International Journal of Systematic and Evolutionary Microbiology (2001), **51**, 1863–1866 Printed in Great Britain

NOTE

Transfer of *Rhodopseudomonas acidophila* to the new genus *Rhodoblastus* as *Rhodoblastus acidophilus* gen. nov., comb. nov.

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***Rhodopseudomonas acidophila* has unique properties among the phototrophic α-*Proteobacteria* and is quite distinct from the type species of *Rhodopseudomonas*, *Rhodopseudomonas palustris*. Therefore, the transfer of *Rhodopseudomonas acidophila* to *Rhodoblastus acidophilus* gen. nov., comb. nov., is proposed. This proposal is in accordance with other taxonomic reclassifications proposed previously and fully reflects the phylogenetic distance from *Rhodopseudomonas palustris*.**

Keywords: phototrophic purple bacteria, *Rhodopseudomonas*, new combination, *Rhodoblastus*

The great diversity of purple non-sulfur bacteria is reflected not only in their morphological properties such as cell form, type of flagellation, internal membrane structures and their physiological functions. It is substantiated by great variation in systematically important molecular structures such as the cytochrome *c* type structure and the composition of fatty acids and quinones (see Pfennig & Trüper, 1974; Imhoff & Trüper, 1989; Imhoff & Bias-Imhoff, 1995). Analysis of 16S rDNA sequences demonstrated that some species of the purple non-sulfur bacteria belong to the β-*Proteobacteria* and that the majority belong to the α-*Proteobacteria* (Gibson *et al*., 1979; Kawasaki *et al*., 1993; Imhoff & Trüper, 1989). Within both subclasses of the *Proteobacteria*, the phototrophic bacteria were phylogenetically closely related to non-phototrophic, purely chemotrophic bacteria. This is also true for species formerly recognized as *Rhodopseudomonas* species (Pfennig & Trüper, 1974), which at that time included all rod-shaped, purple non-sulfur bacteria (Woese *et al*., 1984).

The recognition of the great diversity within the purple non-sulfur bacteria and also within the genus *Rhodopseudomonas* led to a number of taxonomic rearrangements. First of all, the species with vesicular internal membrane systems were removed from the genus and transferred to the genera *Rhodobacter* and *Rhodopila* (Imhoff *et al*., 1984). Also, *Rhodopseudomonas gelatinosa* was transferred to *Rhodocyclus gelatinosus* (Imhoff *et al*., 1984) and later to *Rubrivivax gelatinosus* (Willems *et al*., 1991). Later, the marine species of the genus *Rhodobacter* were transferred to the new genus *Rhodovulum* (Hiraishi & Ueda, 1994a), the green-coloured and bacteriochlorophyll *b*-containing species were transferred to the genus *Blastochloris* (Hiraishi, 1997), *Rhodopseudomonas marina* was transferred to *Rhodobium marinum* (Hiraishi *et al*., 1995) and *Rhodopseudomonas rosea* was transferred to *Rhodoplanes roseus* (Hiraishi & Ueda, 1994b).

Rhodopseudomonas acidophila has properties that are unique among all of these species (Table 1) and is quite distinct from the type species of this genus, *Rhodopseudomonas palustris*. In contrast to *Rhodopseudomonas palustris*, sulfate is assimilated by *Rhodopseudomonas acidophila* via adenosine 5′-phosphosulfate (Imhoff, 1982), a small-sized, soluble cytochrome c_2 is present (Dickerson, 1980), menaquinones and rhodoquinones are found in addition to ubiquinones and significantly different fatty acids occur (Table 1; see Imhoff & Bias-Imhoff, 1995). Furthermore, the lipid A structure is quite different from that of *Rhodopseudomonas palustris* in having only a short chain of sugars and glucosamine as the amino sugar of the backbone instead of 2,3-diamino-2,3-dideoxy-D-glucose (see Weckesser *et al*., 1995). DNA–DNA hybridization between *Rhodopseudomonas palustris* and *Rhodopseudomonas acidophila* is less than 15% (Ivanova *et al*., 1988). The 16S rDNA sequence of *Rhodopseudomonas acidophila* is quite different from that of *Rhodopseudomonas palustris*, at least at a level that distinguishes between *Rhodopseudomonas palustris* and species of *Rhodoplanes* and *Blastochloris* and *Nitrobacter winogradskyi*. Finally, *Rhodopseudomonas acidophila*, in contrast to *Rhodopseudomonas palustris*, is specifically adapted to acidic aquatic environments (Pfennig, 1969).

Table 1. Differential characteristics of *Rhodoblastus acidophilus*, *Rhodopseudomonas palustris* and representatives of other α-2 phototrophic purple non-sulfur bacteria

Taxa are identified as: 1, *Rhodoblastus acidophilus*; 2, *Rhodopseudomonas palustris*; 3, *Rhodobium orientis*; 4, *Rhodobium marinum*; 5, *Rhodoplanes roseus*; 6, *Rhodoplanes elegans*; 7, *Blastochloris viridis*; 8, *Blastochloris sulfoviridis*. +, Positive in most strains; −, negative in most strains; +/−, variable in different strains; (+), weak growth or microaerobic growth only, rosette formation observed only rarely. Abbreviations: p-ABA, p-aminobenzoic acid; TS, thiosulfate; (biotin), biotin is required by some strains; Q-10, ubiquinone 10; MK-10, menaquinones 10; RQ-10, rhodoquinone 10; Bd, buoyant density; CA, chemical analysis; tr, trace; ND, not determined.

Characteristic	1	2	3	4	5	6	7	8
Cell diameter (μm)	1·0–1·3	0·6–0·9	0·7–0·9	0·7–0·9	1·0	0·8–1·0	0·6–0·9	0·5–0·9
Formation of prosthecae	−	+	−	−	−	+	+	−
Rosette formation	(+)	+	(+)	−	−	+	+	+
Colour of cultures	Red to orange-red	Brown-red to red	Pink to red	Pink to red	Pink	Pink	Green to olive-green	Olive-green
Bacteriochlorophyll	*a*	*a*	*a*	*a*	*a*	*a*	*b*	*b*
Salt requirement (%)	None	None	4–5	1–5	None	None	None	None
Optimum pH	5·5–6·0	6·9	7·0–7·5	6·9–7·1	7·0–7·5	7·0	6·5–7·0	7·0
Optimum temperature (°C)	25–30	30–37	30–35	25–30	30	30–35	25–30	28–30
Sulfate assimilation*	+ (APS)	+ (PAPS)	ND	ND	ND	ND	+ (PAPS)	−
Aerobic dark growth	+	+	+	(+)	+	+	(+)	(+)
Denitrification	−	+/−	+	−	+	+	−	−
Fermentation of fructose	−	−	−	+	−	−	ND	ND
Photoautotrophic growth with	H_2	H_2, TS, Sulfide	TS	Sulfide	TS	TS	−	TS, Sulfide
Growth factors	None	p-ABA (biotin)	Biotin, p-ABA	ND	Niacin	Thiamin, p-ABA	Biotin, p-ABA	Biotin, p-ABA
DNA G+C content (mol%)	62·2–66·8 (Bd)	64·8–66·3 (Bd)	65·2–65·7 (HPLC)	62·4–64·1 (HPLC)	66·8 (HPLC)	69·6–69·7 (HPLC)	66·3–71·4 (Bd)	67·8–68·4 (CA)
Cytochrome c_2 size	Small	Large	ND	ND	ND	ND	Small	ND
Major quinones	Q-10, MK-10, RQ-10	Q-10	Q-10, MK-10	Q-10, MK-10	Q-10, RQ-10	Q-10, RQ-10	Q-9, MK-9	Q-8/10, MK-7/8
Content of major fatty acids (%):								
14:0	0·8	tr	ND	0·4	ND	ND	0·5	2·5
16:0	14·8	5·2	ND	1·9	ND	ND	8·4	8·6
16:1	37·2	3·1	ND	0·5	ND	ND	5·5	9·2
18:0	0·8	7·3	ND	14·1	ND	ND	2·2	1·7
18:1	46·0	79·7	ND	69·0	ND	ND	74·6	76·5

* Sulfate assimilation via adenosine 5′-phosphosulfate (APS) or 3′-phosphoadenosine 5′-phosphosulfate (PAPS).

All of these differences support the placement of the two species in different genera. Because *Rhodopseudomonas palustris* is the type species of this genus, *Rhodopseudomonas acidophila* has to be transferred to another genus. Therefore, in accordance with Rules 39a, 39b and 41a of the Bacteriological Code (Lapage *et al.*, 1992), the transfer of *Rhodopseudomonas acidophila* to *Rhodoblastus acidophilus* gen. nov., comb. nov., is proposed, which is in line with other taxonomic reclassifications proposed previously and fully reflects the phylogenetic distance from *Rhodopseudomonas palustris*.

Description of *Rhodoblastus* gen. nov.

Rhodoblastus (Rho.do.blas′tus. Gr. n. *rhodon* the rose; Gr. n. *blastos* bud shoot; N.L. masc. n. *Rhodoblastus* the budding rose, referring to the cell colour and the mode of cell division).

Cells are rod-shaped, motile by means of flagella, show polar growth, budding and asymmetric cell division. Gram-negative and belong to the α-2 proteobacteria. Internal photosynthetic membranes appear as lamellae underlying and parallel to the cytoplasmic membrane. Photosynthetic pigments are bacteriochlorophyll *a* and carotenoids. Straight-chain monounsaturated $C_{18:1}$ and $C_{16:1}$ and saturated $C_{16:0}$ are the major cellular fatty acids. Contain ubiquinones, rhodoquinones and menaquinones with 10 isoprene units (Q-10, MK-10 and RQ-10). Preferred mode of growth is photoheterotrophic under anoxic conditions in the light. Photoautotrophic growth may be possible under anoxic conditions with hydrogen as the electron donor. Chemotrophic growth occurs under microoxic to oxic conditions, but with some substrates also occurs anaerobically by fermentation. Growth factors are not required by the type species. Mesophilic freshwater bacteria with a preference for acidic pH. Habitat is slightly acidic freshwater ponds. The G+C content of the DNA is 62·2–66·8 mol% (buoyant density).

The type species is *Rhodoblastus* (*Rbl.*) *acidophilus* (basonym *Rhodopseudomonas acidophila* Pfennig 1969, 601^{AL}).

Description of *Rhodoblastus acidophilus* comb. nov.

Rhodoblastus acidophilus (a.ci.do′phi.lus. L. adj. *acidus* sour; N.L. neut. n. *acidum* acid; Gr. adj. *philos* loving; N.L. masc. adj. *acidophilus* acid-loving).

Basonym: *Rhodopseudomonas acidophila* Pfennig 1969, 601^{AL}.

Cells are rod-shaped to elongate-ovoid, slightly curved, 1·0–1·3 μm wide and 2·0–5·0 μm long, motile by polar flagella. Daughter cells originate by polar growth as sessile buds at the pole opposite that bearing the flagella; there is no tube or filament between mother and daughter cells. When the daughter cell reaches the size of the mother cell, cell division is completed by constriction. In the next cycle, both cells form buds at the poles of the former cell division. Under certain conditions, rosettes and clusters are formed. In media lacking calcium ions, cells are non-motile. Internal photosynthetic membranes appear as lamellae underlying and parallel to the cytoplasmic membrane. Colour of anaerobic liquid cultures is purple-red to orange-brown. Cells grown under oxic conditions are colourless to light pink or orange. Absorption spectra of living cells show maxima at 375, 460, 490, 525, 590, 805, 855 and 890 nm. Photosynthetic pigments are bacteriochlorophyll *a* (esterified with phytol) and carotenoids of the spirilloxanthin series with glucosides of rhodopin and rhodopinal. The latter are characteristic of this species. Photoheterotrophic growth with a number of organic carbon sources is the preferred mode of growth. Photoautotrophic growth is possible with hydrogen as electron donor; sulfide and thiosulfate cannot be used. Cells grow chemoautotrophically under microoxic to oxic conditions in the dark with hydrogen as electron donor. Organic carbon sources used are acetate, propionate, butyrate, lactate, pyruvate, fumarate, malate, succinate, valerate, formate, methanol and ethanol. Not used are caprylate, pelargonate, glycerol, benzoate, sugars, sugar alcohols, glutamate and other amino acids. Sulfate can be assimilated. Nitrogen sources are ammonia, dinitrogen and some amino acids. Growth factors are not required; yeast extract and other complex nutrients do not increase the growth rate. Ubiquinones, menaquinones and rhodoquinones with 10 isoprene units (Q-10, MK-10, RQ-10) are present. Mesophilic freshwater bacterium with optimum growth at 25–30 °C and pH 5·5–6·0. The G+C content of the DNA is 62·2–66·8 mol% (buoyant density).

The type strain is ATCC 25092^T (=DSM 137^T =Pfennig 7050^T). The EMBL accession number of the 16S rDNA sequence of the type strain is M34128.

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