Emended Description of *Capnocytophaga gingivalis*

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Comparisons of deoxyribonucleic acid base sequence homology and phenotypic properties of *Capnocytophaga gingivalis* and *Cytophaga* sp. DR2001 and DR2002 revealed that the three strains belonged to the same species but that the original species description was not accurate. An emended description of *C. gingivalis* is presented.

The genus *Capnocytophaga* was created for a group of oral gliding bacteria that can be distinguished from members of the genus *Cytophaga* by several physiological criteria (6, 8). Salient among these are (i) a requirement for 10% CO₂ in the gas phase of a culture, (ii) a strictly fermentative physiology, (iii) the inability to liquify agar, and (iv) an absence of catalase activity. While these oral microorganisms were being described, other investigators were isolating and characterizing similar microbes from the same general econiche (namely, human periodontal pockets) (2, 3). However, the latter isolates were tentatively assigned to the genus *Cytophaga* because, like their soil and aquatic counterparts, they required no added CO₂ in the gas phase for growth and were not restricted to a strictly fermentative existence (8). Before two "CO₂-nonrequiring" oral gliding bacteria (strains DR2001 and DR2002) were described for the purpose of assigning specific epithets, deoxyribonucleic acid hybridization studies with these two isolates and the three type strains of *Capnocytophaga* species were performed. Strains DR2001 and DR2002 shared between 76 and 84% of their base sequences; labeled deoxyribonucleic acids of strains DR2001 and DR2002 also showed 82 and 69% homology, respectively, with deoxyribonucleic acid from *Capnocytophaga gingivalis* ATCC 33624^T (= strain 27^T [6]) (T = type strain). Since the three strains shared more than 65% of their base sequences, it was clear that they belonged to the same species (4) and that a new specific epithet could not be assigned to strains DR2001 and DR2002. Phenotypic comparisons of strains DR2001, DR2002, and ATCC 33624^T were undertaken to resolve the conflicting observations surrounding the CO₂ requirement and obligatory fermentative metabolism of these organisms.

A comparative study of the physiological traits of the three strains yielded the results described below.

Capnocytophaga gingivalis ATCC 33624^T did not require an atmosphere enriched with CO₂ to grow either aerobically, anaerobically, or in static culture (Table 1). Furthermore, supplementing the atmosphere with 10% CO₂ or adding a source of CO₃²⁻ to the medium did not increase the growth rate or final cell yield above that observed in the control cultures.

The three strains readily adapted to aerobic growth, with concomitant oxidative dissimilation of glucose. Aerobic dissimilation of glucose by *Cytophaga* sp. strains DR2001 and DR2002 was manifested by (i) a doubling of the cell mass per mole of hexose utilized compared with anaerobic glucose

utilization and (ii) an absence of acid production at the cessation of growth (7). The succinic acid normally produced from the fermentation of glucose by *Cytophaga* sp. strains DR2001 and DR2002 was not found in aerobic cultures grown at the expense of glucose because the organisms induced a functional tricarboxylic acid cycle capable of completely dissimilating glucose (7). Although the end products of aerobic glucose metabolism by *Capnocytophaga gingivalis* were not specifically identified, the cell yields of aerobic cultures also doubled, and the pH remained neutral, indicating that most of the glucose was respired to CO₂ and water.

Phenotypically, strains DR2001 and DR2002 were in-

TABLE 1. Characteristics of *Capnocytophaga gingivalis* ATCC 33624^T and *Cytophaga* species strains DR2001 and DR2002

Characteristic	<i>Capnocytophaga gingivalis</i>	Strain DR2001	Strain DR2002
Growth in standing culture ^a	+	+	+
Growth in air (shaken) ^a	+(20) ^b	+(24)	+(35)
Anaerobic growth ^c	+(10.8)	+(12.2)	+(14)
Respiratory growth ^d	+	+	+
Catalase	—	—	—
Guanine-plus-cytosine content (mol %)	34–41 ^e	40	40
Growth or acid production or both from:			
Glucose	+ ^e	+	+
Sucrose	+	+	+
Maltose	+	+	+
Mannose	+	+	+
Starch	—	—	—
Dextran	+	—	—
Glycogen	—	—	—
Acid end products			
Succinate	+ ^e	+	+
Acetate	+	+	+
Growth in and hydrolysis of:			
Agar	— ^e	—	—
Chitin	—	—	—
Cellulose	—	—	—
Flexirubin ^f	+	+	+

^a Growth in the absence of added carbonate.

^b Values in parentheses are milligrams of cells (dry weight) per mole of glucose.

^c As determined by using the GasPK system (atmosphere containing 95% H₂ and 5% CO₂).

^d Aerobic growth at the expense of glucose with no change in pH.

^e Data from reference 8.

^f Extracted and identified by the method of Achenbach and Kohl (1).

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distinguishable from *Capnocytophaga gingivalis* ATCC 33624^T (Table 1).

Therefore, we suggest that the description of *Capnocytophaga gingivalis* be emended to reflect the physiological characteristics described above. Although the genus epithet no longer reflects one of the salient properties of the organism, the fact that the name and description of the organism appear in a valid publication mandates its continued use. As presently described, *Capnocytophaga gingivalis* differs from fermentative forms of nonoral gliding bacteria like *Cytophaga fermentans* and *Flexibacter succinicans* only with respect to econiche, optimal growth temperature, presence or absence of catalase, and, in one instance (*Cytophaga fermentans*), the ability to hydrolyze, but not utilize, agar (5).

Emended description of *Capnocytophaga gingivalis*. Single flexible rods 0.3 to 0.5 by 3 to 8 μm . The guanine-plus-cytosine content of the deoxyribonucleic acid ranges from 35 to 41 mol%.

Metabolism is fermentative, with glucose fermented to succinic and acetic acids, or respiratory, with glucose metabolized to CO_2 and water by using oxygen as the terminal electron acceptor. Yeast extract, peptones, and other nitrogenous compounds support aerobic growth. Starch, dextran, agar, chitin, and cellulose are not hydrolyzed. Glucose, sucrose, mannose, and maltose are fermented; galactose, cellobiose, trehalose, L-arabinose, D-xylose, D-ribose, L-rhamnose, esculin, melezitose, raffinose, D-mannitol, and D-glucitol are not fermented.

Substrate amounts of carbon dioxide are not required for fermentation or oxidation of glucose but may be required for initial isolation.

Orange pigment is often produced when the organism is

grown either aerobically or anaerobically. *Capnocytophaga gingivalis* is facultatively aerobic. The optimum growth temperature is ca. 37°C; growth also occurs at 30°C.

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