

Identity of *Rhodospirillum centenum*, a unique photosynthetic bacterium

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Sequencing and analysis of the *R. centenum* genome are now in progress. Thus, it is timely to remind photosynthesis researchers of the history and identity of this extraordinary photosynthetic bacterium, especially because a misguided attempt to rename it has introduced some confusion in the literature.

R. centenum was first isolated in our laboratory from an enrichment culture inoculated with a sample collected at Thermopolis Hot Springs, Wyoming. In 1987, the type strain (designated Favinger/Gest), was deposited in the American Type Culture Collection (ATCC no. 43720) and two years later, we published a description of its general and unique properties (Favinger *et al.* 1989). Morphology, spectrum of photopigments, general physiology, and nutritional requirements placed the bacterium in the genus *Rhodospirillum*. We named the organism *Rhodospirillum centenum* in recognition of the fact that it was discovered during the 100th anniversary of the isolation of a pure culture of an anoxyphototroph, *Rhodospirillum rubrum*.

Our original report and subsequent papers (Stadtwald-Demchick *et al.* 1990; Ragatz *et al.* 1995) described the following unusual characteristics of *R. centenum*. (a) Under certain nutritional conditions, vegetative cells become converted to thick-walled cysts which are desiccation – and heat-resistant; (b) in contrast to virtually all other non-sulfur purple bacteria, the production of photopigments by *R. centenum* is not appreciably repressed by molecular oxygen; and (c) on agar, *R. centenum* swim cells (single polar flagellum) differentiate into swarm cells that are hyperflagellated with polar and lateral flagella. Colonies of swarm cells display authentic phototactic behavior, a property never observed before in anoxyphototrophs (Ragatz *et al.* 1995). The foregoing and additional studies of 13 strains by Nickens *et al.* (1996) defined the unique biotype of *R. centenum*.

In 1992, Kawasaki *et al.* published a paper with a title that could be interpreted as announcement of discovery of a previously unknown kind of photosynthetic bacterium, which they named *Rhodocista centenaria*. In fact, their isolate was clearly the same as the previously described *Rhodospirillum centenum*. We questioned the ethics of the name change proposal by Kawasaki *et al.* (1992) and published detailed reasons why the name *Rhodocista centenaria* should be rejected (Gest and Favinger 1998, 2001).

In order to meet arbitrary requirements of the Bacteriological Code, a so-called “validation” of the name *Rhodospirillum centenum sp nov* was effectively published in 1994 (Favinger *et al.* 1994). Nevertheless, a few taxonomists have persisted in using the

Rhodocista centenaria name despite inconsistencies with regulations of the International Code of Nomenclature of Bacteria (1990 Revision).

Some basic principles of nomenclature

Principle 1 of the 1990 Code states that: “The essential points in nomenclature are as follows. (1) Aim at stability of names; (2) avoid or reject names which may cause error or confusion; and (3) avoid the useless creation of names.” To the foregoing, it should be added that the reasons for creating a new genus must be compelling and well documented in order to conform to Principles 1, 4, 6, and 9 of the 1990 Code. We believe that most taxonomists would consider it especially frivolous to propose changing the genus name of a bacterium when there is only a single known species.

In an attempt to justify use of the name *Rhodocista centenaria*, the Chairman of the Judicial Commission of the International Committee on Systematic Bacteriology informed us privately that we had made an error in proposing the species name *centenium* because we did not follow Rule 52(2) of the Code, which states that ‘ordinal numbers cannot be used as specific epithets.’ From consultation with Professor Timothy Long (Indiana University Dept. of Classical Studies) we learned that *centenium* is not an ordinal number. The Latin *centenium* can be either a cardinal or multiplicative number, which is permitted by the Code. The information from Prof. Long was noted in Gest and Favinger 2001.

What does all this mean to experimental scientists?

We can take solace from comments of S. T. Cowan, a noted microbiologist and expert taxonomist. In 1970, he commented: “A hitherto undetected similarity exists between Lewis Carroll’s Alice and taxonomists, and bacterial taxonomists in particular...taxonomy can—and does—drive taxonomists to a topsy-turvy Wonderland.” He pointed out that elaborate rules have been stipulated in codes of nomenclature in the attempt to regulate the formation and use of names, “but these codes would delight the hearts of lawyers because they are too detailed and try to cater for all eventualities. In the event, they are confusing and self-contradicting...The Bacteriological Code should be simplified by deleting the Rules and Recommendations. It should consist of Principles, and discretion should be given to bacteriologists to apply them intelligently.” Those who have an interest (and great patience) in exploring the arbitrary rules of nomenclature and the Bacteriological Code are referred to his classic taxonomic dictionary (Cowan 1978).

The “take home” lesson

In 2001, B. J. Tindall [German Collection of Microorganisms and Cell Cultures (Braunschweig, Germany)] published a response to Gest and Favinger 2001 in which he cited minor technicalities of the Code in an attempt to defend use of the name *Rhodocista centenaria*. But his letter did not comment on the error made by the Judicial Commission Chairman (one of his close colleagues) on our valid use of the Latin word *centenium*. This can be taken as tacit admission that the word *centenium* is, in fact, etymologically correct.

Dr. Tindall ended his published letter as follows:

“While Gest and Favinger have presented a list of objections to using the name *Rhodocista centenaria* based on ‘inconsistencies’ with the Bacteriological Code, closer examination of their points indicates that there is a need to communicate the workings of the Bacteriological Code to a wider audience. In essence the problem boils down to a simple matter of taxonomic opinion, whether one considers *Rhodocista centenaria* to be the correct name of the taxon, or whether the correct

name of the taxon is *Rhodospirillum centenum*, with the associated debate whether one should define one genus or two, and that is something which the Bacteriological Code does not attempt to clarify. As Murray (1998) accurately points out, *the taxonomy which lasts 'is determined by general acceptance', and may that principle continue.*" [our italics].

Despite the International Code of Nomenclature of Bacteria and intricate procedural "rules," (Murray (1998) summarized major aspects of nomenclature decisions as follows: "There is no such thing as 'official sanction' by any body; since the science and understanding is continually evolving, it would seem undesirable. Names are now validated to the extent that the requirements of the Code are met and that the science is good. Even then, *what lasts is determined by general acceptance* [emphasis added] which is eventually summarized in compendia such as Bergey's Manual."

Measures of general acceptance

It is now clear that the name *Rhodospirillum centenum* has passed the acceptance criterion:

- a) Searches within article titles, keywords and abstracts from 1955 to 2006 on the Web of Science show the score:

<i>Rhodospirillum centenum</i>	54
<i>Rhodocista centenaria</i>	4
- b) A Google search on 12/14/06 showed 14,100 hits for *Rhodospirillum centenum* and 629 for *Rhodocista centenaria*.
- c) The authoritative text "Brock Biology of Microorganisms" by M.T. Madigan and J.M. Martinko (11th edition; 2006) has more extensive coverage of photosynthetic microorganisms than any other major microbiology text. There are citations to *Rhodospirillum centenum*, but none to *Rhodocista centenaria*.

Words of wisdom from an authority (see Cowan's 1978 Dictionary, p. 180)

"nomenclature: The scheme (believed to be a system) by which names are attached to objects, including micro-organisms. In the biological sciences there are Codes of Nomenclature which consist of Principles, Rules (Articles), and Recommendations but, since they cannot be enforced, they are no more than codes of good behaviour, or the ethics of nomenclature....The nomenclature of a group of organisms does not depend on the correct latinization of words, but on the thoroughness of the preceding work to define and classify them in their appropriate taxonomic position; when this has been done it is a relatively simple matter to apply the rules of nomenclature. Unfortunately, the rules seem to be unnecessarily involved, trying as they do, to anticipate every possible contingency."

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