**Flexibacter canadensis sp. nov.**

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University of Alberta Soil Microbiology strain 9D is a gram-negative, nonflagellated, gliding, white, facultatively anaerobic, non-polysaccharolytic, long, thin rod or filament. The guanine plus cytosine content of the deoxyribonucleic acid of this strain is 37.0 mol%. This strain belongs to the genus *Flexibacter*, but it differs significantly from strains of previously described species. Therefore, it is regarded as belonging to a new species, for which the name *Flexibacter canadensis* is proposed. A culture of the type strain, 9D, has been deposited in the American Type Culture Collection under the number 29591.

The purpose of this paper is to describe the properties of a gliding, non-polysaccharolytic bacterium, strain 9D, and to determine its taxonomic position.

**MATERIALS AND METHODS**

**Bacterial strain.** University of Alberta Soil Microbiology (UASM) strain 9D was isolated from soil by F.D. Cook, and a culture of this strain has been deposited in the American Type Culture Collection (ATCC), Rockville, Md., under the number ATCC 29591.

**Media and methods.** The media and methods used to characterize this organism have been described previously (1,3).

**RESULTS**

The characteristics of strain 9D are as follows.

**Cell morphology.** Gram-negative, nonflagellated, flexible, thin rods or filaments measuring 0.3 by 3 to 60 μm (Fig. 1) and showing gliding motility and good spreading ability on many dilute media such as Cook cytophaga agar and skim milk-acetate agar.

**Cultural characteristics.** Cook cytophaga agar: 5-Day-old colonies are white with a pale blue-green iridescence, irregular with a rough surface and lobate edge, and effuse and transparent with no water-soluble pigment. The Munsell color of the colonies is 2.5 Y 8/2.

Skim milk-acetate agar: 5-Day-old colonies are whitish with a blue-green iridescence, irregular with a rough surface and lobate edge, and effuse and transparent to opaque with no water-soluble pigment. The Munsell color of the colonies is 10 YR 8/2.

Plate count agar: 5-Day-old colonies are very pale pinkish gray with a blue-green iridescence, irregular with a smooth surface and lobate edge, effuse to raised and translucent to opaque with no water-soluble pigment. The Munsell color of the colonies is 2.5 YR 6/3.

The Munsell colors observed on various media are 2.5 YR 6/3, 6 YR 6/4, 7.5 YR 6/4 and 7/2, 10 YR 7-8/2 and 7/3, and 2.5 Y 7-8/2; no watersoluble pigment has ever been observed.

Broth culture: Overnight growth in a shaken culture is silky but not viscous or flocculent; there is no surface ring or pellicle produced.

Fruiting bodies and microcysts are not produced.

**Physiology.** Growth is reduced by 1% and is inhibited by 2% NaCl; the preferred atmosphere for growth is 10% O₂; the temperature range is 10 to 40°C, optimum growth occurring at 18 to 30°C; the pH range for growth is 5 to 10, optimum growth occurring at pH 6 to 8.

NH₄⁺, glutamate, asparaginate, and various proteins and protein digests (e.g., tryptone, Casein, gelatin, casein), but not or urea, are utilized as sole N sources.

Growth is stimulated by yeast extract on media containing agar only or chitin and agar only.

Growth is not reduced by 0.01% but is inhibited by 0.1% sodium lauryl sulfate. The organism is susceptible to 30 μg of chloramphenicol, 10 μg of dihydrostreptomycin, 300 U of

![Fig. 1. Cells of strain UASM strain 9D.](image-url)
### Table 1 Characteristics which distinguish *F. canadensis* from other species of *flexibacters*"  

<table>
<thead>
<tr>
<th>Species</th>
<th>Habitat</th>
<th>G+C (mol%)</th>
<th>Cell length (μm)</th>
<th>Colony color</th>
<th>% NaCl for growth</th>
<th>Anaerobic growth</th>
<th>Glucose</th>
<th>Sucrose</th>
<th>Glycerol</th>
<th>Hydrolysis of:</th>
<th>NO(_3) as N source</th>
<th>Growth factors required</th>
<th>Catalase</th>
<th>H(_2)S</th>
<th>NO(_3) → NO(_2)</th>
<th>Susceptibility to 0.01% sodium lauryl sulfate</th>
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</thead>
<tbody>
<tr>
<td><em>Flexibacter canadensis</em></td>
<td>Soil</td>
<td>37.0</td>
<td>3-60</td>
<td>White</td>
<td>0-2.0</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td><em>F. aggregans</em></td>
<td>Marine</td>
<td>35.7-42.3</td>
<td>4-10</td>
<td>White</td>
<td>1.25</td>
<td>+</td>
<td>+</td>
<td>±</td>
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<tr>
<td><em>F. albuminosus</em></td>
<td>FW</td>
<td>35.5-32</td>
<td>5-20</td>
<td>Yellow</td>
<td>0</td>
<td>±</td>
<td>±</td>
<td>+</td>
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<tr>
<td><em>F. aurantiacus</em></td>
<td>Soil, FW fish</td>
<td>33.5-32</td>
<td>5-20</td>
<td>Yellow</td>
<td>0</td>
<td>±</td>
<td>±</td>
<td>+</td>
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<tr>
<td><em>F. aurantiacus subsp. copepodarum</em></td>
<td>Marine copepod</td>
<td>33</td>
<td>5</td>
<td>Yellow</td>
<td>0</td>
<td>±</td>
<td>±</td>
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<tr>
<td><em>F. aurantiacus subsp. excathedrus</em></td>
<td>FW</td>
<td>34.5</td>
<td>10</td>
<td>Yellow</td>
<td>0</td>
<td>±</td>
<td>±</td>
<td>+</td>
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<td><em>F. aureus</em></td>
<td>FW</td>
<td>3-5</td>
<td>White, yellow-gilt, orange</td>
<td>0.5</td>
<td>±</td>
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<td>-</td>
<td>+</td>
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<td><em>F. columnaris</em></td>
<td>FW fish, hot-spring</td>
<td>29.8-35.9</td>
<td>4-8</td>
<td>Yellow</td>
<td>0</td>
<td>±</td>
<td>-</td>
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<td><em>F. elegans</em></td>
<td>FW, hot-spring</td>
<td>47.5</td>
<td>20-50</td>
<td>Yellow</td>
<td>0</td>
<td>±</td>
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<tr>
<td><em>F. flexilis</em></td>
<td>FW, hot-spring</td>
<td>40.5-43</td>
<td>10-50</td>
<td>Orange</td>
<td>0</td>
<td>±</td>
<td>±</td>
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<td><em>F. flexilis subsp. algavorum</em></td>
<td>FW</td>
<td>35.9</td>
<td>7-200</td>
<td>Orange</td>
<td>0</td>
<td>±</td>
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<td>-</td>
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<tr>
<td><em>F. flexilis subsp. solanthe</em></td>
<td>FW</td>
<td>41.3</td>
<td>10-30</td>
<td>Orange</td>
<td>0</td>
<td>±</td>
<td>±</td>
<td>+</td>
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<tr>
<td><em>F. flexilis subsp. pelliculosus</em></td>
<td>FW</td>
<td>39.5</td>
<td>10-30</td>
<td>Orange</td>
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<td>±</td>
<td>±</td>
<td>+</td>
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<tr>
<td><em>F. giganteus</em></td>
<td>FW</td>
<td>32</td>
<td>100</td>
<td>Pink, orange-red</td>
<td>0</td>
<td>±</td>
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<tr>
<td><em>F. litoralis</em></td>
<td>Marine, FW</td>
<td>31</td>
<td>180</td>
<td>Red, pink</td>
<td>0</td>
<td>±</td>
<td>±</td>
<td>+</td>
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<tr>
<td><em>F. roseolus</em></td>
<td>Hot-spring</td>
<td>34.5-38</td>
<td>&gt;50</td>
<td>Red</td>
<td>0</td>
<td>±</td>
<td>±</td>
<td>+</td>
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<tr>
<td><em>F. ruber</em></td>
<td>Hot-spring</td>
<td>37</td>
<td>&gt;50</td>
<td>Red</td>
<td>0</td>
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<td>±</td>
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polymyxin B, and actinomycin D; it is resistant to 10 U of penicillin.

Bacteria and fungi are not lysed, but the possible lysis of actinomycete strain UASM 4441 and of a Chlorella sp. culture was noted.

Biochemical reactions. The attack on glucose is both oxidative and fermentative. Acid is produced from lactose, glucose, cellobiose, and glyceral but not from sucrose or mannitol.

Lipolytic activity on tributyrin and on Tweens 20, 40, 60, and 80 has not been detected.

Hydrolyzes starch; weakly hydrolyzes pectate; does not hydrolyze cellulose (filter paper or carboxymethyl cellulose), chitin, agar, or alginate.

Liquefies gelatin; peptonizes milk in 2 days; growth and NH₃ produced from Casitone, casein, Casamino Acids, and Penassay broths; grows well on 0.2% tryptone; produces growth but no hemolysis on sheep blood agar.

H₂S, deoxyribonuclease, catalase, oxidase, and phosphatase are produced; the indole, methyl red, Voges-Proskauer, and citrate tests are negative; there is no growth on McConkey or eosin mephtylene blue. Reduces (denitrifies) NO₃⁻ and NO₂⁻ to gaseous form; however, much NH₃ is present, the significance of which is under investigation.

Habitat. Soil.

Guanine plus cytosine content of the deoxyribonucleic acid. The guanine plus cytosine content of the deoxyribonucleic acid is 37.0 mol%.

DISCUSSION

Strain UASM 9D has been assigned to the order Cytophagales on the basis of its gliding motility, lack of fruiting bodies, and low guanine plus cytosine content of its deoxyribonucleic acid. It has been assigned to the genus Flexibacter because it does not degrade polysaccharides (except pectate [weakly] and starch, of which the latter is generally utilized by flexibacters) and does not produce sheaths, microcysts or helical cells. The description of Flexibacter in the eighth edition of Bergey's Manual (4) will have to be broadened slightly because this new organism has thinner cells (0.3 µm compared to 0.5 µm) and produces a pigment different from those of other flexibacters (4). Strain UASM 9D differs in at least five properties from each of the previously described Flexibacter species (4–8; Table 1), and hence it is proposed that it be regarded as a member of a new species, Flexibacter canadensis (ca na denasis. M.L. adj. canadensis, of Canada, source of the soil from which the organism was isolated). The description of this species is the same as that given above for UASM 9D (= ATCC 29591), the type strain.
ACKNOWLEDGMENTS

I am indebted to F. D. Cook, who isolated this organism and who has contributed helpful advice. Thanks are also due to M. Mandel for determining the guanine plus cytosine content of the deoxyribonucleic acid. The financial assistance of the National Research Council of Canada is gratefully acknowledged.

LITERATURE CITED