The status of the species *Beijerinckia fluminensis* Döbereiner and Ruschel 1958. Request for an Opinion

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In a previous article [Oggerin M., Arahal, D. R., Rubio, V. & Marín, I. (2009). *Int J Syst Evol Microbiol* **59**, 2323–2328], it has been shown that strain *Beijerinckia fluminensis* UQM 1685T and its derived equivalent *B. fluminensis* CIP 106281T do not conform to the description of the type strain of *Beijerinckia fluminensis* Döbereiner and Ruschel 1958. Indeed, both strains were identified as members of the species *Rhizobium radiobacter* and exhibited marked phenotypic and genotypic differences with members of the genus *Beijerinckia*. It was concluded that both strains, and any other equivalents derived from them, do not descend from the nomenclatural type. Since then, our attempts to find older deposits of the type strain, hopefully derived from the original isolate, or other existing strains of *Beijerinckia fluminensis* that could be proposed as a neotype strain, have been in vain. It is therefore proposed that the Judicial Commission should place the name *Beijerinckia fluminensis* Döbereiner and Ruschel 1958 on the list of rejected names if a suitable replacement type strain or a neotype cannot be found within two years following the publication of this Request (Rule 18c).

During the course of a research project with free-living nitrogen fixing bacteria, we confirmed that strains *Beijerinckia fluminensis* UQM 1685T and *B. fluminensis* CIP 106281T have the same origin but do not descend from the nomenclatural type since they exhibit important phenotypic and genotypic differences when compared with the descriptions of *B. fluminensis* or any of the other species of the genus *Beijerinckia*. They could be identified as *Rhizobium radiobacter* (Oggerin et al., 2009).

*B. fluminensis* was first isolated from acidic (pH 4.2–5.2) soil samples collected in locations from four Brazilian states (Döbereiner & Ruschel, 1958). As of February 2011, the StrainInfo.net bioportal (Dawyndt et al., 2005) displayed the following culture collection numbers as equivalents of the type strain CD10: CCUG 53676, CIP 106281, DSM 2327, NCAIM B.01797 and UQM 1685. The succession of exchanges and deposits could be reconstructed as follows: UQM 1685 → DSM 2327 → (Varga, Sz.) → NCAIM B.01797 → DSM 2327. Strain DSM 2327 was also delivered to E. R. B. Moore, Aberdeen, UK, who later deposited it at the CCUG in 2006 (http://www.ccug.se/). The base of this line (UQM 1685) and one of its tips (CIP 106281) had already been tested by Oggerin et al. (2009) and identified as *R. radiobacter* as mentioned above. At that time we also noticed that strain DSM 2327 was no longer in the DSMZ catalogue (http://www.dsmz.de/) and this is still the case as of February 2011. As for strain CCUG 53676, the text displayed in 2008 (‘original DSM ampoules, not yet processed’) has been replaced by a full and very informative entry that includes a long list of coded phenotypic features. We have examined these features and, as expected, they fit with the characteristics determined for strains UQM 1685 and CIP 106281 (Oggerin et al., 2009). We also obtained strains DSM 2327 and CCUG 53676 from their respective collections and confirmed by means of 16S rRNA gene sequence analysis and the characterization of key phenotypic traits (Oggerin et al., 2009) that, as expected, these strains were indistinguishable from strains UQM 1685 and CIP 106281. In summary, all this evidence proves that strain UQM 1685 and subsequent deposits actually correspond to a strain of *R. radiobacter* (Table 1).

It is impossible to determine without further evidence whether the material that arrived at the UQM culture collection was already the incorrect strain or whether a
human error occurred afterwards. The equivalence between
the CD10 and UQM 1685 strain designations could also
not be confirmed. This information appears not only in
StrainInfo, but also in Becking (1984) and later in Kennedy
(2005) with the addition of DSM 2327. In Döbereiner &
Ruschel (1958), one of the twelve strains that conform to
the first description of the species is designated CD10 (with
the number ten as subscript). Although none of the strains
was appointed as the nomenclatural type, this situation
was not exceptional at that time. Indeed a coetaneous
publication that emphasized the importance for modern
bacteriological taxonomy of designating type strains also
noted that they were lacking for most species of bacteria
(Sneath & Cowan, 1958).

In an attempt to obtain any of the original, or even later,
isolates of B. fluminensis, we contacted the Coleção
Bactérias Diaizotróicas at Embrapa Agrobiologia (Brazil).
Unfortunately, we were informed by its curator that no
strains could be recovered from the old stocks (R. M.
Pitard, personal communication). Similar direct searches in
other collections were also in vain.

Most of the literature related to B. fluminensis goes back to
the 1960s or before (Amor Asunció et al., 1980; Becking,
1959, 1961, 1974; Döbereiner, 1961; Döbereiner & Ruschel,
1958; Hilger, 1965; Moore, 1963; Thompson & Skerman, 1979)
and the only evidence of publicly available strains we
could obtain is that displayed in StrainInfo.net (Dawydnt
et al., 2005). Strains LMG 2819, NCIMB 9881, NCIMB
9882, NCIMB 11068, NCIMB 11069 have already been
characterized by Oggerin et al. (2009) who found they
represented a distinct species of the genus Beijerinckia, B.
dobereinerae (type strain LMG 2819 = CECT 7311').

Types are of major importance in prokaryote taxonomy
(Tindall et al., 2010). In the case of a species or a
subspecies, the designation of type strains is regulated by
the International Code of Nomenclature of Bacteria
(Lapage et al., 1992) through Rules 18a–18g and 19.
Alterations to this Code have been made by the Inter-
national Committee on Systematic Bacteriology (ICSB)
and the International Committee on Systematics of
Prokaryotes (ICSP) and the changes proposed by the
Judicial Commission (De Vos & Trüper, 2000) were
accepted at one of its plenary sessions. In the following
paragraphs the new wording introduced by these recent
alterations is used, although the discussion could be also
sustained with that of the last printed version (Lapage
et al., 1992).

According to Rule 18b, if the author in the effective or valid
publication of the name of a species or subspecies definitely
designated a type strain, then this strain shall be accepted as
the type strain and may be referred to as the holotype
(Lapage et al., 1992; De Vos & Trüper, 2000). The valid
publication of the name B. fluminensis is that of Skerman
et al. (1980). This species has its entry on pages 262–263
and, after crediting Döbereiner & Ruschel (1958) for the
name, strain UQM 1685 is designated as the type (thus,
holotype). A book chapter by Thompson & Skerman
(1979) is cited as giving the description of the species. The
description referred to is the result of a large taxonomic
study conducted on free-living aerobic nitrogen-fixing
bacteria and is presented in the same book. In the case of B.
fluminensis it is consistent, but much more detailed, with
the description given in Döbereiner & Ruschel (1958). The
data were collected from ten strains considered to be
members of the species: one of them (strain F1–100 = WR-
162) was donated by J. Döbereiner who received it from
Y. T. Dommergues who isolated it from soil in the Congo.
The remaining nine strains were isolated from Australian
soils by J. P. Thompson. Another strain of B. fluminensis
(F1–60 from Brazilian soil) donated as a cotype by J.
Döbereiner was considered not typical of the species. The
authors of the book chapter concluded that strain WR-162
would be suitable for designation as a neotype strain if
authentic cotype strains were no longer extant. The term
cotype is not defined in the Bacteriological Code (Lapage
et al., 1992) or in its previous printed versions (Buchanan
et al., 1948, 1958; The Editorial Board of the Judicial
Commission of the International Committee on
Nomenclature of Bacteria, 1966), but it is used in various
papers dealing with bacterial taxonomy (Buchanan, 1962;
Sneath & Cowan, 1958; Sneath & Skerman, 1966) and
defined as ‘any specimen of the describing author’s
collection if he did not designate a holotype strain’
(Sneath & Cowan, 1958). Unfortunately, to the best of
our knowledge all of the strains used in the description by
Thompson & Skerman (1979) have been lost.

According to Rule 18c of the International Code of
Nomenclature of Bacteria (Lapage et al., 1992), if a suitable
replacement type strain or a neotype cannot be found or
proposed, respectively, within two years of the publication
of this Request for an Opinion, it is proposed that the

Table 1. Differential characteristics between strains designated as B. fluminensis and related strains

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
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<tbody>
<tr>
<td>Aerobic N₂ fixation</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Growth at 37 °C</td>
<td>+</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>Growth on peptone medium</td>
<td>+</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>Urease</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Assimilation of starch</td>
<td>+</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>Hydrolysis of aesculin</td>
<td>+</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>DNA G+C content (mol%)</td>
<td>60.7</td>
<td>56.2</td>
<td>61.0</td>
</tr>
</tbody>
</table>

†Thompson & Skerman, (1979).
Judicial Commission places the name *Beijerinckia fluminensis* on the list of rejected names.

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**References**


