, *Pseudomonas flavescens*.

Recently, Behrendt *et al.* (1999) reported the isolation of yellow-pigmented bacteria from the phyllosphere of grasses and identified them as *Pseudomonas graminis*. The distribution of these *Pseudomonas* species that produce water-insoluble yellow pigments is rather limited to plant materials, and their pathogenicity has not been reported (Iizuka & Komagata, 1963c; Hildebrand *et al.*, 1994; Behrendt *et al.*, 1999).

Some chemosystematic data have been reported for *Pseudomonas* species that produce water-insoluble yellow pigments: DNA base compositions (Kodama *et al.*, 1985; Hildebrand *et al.*, 1994; Behrendt *et al.*, 1999), DNA relatedness (Hildebrand *et al.*, 1994; Behrendt *et al.*, 1999), quinone systems (Yamada *et al.*, 1982; Oyaizu & Komagata, 1983; Behrendt *et al.*, 1999) and cellular fatty acid compositions (Ikemoto *et al.*, 1978; Oyaizu & Komagata, 1983; Behrendt *et al.*, 1999). In addition, on the basis of 16S rRNA gene sequences, *Pseudomonas* species that produce water-insoluble yellow pigments such as *P. straminea*, *Pseudomonas fulva*, *P. oryzihabitans*, *P. luteola*, *P. flavescens* and *P. graminis* are included in group 1 of the genus *Pseudomonas* of Palleroni (1984) (Hildebrand *et al.*, 1994; Anzai *et al.*, 1997; Behrendt *et al.*, 1999).

The aims of this study are to recharacterize *P. straminea*, including '*P. ochracea*' strains, and to emend the description of *P. straminea* with newly obtained phenotypic characteristics and chemosystematic data.

The designations of strains used in this study and the

Table 1. Strains used in this study

Abbreviations: AJ, Central Research Laboratories, Ajinomoto Co., Kawasaki, Japan; ATCC, American Type Culture Collection, Manassas, VA, USA; CCEB, Culture Collection of Entomogenous Bacteria, Institute of Entomology, Prague, Czech Republic; DSM, Deutsche Sammlung von Mikroorganismen und Zellkulturen, Braunschweig, Germany; IAM, IAM Culture Collection, University of Tokyo, Tokyo, Japan; IFO, Institute for Fermentation, Osaka, Japan; JCM, Japan Collection of Microorganisms, Saitama, Japan; KM, strain designations used in this study; KS, strains reported by Ikemoto *et al.* (1978); LMG, BCCM/LMG Bacteria Collection, Laboratorium Microbiologie, Universiteit Gent, Gent, Belgium; NCIMB, National Collections of Industrial and Marine Bacteria, Aberdeen, UK; NCTC, National Collection of Type Cultures, London, UK; NRIC, NODAI Culture Collection, Tokyo University of Agriculture, Tokyo, Japan.

Strain	Other names	Reference
<i>P. straminea</i>		
KM 501 ^T	NRIC 0164 ^T , AJ 2124 ^T , ATCC 33636 ^T , IAM 1598 ^T , JCM 2783 ^T , CB-7 ^T	Iizuka & Komagata (1963d)
KM 502 ^T	AJ 2124 ^T , IAM 1598 ^T , CB-7 ^T	Iizuka & Komagata (1963d)
<i>'P. ochracea'</i>		
KM 503	KS 0026, AJ 2122, IAM 1530, CB-12	Iizuka & Komagata (1963c), Ikemoto <i>et al.</i> (1978)
KM 504	AJ 2122, IAM 1530, CB-12	Iizuka & Komagata (1963c)
KM 505	KS 0027, AJ 2123, IAM 1542, CB-15	Iizuka & Komagata (1963c), Ikemoto <i>et al.</i> (1978)
KM 506	AJ 2123, IAM 1542, CB-15	Iizuka & Komagata (1963c)
<i>P. fulva</i>		
KM 307 ^T	NRIC 0180 ^T , AJ 2219 ^T , ATCC 31418 ^T , IAM 1529 ^T , Y-8 ^T	Iizuka & Komagata (1963d)
KM 310	AJ 2131, IAM 1576, CB-14	Iizuka & Komagata (1963d)
KM 318	AJ 2126, CB-10	Iizuka & Komagata (1963d)
<i>P. fluorescens</i>		
KM 009 ^T	IFO 14160 ^T , ATCC 13525 ^T , NCTC 10038 ^T	—
<i>P. putida</i>		
KM 105 ^T	IFO 14164 ^T , ATCC 12633 ^T , NCIMB 9494 ^T	—
<i>P. flavescent</i>		
KM 701 ^T	B62 ^T *	Hildebrand <i>et al.</i> (1994)
KM 702	B62-D5*	Hildebrand <i>et al.</i> (1994)
<i>P. mendocina</i>		
KM 751 ^T	DSM 50017 ^T , ATCC 25411 ^T	—
<i>P. luteola</i>		
KM 771 ^T	NRIC 0276 ^T , ATCC 43273 ^T , IAM 13000 ^T , JCM 3352 ^T , KS 0921 ^T	Kodama <i>et al.</i> (1985)
KM 772	NRIC 0275, IAM 12996, JCM 2953, KS 0919	Kodama <i>et al.</i> (1985)
<i>P. oryzihabitans</i>		
KM 781 ^T	NRIC 0277 ^T , AJ 2197 ^T , ATCC 43272 ^T , IAM 1568 ^T , JCM 2952 ^T , LMG 7040 ^T , KS 0036 ^T	Kodama <i>et al.</i> (1985)
KM 782	NRIC 0278, ATCC 43274, IAM 13017, JCM 3835, KS 0905	Kodama <i>et al.</i> (1985)
KM 783	NRIC 0279, IAM 13022, JCM 3840, KS 0910	Kodama <i>et al.</i> (1985)
KM 784	NRIC 0280, ATCC 43271, IAM 13025, JCM 3843, KS 0913	Kodama <i>et al.</i> (1985)
<i>P. aeruginosa</i>		
KM 731 ^T	NRIC 0201 ^T , AJ 2116 ^T , ATCC 10145 ^T , CCEB 481 ^T , IFO 12689 ^T , NCTC 10332 ^T	—

* Obtained from D. J. Hildebrand, University of California, Berkeley, CA, USA.

corresponding culture collection accession numbers and authors are shown in Table 1. All of the morphological, biochemical and physiological characteristics of *P. straminea* and '*P. ochracea*' strains were newly determined in this study. The *P. straminea* and '*P. ochracea*' strains tested showed phenotypic characteristics similar to those described by Iizuka & Komagata (1963c, e). Cells of all of the *P. straminea* and '*P. ochracea*' strains were Gram-negative rods measuring 0.4–0.6 by 1.6–2.0 µm with rounded ends and were motile by a single polar flagellum. The *P. straminea* and '*P. ochracea*' strains produced a water-insoluble yellow pigment on nutrient agar, but the tint of the yellow colour was variable from light to dark in different strains. The strains tested did not produce water-soluble fluorescent pigments on King B agar, Pseudomonas agar F (Difco), Pseudomonas agar P (Difco) or P-1 agar of Kato & Ito (1983). In contrast to the original description, KM 501^T and KM 502^T, derived from CB-7^T, did not produce a fluorescent pigment. *P. straminea* and '*P. ochracea*' were described to liquefy gelatin slowly at 30 °C but not at 20 °C in the original descriptions. The strains of neither species liquefied gelatin at 20 °C but liquefaction at 30 °C was not clear in this study. This might be due to a little melting of the gelatin at 30 °C and might lead to misinterpretation. Casein was not decomposed on skimmed-milk-agar plates at 20 or 30 °C. Therefore, the strains of both species were concluded not to liquefy gelatin. Production of hydrogen sulfide was tested by the use of lead acetate paper slips in the original descriptions, but lead acetate paper slips are hardly used in modern bacterial identification. No *P. straminea* or '*P. ochracea*' strains produced hydrogen sulfide on TSI agar or produced arginine dihydrolase, tested according to Thornley (1960). Cleavage of protocatechuate was examined by the method of Hugh & Gilardi (1974) and the strains tested showed the *ortho* type. *P. straminea* and '*P. ochracea*' were described to be oxidative for the OF test. This was confirmed in this study. *P. straminea* was reported not to produce acid from any sugars in peptone media. This was confirmed by the use of phenol red broth base (Difco) in this study. '*P. ochracea*' was described to produce acid from D-xylose and D-glucose but not from other sugars. The '*P. ochracea*' strains tested did not show the production of acid from the above sugars in this study. These results might be due to a weak metabolic activity of these species. The *P. straminea* and '*P. ochracea*' strains grew on glutamate agar as reported by Komagata (1961) and the strains did not require any growth factors. The above strains assimilated rather small numbers of organic compounds compared with other species in the genus *Pseudomonas* as tested in this study and by Stanier *et al.* (1966). The *P. straminea* and '*P. ochracea*' strains assimilated 19 of 118 organic compounds. Data on variable phenotypic characteristics newly obtained in this study are shown in Table 2. Reactions that were positive or negative for all the strains are shown in the legend to Table 2.

A water-insoluble yellow pigment was analysed as described by Hildebrand *et al.* (1994). *P. straminea* KM 501^T produced a water-insoluble yellow pigment with an absorption peak at 445.8 nm and *P. fulva* KM 307^T had a pigment with an absorption peak at 444.8 nm. *P. oryzihabitans* KM 781^T produced a yellow pigment with two major peaks at 446.8 and 471.0 nm. Strains of *Pseudomonas fluorescens*, *Pseudomonas mendocina* and *Pseudomonas putida* did not produce a water-insoluble yellow pigment.

The DNA base composition was determined by the method of Tamaoka & Komagata (1984). The G + C contents of the two *P. straminea* strains were 62.5 and 63.7 mol %, respectively, and the composition of the '*P. ochracea*' strains ranged from 62.6 to 63.2 mol % G + C (Table 3). DNA–DNA hybridization was carried out by the method of Ezaki *et al.* (1989). The *P. straminea* strains exhibited high similarity values with each other and low similarity values with the type strains of other species (Table 3). The '*P. ochracea*' strains showed high values of DNA–DNA relatedness with the type strain of *P. straminea*. The quinones were determined by the method of Komagata & Suzuki (1987). The major quinone of the *P. straminea* and '*P. ochracea*' strains was ubiquinone 9 and all strains shared more than 96 % of their quinones. Cellular fatty acids were analysed by the method of Komagata & Suzuki (1987). Further, methylated esters were separated for determination of hydroxy fatty acids by the method of Oyaizu & Komagata (1983). The major fatty acids of the *P. straminea* and '*P. ochracea*' strains were C_{16:0} (20.8 ± 1.2 %), C_{16:1} (19.0 ± 3.2 %) and C_{18:1} (47.9 ± 3.7 %). In addition, small amounts of 3-hydroxy C_{10:0} and C_{12:0} fatty acids and 2-hydroxy C_{12:0} fatty acid were detected in the *P. straminea* and '*P. ochracea*' strains. 3-Hydroxy C_{14:0} and C_{16:0} fatty acids were not detected. The major fatty acids of the *P. fluorescens* strains were C_{16:0} (21.9 ± 0.8 %), C_{16:1} (18.9 ± 0.9 %) and C_{18:1} (46.9 ± 1.5 %). In addition, small amounts of 3-hydroxy C_{10:0} and C_{12:0} fatty acids and 2-hydroxy C_{12:0} fatty acid were detected in the *P. fluorescens* strains. 3-Hydroxy C_{14:0} and C_{16:0} fatty acids were not detected.

As mentioned above, the phylogenetic relationships deduced from 16S rRNA gene sequences revealed that *Pseudomonas* species that produce water-insoluble yellow pigments such as *P. straminea*, *P. fulva*, *P. oryzihabitans*, *P. luteola*, *P. fluorescens* and *P. graminis* are included in group 1 of Palleroni (1984). However, these species did not join in a single subcluster but were scattered on different subclusters. *P. straminea* and *P. fluorescens* are located in a neighbouring cluster (Anzai *et al.*, 1997; Behrendt *et al.*, 1999). According to our estimate, the sequence homology of *P. straminea* to *P. fluorescens* is 98.2 %. The species are differentiated by their assimilation patterns, as shown in Table 2, but DNA–DNA hybridization is recommended for correct identification. In addition, the '*P. ochracea*' strains were identified as *P. straminea* based on the values of DNA–DNA relatedness. *P. graminis* is located in a

Table 2. Morphological, biochemical and physiological characteristics and assimilation of carbon compounds

Characteristics are scored as: +, positive reaction; –, negative reaction; d, strain-dependent reaction. Numbers in parentheses indicate the number of strains showing a positive reaction. All strains were positive for the OF test, catalase activity, growth on glutamate agar and assimilation of D-fructose, D-glucose, gluconate, caprate, succinate, citrate, salicylate, L-serine and betaine. All strains were negative for production of pyocyanine on Pseudomonas agar P, starch hydrolysis, growth at pH 3.6, acid production from glycerol, lactose, cellobiose and soluble starch and assimilation of cellobiose, lactose, soluble starch, inulin, poly- β -hydroxybutyrate (PHB), phenol, xylene, *p*-aminobenzoate, naphthalene, testosterone, D-aspartate, D-tryptophan and anthranilate. All strains showed the *ortho* type of cleavage of protocatechuate.

Characteristic	KM 501 ^T	<i>P. straminea</i> *	<i>P. flavescens</i>	<i>P. fulva</i>	<i>P. oryzihabitans</i>	<i>P. luteola</i>	<i>P. aeruginosa</i>	<i>P. fluorescens</i>	<i>P. putida</i>	<i>P. mendocina</i>
No. of strains	1	3	2	3	4	2	1	1	1	1
No. of flagella	1	1	1	>1	1	>1	1	>1	>1	1
PHB accumulation	–	–	–	–	+	+	–	–	–	–
Production of water-soluble fluorescent pigment on:										
Agar F	–	–	d (1/2)	–	–	–	F†	F	–	–
King B	–	–	d (1/2)	–	–	–	F	F	F	–
Kato's P1	–	–	F	d (1/3)	–	–	F	F	F	–
Production of water-insoluble yellow pigment on:										
Nutrient agar	+	+	+	+	+	+	–	–	–	–
Glutamate agar	+	+	+	+	+	+	–	–	–	–
Gelatin liquefaction	–	–	–	–	+	+	+	–	–	–
Nitrate reduction	–	–	–	–	–	+	+	+	–	+
Nitrate respiration	–	–	–	–	–	–	+	–	–	+
Arginine dihydrolase	–	–	–	+	–	+	+	+	+	+
Levan formation	–	–	–	–	–	–	–	+	–	–
Oxidase	+	+	+	+	–	–	+	+	+	+
Growth at 4 °C	+	+	+	+	d (1/4)	–	–	+	+	–
Growth at 41 °C	–	–	–	–	–	+	+	–	–	+
Acid production from:										
D-Xylose	–	–	d (1/2)	d (1/3)	d (3/4)	+	–	–	+	–
D-Glucose	–	–	+	d (1/3)	+	+	–	+	+	–
D-Fructose	–	–	–	–	d (2/4)	–	–	–	–	–
D-Mannose	–	–	d (1/2)	–	d (2/4)	d (1/2)	–	–	+	–
Maltose	–	–	–	–	d (1/4)	–	–	–	–	–
Sucrose	–	–	–	–	d (1/4)	–	–	–	–	–
Assimilation of:										
<i>meso</i> -Erythritol	–	–	–	–	d (2/4)	–	–	+	–	–
D-Ribose	+	d (1/3)	–	d (2/3)	+	+	+	+	+	–
D-Arabinose	–	–	–	–	d (3/4)	+	–	–	–	–
L-Arabinose	+	+	d (1/2)	+	+	d (1/2)	–	+	+	–
D-Xylose	+	+	+	–	+	+	–	+	–	–
D-Mannose	+	+	+	+	+	+	+	+	–	–
D-Galactose	+	+	+	–	+	+	–	+	–	–
L-Rhamnose	–	–	–	–	+	d (1/2)	–	–	–	–
L-Fucose	–	–	–	–	d (3/4)	+	–	–	–	–
Sucrose	–	–	+	–	–	d (1/2)	–	+	+	–
Maltose	–	–	–	–	+	+	–	–	–	–
Trehalose	–	–	+	–	+	+	–	+	–	–
α -D-Melibiose	–	–	–	–	d (2/4)	+	+	–	–	–
Raffinose	+	d (1/3)	–	–	–	–	–	–	–	–
Adonitol	–	–	–	–	–	–	–	+	–	–
D-Arabitol	–	d (2/3)	–	–	+	+	+	+	–	–
L-Arabitol	+	d (1/3)	+	d (1/3)	–	–	–	+	–	+
D-Xylitol	–	–	–	–	–	–	–	+	–	–
Sorbitol	–	–	–	–	+	–	–	+	–	–
Mannitol	+	+	+	–	+	+	+	+	–	–
Inositol	–	–	d (1/2)	–	d (3/4)	+	–	+	–	–
2-Ketogluconate	–	–	–	+	+	+	+	–	+	–
5-Ketogluconate	–	–	+	–	+	+	+	+	–	–
Glucosamine	–	–	–	–	d (3/4)	+	–	+	–	–
Acetate	–	d (1/3)	+	+	+	d (1/2)	–	+	+	–
Propionate	–	d (1/3)	–	+	+	+	+	+	+	+
<i>n</i> -Butyrate	–	–	–	d (1/3)	–	+	+	+	+	–
Valerate	–	–	+	d (1/3)	–	–	+	+	+	–
Isobutyrate	–	–	–	d (1/3)	d (1/4)	+	–	+	+	–
Isovalerate	–	–	–	d (2/3)	–	–	+	–	+	–
Malonate	–	d (1/3)	+	d (2/3)	d (3/4)	–	+	+	+	–
Adipate	–	–	–	–	–	–	+	–	–	–
Fumarate	+	d (2/3)	+	+	+	+	+	+	+	+
Azelate	–	–	–	–	–	–	+	–	–	–
Sebacate	–	–	–	–	–	–	+	–	–	–
Itaconate	+	+	+	+	+	–	+	+	+	+

Table 2 (cont.)

Characteristic	KM 501 [†]	<i>P. straminea</i> *	<i>P. flavescens</i>	<i>P. fulva</i>	<i>P. oryzihabitans</i>	<i>P. luteola</i>	<i>P. aeruginosa</i>	<i>P. fluorescens</i>	<i>P. putida</i>	<i>P. mendocina</i>
Citraconate	—	—	—	—	+	—	—	+	—	—
Mucate	+	+	+	+	+	+	—	+	+	—
Glycerate	—	d (1/3)	—	+	d (3/4)	—	—	—	+	—
Glycolate	—	—	—	—	—	—	—	—	+	—
L-Lactate	+	+	+	+	+	+	—	+	+	+
β -Hydroxybutyrate	+	d (2/3)	—	—	—	d (1/2)	+	+	—	+
D-Malate	—	—	—	d (2/3)	+	+	—	—	—	+
D(–)-Tartrate	—	—	—	—	d (1/4)	—	—	—	—	—
L(+)-Tartrate	—	—	—	—	d (3/4)	—	—	—	+	—
meso-Tartrate	—	—	+	d (1/3)	+	+	—	+	+	—
D-Galactonolactone	+	d (2/3)	+	d (1/3)	+	+	+	+	—	—
Pyruvate	+	d (2/3)	+	+	+	+	—	+	+	+
Levulinate	—	—	+	d (2/3)	—	—	—	—	+	—
DL-2-Aminobutyrate	—	—	—	—	—	—	—	—	+	—
Tween 80	—	—	d (1/2)	+	+	+	—	—	—	—
Ethanol	—	d (1/3)	—	d (2/3)	+	+	+	—	+	+
n-Propanol	—	—	—	+	+	+	+	—	+	+
n-Butanol	—	—	—	—	—	+	—	—	+	+
Isobutanol	—	—	—	d (1/3)	d (2/4)	d (1/2)	+	—	—	—
1-Hexanol	—	—	—	d (1/3)	d (2/4)	+	—	—	+	+
Geraniol	—	—	—	—	—	d (1/2)	+	—	—	+
Ethylene glycol	—	—	—	—	—	—	—	—	—	+
Propylene glycol	—	—	—	+	—	+	+	—	+	+
Benzoate	+	+	—	—	—	—	+	—	+	+
m-Hydroxybenzoate	—	—	+	—	—	—	—	+	+	—
p-Hydroxybenzoate	+	+	+	—	+	+	+	+	+	—
Protocatechuate	—	—	—	—	d (3/4)	+	—	—	—	—
Gentisate	—	—	—	—	—	—	+	—	—	—
D-Mandelate	—	—	—	—	—	—	—	—	+	—
L-Mandelate	—	—	—	—	—	—	+	—	+	—
Benzylformate	—	d (1/3)	—	d (1/3)	—	—	+	—	+	—
Phenyl acetate	—	—	—	d (2/3)	—	—	—	—	+	—
Inosine	—	d (1/3)	+	+	d (3/4)	+	+	+	+	—
Taurocholate	—	—	—	—	—	d (1/2)	—	—	+	—
Glycine	—	d (1/3)	d (1/2)	+	—	—	+	—	+	+
β -Alanine	—	—	+	+	d (1/4)	+	+	+	+	+
L-Valine	—	—	—	+	+	—	+	+	+	+
L-Leucine	—	—	+	+	d (2/4)	d (1/2)	+	+	+	+
L-Isoleucine	—	—	—	+	+	+	+	+	+	+
L-Threonine	—	—	—	d (2/3)	—	—	—	—	+	+
L-Phenylalanine	—	—	—	d (2/3)	—	—	+	+	+	+
L-Tyrosine	—	—	—	d (1/3)	d (1/4)	+	+	+	+	+
L-Tryptophan	—	—	—	—	—	—	+	+	—	—
L-Lysine	—	—	—	+	d (2/4)	d (1/2)	+	—	+	+
L-Ornithine	—	—	—	+	d (1/4)	+	+	+	+	+
L-Histidine	+	d (2/3)	+	d (2/3)	d (3/4)	d (1/2)	—	+	+	+
DL-Norvaline	—	—	—	—	—	—	+	—	+	+
Creatine	—	—	—	—	—	—	—	—	+	—
L-Citrulline	—	—	+	+	—	—	+	—	+	+
Hippurate	—	—	—	—	—	—	—	—	+	—
Pantothenate	—	—	—	—	d (1/4)	+	+	—	—	—
Nicotinate	+	+	—	+	—	—	—	+	+	—
Glutathione	—	—	—	—	d (1/4)	—	—	—	—	—
Trigonelline	+	d (2/3)	—	+	d (3/4)	d (1/2)	—	—	+	—
Acetamide	—	—	—	—	—	—	+	—	—	—
Butylamine	—	—	—	+	—	—	—	—	+	—
Tryptamine	—	d (1/3)	d (1/2)	—	—	—	—	—	+	—
Amylamine	—	d (1/3)	+	—	—	—	—	—	+	—
Benzylamine	—	d (1/3)	—	—	—	—	—	—	+	—
Dodecane	—	—	—	d (1/3)	—	—	—	—	—	—

* Includes '*P. ochracea*' strains. Six strains from culture collections were used in this study, but strains derived from the same origins were joined together. See Table 1.

[†] F, Production of fluorescent pigment.

different subcluster from *P. straminea* and *P. flavescens* and sequence homologies between *P. graminis* and each of *P. straminea* and *P. flavescens* were 96.6% and 97.3%, respectively. This indicates the separation of *P. graminis* from other *Pseudomonas* species that produce water-insoluble yellow pigments.

Iizuka & Komagata (1963a, b, c, d, e) reported a taxonomic study of the genus *Pseudomonas* employing the type strains, reference strains and strains isolated from rice, petroleum and natural gas brine and divided this genus into three groups, the fluorescent group, the achromogenic group and the chromogenic group,

Table 3. DNA base composition and levels of DNA–DNA relatedness between strains of *P. straminea* and related species

All values for DNA relatedness are means of at least three determinations.

Strain	G + C content (mol %)	Level of DNA relatedness (%)							
		1	7	10	11	12	14	15	17
1. <i>P. straminea</i> KM 501 ^T	62.5	100	17	26	19	47	31	11	20
2. <i>P. straminea</i> KM 502 ^T	62.6	97	13	27	17	35	25	9	19
3. ' <i>P. ochracea</i> ' KM 503	62.5	93	13	26	23	45	38	13	25
4. ' <i>P. ochracea</i> ' KM 504	62.6	94	9	30	17	33	27	9	18
5. ' <i>P. ochracea</i> ' KM 505	62.6	85	22	27	25	40	40	14	31
6. ' <i>P. ochracea</i> ' KM 506	62.6	89	16	18	19	35	31	11	21
7. <i>P. fulva</i> KM 307 ^T	60.0	22	100	18	44	12	23	13	19
8. <i>P. fulva</i> KM 310	61.0	23	100	5	44	12	21	12	17
9. <i>P. fulva</i> KM 318	61.5	18	100	18	37	8	18	10	15
10. <i>P. fluorescens</i> KM 009 ^T	60.5	19	8	100	22	11	15	7	12
11. <i>P. putida</i> KM 105 ^T	62.0	33	34	20	100	17	27	13	23
12. <i>P. flavescentis</i> KM 701 ^T	62.7	37	5	9	17	100	25	7	16
13. <i>P. flavescentis</i> KM 702	62.7	32	14	5	15	96	21	6	13
14. <i>P. mendocina</i> KM 751 ^T	62.8	34	7	8	18	20	100	11	22
15. <i>P. luteola</i> KM 771 ^T	54.8	10	5	4	5	5	6	100	9
16. <i>P. luteola</i> KM 772	55.5	7	3	9	9	3	6	96	10
17. <i>P. oryzihabitans</i> KM 781 ^T	66.4	35	16	16	16	18	14	11	100
18. <i>P. oryzihabitans</i> KM 782	65.7	30	11	11	27	14	17	13	100
19. <i>P. oryzihabitans</i> KM 783	65.3	39	14	14	20	16	22	17	100
20. <i>P. oryzihabitans</i> KM 784	65.6	23	9	9	13	13	13	10	76

mainly on the basis of pigmentation. According to their grouping, *P. straminea* and *P. fulva* belonged to the fluorescent group because they produced both a water-insoluble yellow pigment and a water-soluble greenish-yellow pigment. In contrast to the original description, the *P. straminea* strains did not produce a fluorescent pigment in this study. *P. flavescentis* was reported to produce both a yellow cellular pigment and a fluorescent pigment. *P. straminea* strains producing both pigments are probably encountered in fresh isolates.

Emended description of *Pseudomonas straminea* Iizuka and Komagata 1963, emend. Uchino, Kosako, Uchimura and Komagata

Pseudomonas straminea (stra.min'e.a. L. adj. *stramineus*, -a, -um straw-coloured).

Cells are Gram-negative rods measuring 0.4–0.6 by 1.6–2.0 µm with rounded ends. Cells occur singly or in pairs and are motile by means of a single polar flagellum. Granules of poly-β-hydroxybutyrate are not accumulated in the cells. Colonies are smooth, entire, raised and yellow on nutrient agar. A water-insoluble yellow pigment is produced and the colour becomes dark with age. Water-soluble fluorescent pigments may be produced. Oxidative but not fermentative.

Catalase and oxidase are produced but the activity of oxidase is weak. Gelatin is not liquefied. Nitrate is not reduced to nitrite in nitrate broth. Nitrate respiration is negative. Production of hydrogen sulfide is not detected on TSI agar. Indole is not produced. Soluble starch is not hydrolysed. Arginine dihydrolase is not produced. Levan is not produced. Cleavage of proto-catechuate is of the *ortho* type. Growth factors are not required. Acid is not produced from glycerol, D-xylose, D-glucose, D-fructose, D-mannose, maltose, sucrose, lactose, cellobiose or soluble starch in phenol red broth base (Difco). The assimilation pattern of organic compounds by the species is shown in Table 2. Growth occurs at 4, 25 and 30 °C and occurs weakly at 37 °C but not at 41 °C.

The DNA G + C content ranges from 62.5 to 63.7 mol% and that of the type strain (KM 501^T) is 62.5 mol%. The cellular fatty acids consist of large amounts of even-numbered straight-chain acids, C_{16:0}, C_{16:1} and C_{18:1}, and small amounts of even-numbered straight chain C_{12:0}, 3-hydroxy C_{10:0}, 3-hydroxy C_{12:0} and 2-hydroxy C_{12:0} acids. The major ubiquinone is Q-9. The major absorbance peak of a water-insoluble yellow pigment is at 445.8 nm.

P. straminea strains were isolated from Japanese paddies by Iizuka & Komagata (1963e). The name was given incorrectly in the Approved Lists of Bacterial Names (Skerman *et al.*, 1980) as *Pseudomonas*

stramineae. The type strain is IAM 1598^T (= JCM 2783^T = NRIC 0164^T).

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