

Felix D. Dakora
Samson B. M. Chimphango
Alex J. Valentine
Claudine Elmerich
William E. Newton
Editors



CURRENT PLANT SCIENCE AND BIOTECHNOLOGY IN AGRICULTURE 42

Biological Nitrogen Fixation: Towards Poverty Alleviation through Sustainable Agriculture

 Springer



INFECTION OF LEGUMES BY BETA-RHIZOBIA

E. K. James¹, G. N. Elliott¹, W.-M. Chen², C. Bontemps³, J. P. W. Young³,
S. M. de Faria⁴, F. B. dos Reis, Jr.⁵, M. F. Simon⁶, E. Gross⁷,
M. F. Loureiro⁸, V. M. Reis⁴, L. Perin⁴, R. M. Boddey⁴, C. E. Hughes⁶,
L. Moulin⁹, A. R. Prescott¹ and J. I. Sprent¹

¹College of Life Sciences, University of Dundee, Dundee DD1 5EH, UK;

²National Kaohsiung Marine University, Kaohsiung City 811, Taiwan;

³Department of Biology, University of York, York YO10 5YW, UK;

⁴EMBRAPA-Agrobiologia, km 47, Seropédica, 23851-970, RJ, Brazil;

⁵EMBRAPA-Cedrrados, Planaltina, Brasília, 73301-970, DF Brazil;

⁶Department of Plant Science, University of Oxford, Oxford, OXI 3RB, UK;

⁷Depto de Ciências Agrárias e Ambientais, UESC, km 16, Ilhéus 45662-000
BA, Brazil; ⁸Faculdade de Agronomia, UFMT, Cuiabá, 78060-900, MT,
Brazil; ⁹LSTM, IRD/CIRAD/INRA/AGROM/UMII, 34398 Montpellier,
France

It is now well established that many species and strains in the large genus *Burkholderia* have the ability to fix nitrogen in free-living culture, particularly those, such as *B. tropica*, *B. unamae* and *B. Vietnamensis*, that are associated with (mainly tropical) gramineous plants (Reis et al., 2004). Many *Burkholderia* strains have also been found within nodules of tropical legumes (Moulin et al., 2001), particularly in nodules on *Mimosa* spp. (Barrett and Parker, 2005, 2006; Chen et al., 2005a, b). Some of these strains have now been described as novel species of *Burkholderia*, including *B. mimosarum* and *B. nodosa* isolated from *Mimosa* spp. (Chen et al., 2006, 2007), *B. phymatium* isolated from *Machaerium lunatum* (Vandamme et al., 2002), and *B. tuberum* isolated from *Aspalathus carnosa* (Vandamme et al., 2002). These *Burkholderia* strains possess *nod* genes and, together with strains of a newly described species of *Ralstonia*, *R. taiwanensis* (now renamed *Cupriavidus taiwanensis* and also isolated from *Mimosa* nodules; Chen et al., 2001, 2003a; Verna et al., 2002), are collectively termed “beta-rhizobia”. Recent studies with strains from South America and Taiwan have confirmed that both *C. taiwanensis* and *Burkholderia* beta-rhizobia isolated from *Mimosa* spp. (including *B. mimosarum* and *B. nodosa*) are effective symbionts of plants in this genus (Chen et al., 2003b, 2005a, b). More surprising is the recent discovery that *B. phymatium* is also a highly effective symbiont of several *Mimosa* spp. and that it has a broader host range in the genus *Mimosa* than *C. taiwanensis* (Elliott et al., 2007).

So far, all attempts to nodulate *Machaerium* spp. with *B. phymatum* have been unsuccessful (Elliott et al., 2007) and, indeed, there has been very little evidence published of effective nodulation by beta-rhizobia of legumes in any genera other than *Mimosa*. However, we have recently obtained evidence for effective nodulation by *B. phymatum* STM815 of other Mimosoid genera, including *Acacia seyal*, *Leucaena leucocephala*, *Piptadenia gonoacantha*, *P. oblique*, *P. stipulacea* and *Pithecellobium dulce* (G.N. Elliott et al., unpublished data, 2006). Interestingly, although *Piptadenia* spp. are close taxonomically to *Mimosa* and, therefore, it might not be considered surprising that they would be nodulated by a *Mimosa* symbiont, the other species, in particular *P. dulce*, are not. These results suggest that beta-rhizobia are widespread within the sub-family Mimosoideae, but are not universally symbiotic within it. We are collaborating closely with legume taxonomists to determine the depth of the relationship between Mimosoid legumes and beta-rhizobia.

With regard to nodulation of papilionoid legumes by Beta-rhizobia, with the exception of the ineffective nodulation of the promiscuous legume, *Macroptilium atropurpureum*, by *B. phymatum* and *B. tuberum* (Moulin et al., 2001), to date there have been no published reports of a genuinely symbiotic relationship with plants in this sub-family. However, Elliott et al. (this volume) have recently reported effective nodulation of the South African endemic papilionoid legumes, *Cyclopia galioides*, *C. genistoides* and *C. pubescens*, by *B. tuberum* STM678.

STM678 appears to be unique among the known beta-rhizobia in having a *nodA* gene very separate in phylogenetic terms from *Mimosa*-nodulating bacteria. Further, it can nodulate neither any *Mimosa* spp. nor any *Aspalathus* spp., although its original host, *A. carnosa*, has not yet been tested. Regardless of whether it can or cannot nodulate *A. carnosa*, our very strong evidence that *B. tuberum* can nodulate *Cyclopia* spp. is the first confirmed report of nodulation by beta-rhizobia in the sub-family Papilionoideae.

References

- Barrett CF and Parker M (2005) Syst. Appl. Microbiol. 28, 57–65.
- Barrett CF and Parker M (2006) Appl. Environ. Microbiol. 72, 1198–1206.
- Chen W-M et al. (2001) Int. J. Syst. Evol. Microbiol. 51, 1729–1735.
- Chen W-M et al. (2003a) J. Bacteriol. 185, 7266–7272.
- Chen W-M et al. (2003b) Mol. Plant-Microbe Interact. 16, 1051–1061.
- Chen W-M et al. (2005a) Appl. Environ. Microbiol. 71, 7461–7471.
- Chen W-M et al. (2005b) New Phytol. 168, 661–675.
- Chen W-M et al. (2006) Int. J. Syst. Evol. Microbiol. 56, 1847–1851.
- Chen W-M et al. (2007) Int. J. Syst. Evol. Microbiol. 57, 1055–1059.
- Elliott GN et al. (2007) New Phytol. 173, 168–180.
- Moulin L et al. (2001) Nature 411, 948–950.
- Reis VM et al. (2004) Int. J. Syst. Evol. Microbiol. 54, 2155–2162.
- Vandamme P et al. (2002) Int. J. Syst. Evol. Microbiol. 25, 507–512.
- Verna et al. (2002) Can. J. Microbiol. 50, 313–322.