Type and Neotype Strains of the Species of Phototrophic Bacteria Maintained in Pure Culture

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The type or neotype strains of 41 species of phototrophic bacteria are given. Thirteen types, of which four are designated as types by the authors, are cited. Twenty-eight neotype strains, twenty-four of which are designated as neotypes, are also given. Fifteen of the newly designated neotype strains are described and references are given to previously published descriptions of the other nine neotypes.

According to Rule 9 of the *International Code of Nomenclature of Bacteria* (7), a type should be designated for each named taxon. The type of a species is preferably a living strain maintained in a culture collection or, if neither type nor neotype strains exist, the type is the original description or illustration. Among the phototrophic bacteria only very few type strains were designated by the original authors. For example, most species of the *Chromatiaceae* and *Chlorobiaceae* were originally described from natural sources and crude cultures (8, 27) so that no pure cultures of type strains existed. During the past 10 years, however, many representative strains of described species of these families have been isolated in pure culture, and a number of new species were described.

In view of the increasing number of studies on phototrophic (photosynthetic) bacteria, it is necessary to facilitate the identification of new isolates by the designation of type and neotype strains of the already named species. For species of phototrophic bacteria presently available in pure culture, we will cite or designate the type or neotype strains (Tables 1-3).

Table 1 represents species that were originally described from pure cultures. In most of these cases the original description contains the designation of a type strain. In a few cases, however, a type strain was not designated (viz. *Ectothiorhodospira shaposhnikovii*, *Chloropseudomonas ethylica*, *Rhodomicrobium vanielli*, and *Rhodospirillum molischianum*). Since strains on which the original descriptions of these four species were based are still available and have been deposited in type culture collections, we herewith designate the

strains cited in Table 1 as the type strains for these species.

Table 2 lists those species for which the type had never been isolated or was lost, and for which the strains listed were proposed as neotypes, but not in all cases in accordance with Rule 9d(1) Note 2(c) of the bacteriological code (7). In those cases where neotypes were not properly proposed, the strains are here designated as neotypes.

Table 3 lists species of phototrophic bacteria (available in pure cultures) for which types were never designated or were lost and for which neotypes have not been proposed to date. Therefore, we hereby designate the strains listed in Table 3 as neotype strains. In the cases of *Rhodopseudomonas capsulata*, *R. gelatinosa*, *R. palustris*, and *R. rubrum*, the descriptions of the neotype strains are in complete agreement with the species descriptions given by van Niel (25). These strains are indeed those on which van Niel based his species descriptions and which he deposited at the American Type Culture Collection. Therefore we omit here the repetition of those descriptions. The other designated neotype strains are, in our opinion, in sufficiently close agreement with the original descriptions of the organisms to make them suitable as neotypes.

***Rhodospirillum photometricum*, neotype strain NTHC132.**

Cells spiral shaped, 1.2 to 1.5 μm wide; one complete turn of spiral 4 to 6 μm wide and 7 to 10 μm long. Cells 14 to 30 μm long not uncommon. Internal photosynthetic membrane system consisting of several stacks of short lamellae; the stacks are not parallel to the

TABLE 1. *Type strains of phototrophic bacteria*

Species	Original strain designation	Culture collection no. ^a	Description of species and type strain by
<i>Ectothiorhodospira halophila</i>	SL1 ^b	SMG 244	Raymond and Sistrom (20)
<i>Ectothiorhodospira shaposhnikovii</i>	1 ^c	KMMGU, N1; SMG 243	Cherni et al. (1)
<i>Chlorobium phaeobacteroides</i>	Blankvann; 2430 ^b	SMG 266	Pfennig (14)
<i>Chlorobium phaeovibrioides</i>	Langvik; 2631 ^b	SMG 269	Pfennig (14)
<i>Chloropseudomonas ethylica</i>	1M ^c	KMMGU, 1M	Shaposhnikov et al. (21)
<i>Chromatium buderii</i>	Sta. Cruz; 8111 ^b	ATCC 25588; SMG 176	Trüper and Jannasch (24)
<i>Prosthecochloris aestuarii</i>	SK-413 ^b	SMG 271	Gorlenko (6)
<i>Rhodomicrobium vannielii</i>	—	ATCC 17100 ^{c,d}	Duchow and Douglas (3) ^b
<i>Rhodopseudomonas acidophila</i>	Crystal Lake; 7050 ^b	ATCC 25092; SMG 137	Pfennig (15)
<i>Rhodopseudomonas viridis</i>	Dreisam; F ^b	ATCC 19567	Drews and Giesbrecht (2)
<i>Rhodospirillum molischianum</i>	5; S ^{c,e}	ATCC 14031	Giesberger (5) ^c
<i>Rhodospirillum tenue</i>	Grünenplan; 2761 ^b	ATCC 19137; SMG 109	Pfennig (16)
<i>Thiocapsa pfennigii</i>	Nidelven ^b	NTHC, Nidelven	Eimhjellen (4)

^a Abbreviations: SMG, Sammlung für Mikroorganismen Göttingen, Göttingen, Germany; ATCC, American Type Culture Collection, Rockville, Md.; NTHC, Norwegian Technical University Collection of Microorganisms, Trondheim, Norway; KMMGU, Collection of Microorganisms, of Moscow State University, Moscow, USSR.

^b Designated as the type strain by the original author.

^c Here designated as the type strain.

^d C. B. van Niel reported (*personal communication*) that he received this strain, on which the original species description by Duchow and Douglas (3) was based, from these authors and deposited it with the ATCC.

^e C. B. van Niel (*personal communication*) confirmed the identity of Geisberger's strain 5 with strain ATCC 14031.

cytoplasmic membrane but form a sharp angle to it. Do not contain gas vacuoles. Cells motile by means of polar flagella. Anaerobic liquid cultures are orange brown to reddish brown.

Photosynthetic pigments: bacteriochlorophyll a.

Carotenoids: predominantly rhodopin and lycopene. Gram reaction: negative.

Photoorganotrophs, growing anaerobically in the light; unable to adapt to growth under aerobic conditions. In deep-agar tubes in the dark, microaerophilic growth occurs 5 to

TABLE 2. *Strains previously suggested or designated as neotypes of phototrophic bacteria*

Species	Original designation	Culture collection no. ^a	Neotype described by
<i>Amoebobacter pendens</i>	Kleinkalden; 1314 ^b	SMG 236	Pfennig and Trüper (17)
<i>Ectothiorhodospira mobilis</i>	Sta. Cruz I; 8112 ^c	SMG 237	Trüper (23)
<i>Lamprocystis roseopersicina</i>	Bergkamen; 3012 ^c	SMG 229	Pfennig et al. (19)
<i>Pelodictyon luteolum</i>	Polden; 2530 ^b	SMG 273	Pfennig and Trüper (17)
<i>Rhodopseudomonas sphaeroides</i>	ATH 2.4.1. ^c	ATCC 17023	van Niel (25) ^d
<i>Rhodospirillum fulvum</i>	KK; Kleinkalden, 1360 ^c	ATCC 15798, SMG 113	Pfennig et al. (18)
<i>Thiocystis gelatinosa</i>	Langvik; 2611 ^b	SMG 215	Pfennig and Trüper (17, <i>see also</i> 19)
<i>Thiodictyon bacillosum</i>	Zeulenroda; 1814 ^b	SMG 234	Pfennig and Trüper (17)
<i>Thiodictyon elegans</i>	Bergkamen; 3011 ^c	SMG 232	Pfennig et al. (19)

^a SMG, Sammlung für Mikroorganismen Göttingen; ATCC, American Type Culture Collection.

^b Previous designation of neotype by Pfennig and Trüper (17).

^c Strains previously suggested as neotypes, but not in accordance with the rules of the Bacteriological Code; here designated as the neotype strain.

^d C. B. van Niel reported (*personal communication*) that this is one of the strains on which his description of the species was based.

TABLE 3. Additional strains of phototrophic bacteria here designated as neotypes

Species	Author of species name	Original strain designation (isolated by)	Culture collection no. ^a
<i>Amoebobacter roseus</i>	Winogradsky 1888 (27)	Davis; 6611 (Pfennig)	SMG 235
<i>Chlorobium limicola</i>	Nadson 1906 (11)	GHS; 6330 (Pfennig)	SMG 245
<i>Chlorobium vibrioforme</i>	Pelsh 1936 (12)	Moss Ldg.; 6030 (Pfennig)	SMG 260
<i>Chromatium gracile</i>	Strzeszewski 1913 (22)	Hadley Harbor; 8611 (Trüper)	SMG 203
<i>Chromatium minus</i>	Winogradsky 1888 (27)	Reyershausen; 1211 (Pfennig)	SMG 178
<i>Chromatium minutissimum</i>	Winogradsky 1888 (27)	Glubokoe (Kondratieva)	KMMGU Glubokoe
<i>Chromatium okenii</i>	(Ehrenberg) Perty 1852 (13)	Ostrau; 1111 (Pfennig)	SMG 169
<i>Chromatium vinosum</i>	(Ehrenberg) Winogradsky 1888 (27)	D (Roelofsen)	SMG 180; ATCC 17899
<i>Chromatium violascens</i>	Perty 1852 (13)	Carmel River; 6111 (Pfennig)	SMG 198; ATCC 17096
<i>Chromatium warmingii</i>	(Cohn) Migula 1900 (9)	Melbourne; 6512 (Pfennig)	SMG 173; ATCC 14959
<i>Chromatium weissei</i>	(Perty) van Niel 1948 (26)	Göttingen; 2111 (Pfennig)	SMG 171
<i>Rhodopseudomonas capsulata</i>	(Molisch) van Niel 1944 (25)	ATH 2.3.1 (van Niel)	ATCC 11166
<i>Rhodopseudomonas gelatinosa</i>	(Molisch) van Niel 1944 (25)	ATH 2.2.1 (van Niel)	ATCC 17011
<i>Rhodopseudomonas palustris</i>	(Molisch) van Niel 1944 (25)	Pal6; ATH 2.1.6 (van Niel)	ATCC 17001
<i>Rhodospirillum photometricum</i>	Molisch 1907 (10)	132 (Eimhjellen)	NTHC 132
<i>Rhodospirillum rubrum</i>	(Esmarch) Molisch 1907 (10)	S1 (van Niel)	ATCC 11170; NCIB 8355
<i>Thiocapsa roseopersicina</i>	Winogradsky 1888 (27)	Hardenberg; 1711 (Pfennig)	SMG 217
<i>Thiocystis violacea</i>	Winogradsky 1888 (27)	Grünenplan; 2711 (Pfennig)	SMG 207
<i>Thiospirillum jenense</i>	(Ehrenberg) Migula 1900 (9)	Ostrau; 1112 (Pfennig)	SMG 216

^a SMG Sammlung für Mikroorganismen Göttingen; KMMGU, Collection of Microorganisms of Moscow State University, Moscow, USSR; ATCC, American Type Culture Collection; NCIB, National Collection of Industrial Bacteria, Aberdeen, Scotland.

TABLE 4: Morphological and structural properties of the neotype strains of Chromatiaceae and Chlorobiaceae listed in Table 3

Species	Neotype strain ^a	Gram reaction	Shape	Width or diameter (µm)	Length (µm)	Motility	Polar flagella	Permanent slime capsule	Gas vacuoles	Sulfur stored inside	Color of cell suspension	Photosynthetic apparatus ^b	Predominant bacteriochlorophyll	Predominant carotenoids ^c	DNA base ratios ^d
<i>Amoebobacter roseus</i>	SMG 235	—	Spherical	2–3		—	—	+	+	+	Pink red	imv	a	sp	64.3
<i>Chlorobium limicola</i>	SMG 245	—	Rod	0.7–1.1	0.9–1.5	—	—	—	—	—	Green	cv	c	ch	51.0
<i>Chlorobium vibrioforme</i>	SMG 260	—	Vibrio	0.5–0.7	1–2	—	—	—	—	—	Green	cv	d	ch	53.3
<i>Chromatium gracile</i>	SMG 203	—	Rod	1–1.3	2–6	+	+	—	—	+	Brown red	imv	a	sp,ly,rh	69.9
<i>Chromatium minus</i>	SMG 178	—	Rod	2	2.5–6	+	+	—	—	+	Purple	imv	a	ok	52.0
<i>Chromatium minutissimum</i>	KMMGU Glubokoe	—	Rod	1–1.2	2	+	+	—	—	+	Brown red	imv	a	sp,ly,rh	63.7
<i>Chromatium okenii</i>	SMG 169	—	Rod	4.5–6	8–15	+	+	—	—	+	Purple	imv	a	ok	50.0
<i>Chromatium vinosum</i>	SMG 180	—	Rod	2	2.5–6	+	+	—	—	+	Brown red	imv	a	sp,ly,rh	64.3
<i>Chromatium violascens</i>	SMG 198	—	Rod	2	2.5–6	+	+	—	—	+	Purple violet	imv	a	rl	62.2
<i>Chromatium warmingii</i>	SMG 173	—	Rod	3.5–4	5–11	+	+	—	—	+	Purple violet	imv	a	rl	55.1
<i>Chromatium weissei</i>	SMG 171	—	Rod	3.5–4.5	7–9	+	+	—	—	+	Purple	imv	a	ok	48.0
<i>Thiocapsa roseopersicina</i>	SMG 217	—	Spherical	1.2–3		—	—	+	—	+	Pink red	imv	a	sp	65.3
<i>Thiocystis violacea</i>	SMG 207	—	Spherical	2.5–3		+	+	—	—	+	Purple violet	imv	a	rl	63.1
<i>Thiospirillum jenense</i>	SMG 216	—	Spiral	2.5–4	30–40	+	+	—	—	+	Orange brown	imv	a	ly,rh	45.5

^a SMG, Sammlung für Mikroorganismen Göttingen; KMMGU, Collection of Microorganisms of Moscow State University, Moscow, USSR.

^b Located at intracytoplasmic membrane vesicles (imv) or chlorobium vesicles (cv).

^c sp, Spirilloxanthin; ch, chlorobactene; rh, rhodopin; rl, rhodopinal; ly, lycopene; ok, okenone.

^d Moles per cent guanine plus cytosine.

TABLE 5: *Physiological and biochemical properties of the neotype strains of Chromatiaceae and Chlorobiaceae listed in Table 3*

Species	Neotype strain ^a	NaCl requirement	Vitamin B ₁₂ requirement	Utilized as electron donor and/or carbon source																	Hydrogenase activity	Assimilatory sulfate reduction
				Thiosulfate	Acetate	Butyrate	Citrate	Ethanol	Formate	Fructose	Fumarate	Glucose	Glycerol	Lactate	Malate	Propionate	Pyruvate	Succinate	Peptone	Casamino Acids		
<i>Amoebobacter roseus</i>	SMG 235	-	-	+	+	-	-	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-
<i>Chlorobium limicola</i>	SMG 245	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-
<i>Chlorobium vibrioforme</i>	SMG 260	+	-	-	+	-	-	-	-	-	-	-	-	+	+	+	+	-	-	-	-	-
<i>Chromatium gracile</i>	SMG 203	+	-	+	+	-	-	-	-	-	+	-	-	+	+	+	+	+	-	-	+	+
<i>Chromatium minus</i>	SMG 178	-	-	+	+	n ^b	n	n	n	n	n	+	n	n	n	-	+	+	+	n	+	-
<i>Chromatium minutissimum</i>	KMMGU Glubokoe	-	-	-	+	n	n	n	n	n	n	n	n	n	n	+	+	+	n	n	n	-
<i>Chromatium okenii</i>	SMG 169	-	+	-	+	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-
<i>Chromatium vinosum</i>	SMG 180	-	-	+	+	-	-	-	+	-	+	-	-	+	+	+	+	+	-	-	+	-
<i>Chromatium violascens</i>	SMG 198	-	-	+	+	-	-	-	-	-	-	+	-	-	-	-	+	+	+	+	+	-
<i>Chromatium warmingii</i>	SMG 173	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	+	-
<i>Chromatium weissei</i>	SMG 171	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	-
<i>Thiocapsa roseopersicina</i>	SMG 217	-	-	+	+	-	-	-	-	+	+	-	+	-	+	-	+	+	+	+	+	-
<i>Thyocystis violacea</i>	SMG 207	-	-	-	+	+	-	-	+	+	-	-	-	+	+	+	+	+	-	-	-	-
<i>Thiospirillum jenense</i>	SMG 216	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-

^a SMG, Sammlung für Mikroorganismen Göttingen; KMMGU, Collection of Microorganisms of Moscow State University, Moscow, USSR.^b n, Not tested or not available from the literature.

10 mm below the surface (cells are fully pigmented). Capable of growth under strictly anaerobic conditions in the light in media containing citrate, ethanol, fatty acids, fructose, hydroxy acids, or asparagine as substrates.

Not utilized: glucose, glycerol, sulfide, or thiosulfate.

Deoxyribonucleic acid (DNA) base ratio: 65.8 moles per cent guanine plus cytosine (buoyant density).

The differentiating properties of the neotype strains for species belonging to the *Chromatiaceae* and *Chlorobiaceae* listed in Table 3 are given in Tables 4 and 5. Common properties of the strains listed in Tables 4 and 5 are their obligate phototrophy, anaerobic way of life, and ability to utilize sulfide and elemental sulfur as photosynthetic electron donors.

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