**Supplementary Information**

# Bacteria associated with spores of arbuscular mycorrhizal fungi: a review.

Biology and Fertility of Soils

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**Supplementary Table:**

*Table S1*

**Table S1**. Occurrence and functional properties of bacteria (excluding known endobacteria *Ca*Gg and *Ca*Mg) associated with AMF spores, as detected by transmission electron microscopy (TEM), culture-dependent (CD) and culture-independent (CI) methods. The names of AMF taxa refer to the current names of each species (see INVAM 20024 and amf-phylogeny.com).

| **AMF species** | **Bacterial taxa (genus/species/strain)** | **Functional characterization** | **Decontamination procedure and molecular method** | **References** |
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| *Funneliformis caledonius* | Unidentified bacteria embedded in spore wall layers | - | TEM<br>Surface-decontaminated spores<br>*(20 min with 2% chloramine T + 0.02% streptomycin sulphate + trace of Teepol by the "filter paper sandwich method")* | Macdonald and Chandler 1981 |
| *Diversispora epigaea* | *Pseudomonas* sp.<br>*Corynebacterium* spp.<br>Lactobacillaceae | Spore germination increases | CD<br>Surface-decontaminated spores<br>*(5 min with sodium hypochlorite 0.05%)* | Mayo et al. 1986 |
| *Rhizophagus clarus* | Unidentified bacteria embedded in spore wall layers | - | TEM<br>Surface-decontaminated spores<br>*(SDS wash, multiple 20–30 min chloramine-T exposures)* | Walley and Germida 1995 |
| *Funneliformis mosseae* | Unidentified bacteria embedded in spore wall layers | - | TEM<br>Spore without surface decontamination | Filippi et al. 1998 |
| *R. clarus* NT4 | *Arthrobacter ilicis* WA2<br>*Bacillus alvei* TA8<br>*B. brevis* WA4<br>*B. chitinosporus* LA6a<br>*B. circulans* WA3<br>*B. firmus* YA5<br>*B. laterosporus* LA6b<br>*B. longisporus* LA4<br>*B. megaterium* LA1<br>*B. pabuli* LA3 | Variable effects on spore germination, depending on the strain | CD<br>Surface-decontaminated spores<br>*(60 min with chloramine-T and streptomycin)* | Xavier and Germida 2003 |
| *R. clarus* NT4 | *B. pabuli* LA3 | Increase in plant shoot N and P content | CD<br>Surface-decontaminated spores | Id. |

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| | | | *(60 min with chloramine-T + streptomycin)* | |
| *Funneliformis geosporus* and *Septoglomus constrictum* | *Cellvibrio, Chondromyces, Flexibacter, Lysobacter, Pseudomonas* | - | CI (PCR-DGGE) *(Spores rinsed 3 times in sterile water)* | Roesti et al. 2005 |
| *Funneliformis mosseae* | *Arthrobacter atrocyneus*<br>*A. globiformis*<br>*A. ilicis*<br>*A. oxydans*<br>*A. ramosus*<br>*Micrococcus halobius*<br>*M. kristinae*<br>*M. roseus*<br>*Aureobacterium saperdae*<br>*Curtobacterium citreum*<br>*Cellulomonas flavigena*<br>*Bacillus brevis*<br>*B. megaterium* GC subgroup A<br>*B. megaterium* GC subgroup B<br>*Agrobacterium radiobacter*<br>*Burkholderia picketti*<br>*Acidovorax delafieldii*<br>*Hydrogenophaga pseudoflava*<br>*Pseudomonas alcaligenes*<br>*P. chlororaphis*<br>*P. pseudoalcaligenes*<br>*P. putida biotype B*<br>*P. stutzeri*<br>*Stenotrophomonas maltophilia* | 10% of the isolates showed *in vitro* growth inhibition of the pathogen *Rhizoctonia solani* | CD<br>Surface-decontaminated spores<br>*(30 washes with sterile potassium phosphate)* | Bharadwaj et al. 2008 |
| *Rhizophagus intraradices* | *A. globiformis*<br>*A. ilicis*<br>*A. oxydans*<br>*A. ramosus*<br>*Micrococcus kristinae*<br>*M. luteus GC subgroup* C<br>*M. roseus*<br>*Clavibacter michiganense insidiosum*<br>*Cellulomonas flavigena*<br>*Corynebacterium bovis*<br>*Bacillus brevis*<br>*B. chitinosporus*<br>*B. subtilis*<br>*Agrobacterium radiobacter*<br>*Achromobacter piechaudii* | 40% of the isolates showed *in vitro* growth inhibition of the pathogen *Rhizoctonia solani* | CD<br>Surface-decontaminated spores<br>*(30 washes with sterile potassium phosphate)* | Id. |

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| | *A. xylosoxydans denitrificans*<br>*Janthinobacterium lividum*<br>*Pseudomonas alcaligenes*<br>*P. fluorescens biotype* F<br>*P. pseudoalcaligenes*<br>*P. putida biotype* A<br>*P. putida biotype* B<br>*P. syringae tagetes*<br>*Stenotrophomonas maltophilia* | | | |
| *R. intraradices* | *Stenotrophomonas maltophilia* FWC14<br>*Pseudomonas putida* biotype B FWC16<br>*P. fluorescens* biotype F FWC30<br>*Bacillus subtilis* FWC42<br>*P. putida* biotype A FWC70<br>*Arthrobacter ilicis*<br>*S. maltophilia* LWC2 | All the isolates showed *in vitro* growth inhibition of *Erwinia carotovora* var *carotovora* (*Ecc*), *P. infestans*, *Verticillium dahliae* and *Rhizoctonia solani* and production of siderophores | CD<br>Surface-decontaminated spores<br>*(30 washes with sterile potassium phosphate)* | Id. |
| *R. intraradices* | *P. putida* biotype A | Increased mycorrhizal colonization, number of primary and lateral roots, root and shoot length, and number of leaves in potato plants | CD<br>Surface-decontaminated spores<br>*(30 washes with sterile potassium phosphate)* | Id. |
| *Gigaspora margarita* | *Janthinobacterium lividum*<br>*Paenibacillus polymyxa* | P solubilisation and in vitro growth inhibition of the phytopathogens *Pythium ultimum*, *Fusarium oxysporum*, *Rhizoctonia solani* | CD<br>Surface-decontaminated spores<br>*(30 min with chloramine-T + streptomycin + chloramphenicol)* | Cruz et al. 2008 |
| *G. margarita* | *Amycolatopsis* sp.<br>*Azospirillum* sp.<br>*Flexibacter* sp.<br>*Polyangium* sp.<br>*Pseudonocardia* sp.<br>*Ramlibacter* sp.<br>*Rhizobium* sp.<br>*Rubrivirax* spp.<br>*Sphingomonas* sp.<br>*Streptomyces* sp. | - | CI (PCR-DGGE)<br>Bacteria colonizing spore surfaces<br>*(3 washes in water, followed by vortexing and analysis of the supernatant)* | Long et al. 2008 |
| *G. margarita* | *Bacillus* sp. BD-107<br>*Bacillus megaterium* EG24<br>*Bacillus subtilis* DF61<br>*Bacillus flexus* KSC_SF9c | *B. megaterium* increased AMF colonization. *B. megaterium* and *Bacillus* BD-107 | CD<br>Surface-decontaminated spores | Budi et al. 2012 |

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| | | increased shoot and dry weights of Neem plants | *(ethanol, chloramine-T, + streptomycin + gentamycin)* | |
| *G. margarita* | *Bacillus* sp.<br>*Bacillus thuringiensis*<br>*Paenibacillus rhizospherae* | Promotion of hyphal growth<br>P solubilisation<br>Variable antagonistic activity against phytopathogens | CD<br>Surface-decontaminated spores<br>*(ethanol chloramine-T + streptomycin + chloramphenicol)* | Cruz and Ishii 2011 |
| *Funneliformis coronatum* IMA3 | *Agrobacterium, Artrobacter, Sinorhizobium* | - | CI (PCR-DGGE)<br>Surface-decontaminated spores<br>*(15 washes by 1500 rpm vortexing in sterile physiological solution)* | Agnolucci et al. 2015 |
| *F. mosseae* AZ225C | *Acidobacteria, Agrobacterium, Artrobacter, Bacteroidetes, Duganella, Herbaspirillum, Ideonella, Rhizobium, Sinorhizobium, Streptomyces, Paenibacillus* | - | Id. | Id. |
| *F. mosseae* IMA1 | *Amycolatopsis, Bacteroidetes, Deltaproteobacteria* | - | Id. | Id. |
| *F. mosseae* IN101C | *Propionibacterium, Methylibium* | - | Id. | Id. |
| *R. intraradices* IMA5 | *Sinorhizobium, Pseudomonas, Streptomyces, Deltaproteobacteria* | - | Id. | Id. |
| *R. intraradices* IMA6 | *Artobacter, Bacillus, Herbaspirillum, Massilia, Pseudomonas, Rhizobium, Streptomyces* | - | Id. | Id. |
| *R. intraradices* IMA6 | *Arthrobacter phenanthrenivorans* N17<br>*Bacillus pumilus* CH10<br>*Fictibacillus barbaricus* TSA50<br>*Lysinibacillus fusiformis* CH19<br>*Nocardioides albus* N13<br>*Sinorhizobium meliloti* CH5, CH8, CH17, N23, N28, N29, TSA3, TSA26, TSA41 | 19 out of 374 isolates showed high PGP activities: production of siderophores and IAA, solubilisation of mineral and organic P | CD<br>Surface-decontaminated spores<br>*(15 washings by 1500 rpm vortexing in sterile physiological solution)* | Battini et al. 2016 |

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| | *Streptomyces* W43N, W64, W77, W94, W115 | | | |
| *F. caledonius*<br>*Racocetra alborosea*<br>*F. mosseae* | *Bacillus anthracis*<br>*B. aryabhattai*<br>*Lysinibacillus fusiformis* | | CD<br>Surface-decontaminated spores<br>*(chloramine-T + streptomycin)* | Selvakumar et al. 2016 |
| *G. margarita* | *Achromobacter*<br>*Aquitalea*<br>*Bosea*<br>*Burkholderia*<br>*Cupriavidus*<br>*Ensifer*<br>*Lysobacter*<br>*Mitsuaria*<br>*Proteus*<br>*Pseudomonas*<br>*Ralstonia*<br>*Rhizobium*<br>*Amycolatopsis*<br>*Arthrobacter*<br>*Curtobacterium*<br>*Gordonia*<br>*Leifsonia*<br>*Mycobacterium*<br>*Nocardia*<br>*Streptomyces*<br>*Bacillus*<br>*Brevibacillus*<br>*Paenibacillus* | P solubilisation, chitin degradation, stimulation of spore germination and hyphal growth, varying across the isolates | CD<br>Surface-decontaminated spores<br>*(washed 3 times in sterile NaCl)* | Long et al. 2017 |
| <u>*Gigaspora*</u><br><u>*Racocentra*</u><br><u>*Scutellospora*</u><br><u>*Acaulospora*</u><br><u>*Dentiscutata*</u> | *Burkholderia* species | | CI (Sanger sequencing)<br>Surface-decontaminated spores<br>*(chloramine-T +* $H_2O_2$*)* | Lastovetsky et al. 2018 |
| *Acaulospora*<br>*Ambispora*<br>*Diversispora*<br>*Funneliformis*<br>*Glomus*<br>*Paraglomus*<br>*Scutellospora* | *Acidobacteria,*<br>*Proteobacteria*<br>*Verrucomicrobia*<br>*Alphaproteobacteria*<br>*(Rhizobiales, Rhodospiralles)*<br>*Gammaproteobateria*<br>*(Escherichia, Aquicella, Pseudomonas)*<br>*Actinobacteria* | - | CI (Illumina MiSeq)<br>Surface-decontaminated spores<br>*(chloramine-T +* $H_2O_2$*)* | Lastovetsky et al. 2024 |
| Glomerales<br>*Paraglomerales*<br>*Archaeosporales*<br>*Diversisporales* | *Burkholderiales*<br>*Micromonosporales*<br>*Bacillales*<br>*Pseudomonadales*<br>*Flavobacteriales*<br>*Aeromonadales* | | CI (Illumina MiSeq)<br>Surface-decontaminated (*chloramine-T +* $H_2O_2$ *+ chlorphenamine)* | Chávez-González et al. 2024 |

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| | *Lactobacilliales*<br>*Streptomycetales*<br>*pasteurellales*<br>*Fusobacteriales*<br>*Corynebacteriales*<br>*Pseudonocardiales*<br>*Neisseriales*<br>*Rhizobiales*<br>*Xanthomonodales*<br>*Clostridiales*<br>*Bacteroidales*<br>*Caulobacterales* | | | |

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