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Biological Nitrogen Fixation: Towards Poverty Alleviation through Sustainable Agriculture



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INFECTION OF LEGUMES BY BETA-RHIZOBIA

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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. phymatum* 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. phymatum* 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 *Minosa*. However, we have recently obtained evidence for effective nodulation by *B. phymatum* STM815 of other Mimosoid genera, including *Acacia seyal*, *Leucaena leu-cocephala*, *Piptadenia gonoacantha*, *P. oblique*, *P. stipulacea* and *Pitecellobium dulce* (G.N. Elliott et al., unpublished data, 2006).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 galoides*, *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.

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