

Part A. PERSONAL INFORMATION

CV date	01/08/2022
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First and Family name	María Socorro Mesa Banqueri		
Researcher codes	Open Researcher and Contributor ID (ORCID)	0000-0001-7285-3940	
	SCOPUS Author ID	35610827400	
	WoS Researcher ID	G-7775-2015	

A.1. Current position

Name of University/Institution	Estación Experimental del Zaidín/Spanish National Research Council (EEZ-CSIC)		
Department	Soil Microbiology and Symbiotic Systems		
Phone number	+34 958 181600 (Ext. 439088)	E-mail	socorro.mesa@eez.csic.es
Current position	Permanent Independent Scientific Researcher (Científica Titular)	From	08/10/2009
Key words	Clp chaperone-proteases, CRP/FNR transcription factors, denitrification, greenhouse gases, legume endosymbionts, microoxia, plant-bacteria-environment interaction, polyhydroxybutyrate		

A.2. Education

PhD, Licensed, Graduate	University	Year
PhD in Pharmacy	Granada	2001
Licensed in Pharmacy	Granada	1996

A.3. General indicators of quality of scientific production (*see instructions*)

4 “Quinquenios” (2001-2020). 3 “Sexenios” (2000-2017). 4 PhD Theses (Luzia Reutimann, 2010, <https://doi.org/10.3929/ethz-a-006199802>; Mariette Bonnet, 2011, <https://doi.org/10.3929/ethz-a-006688030>; Maria Jesús Torres Porras, 2013, <http://hdl.handle.net/10481/29948>; Andrea Jiménez Leiva, 2019, <http://hdl.handle.net/10481/59614>). 34 SCI articles (19 in Q1, 3 in D1). One non SCI article. 9 book chapters. 19 first- or last- author publications. Corresponding author of 14 publications. 949 citations. 93 citations/year (last 5 years). h-index=18 (source: Web of Knowledge).

Part B. CV SUMMARY (*max. 3500 characters, including spaces*)

My career started in 1997, when I joined the group of Prof. Eulogio J. Bedmar (EEZ-CSIC, Granada, Spain). In a competitive selection process, I obtained a 4-year FPU grant from the Ministry of Education and Science (Spain) to do my PhD, which I successfully completed in July 2001. During my PhD, I visited the laboratories of Prof. Michael Göttfert (TU-Dresden, Germany) in 1999, and of Prof. Hauke Hennecke (ETH-Zurich, Switzerland) in 2000. After the completion of my PhD Thesis, I returned as postdoctoral student to the Hennecke's group in October 2001 with financial support from a 2-year fellowship from ETH-Zurich. From 2004 to 2010, I got additional support from the ETH-Zurich: first as Postdoctoral assistant, and later in 2007, I became Group leader as part of Hennecke's laboratory. During this time, I co-led my first grant (Swiss National Foundation, 2006-2010) that allowed hiring two students: Luzia Reutimann and Mariette Bonnet, who both successfully passed their Doctoral examination in 2010 and 2011, respectively. In 2009, I received from the Swiss Society for Microbiology the "Encouragement Award" for young investigators.

In October 2009, I was appointed as permanent scientific researcher for the Spanish National Research Council, which I started in June 2010 at the Department of Soil Microbiology and Symbiotic Systems (EEZ-CSIC). Since then, my research has been supported by 9 grants (7 of them as Principal Investigator [PI]) and 2 technological contracts. In 2013, the Spanish Society for Nitrogen Fixation (SEFIN) otorgued me the "Antonio Palomares Award".

My research has mainly been focused on the denitrification and nitrogen fixation processes in the soybean endosymbiont and model organism *Bradyrhizobium diazoefficiens* (formerly *B. japonicum*). Specially, I have been involved in the identification and characterization of relevant genes, in the regulatory mechanisms underlying both pathways, as well as in the discovery of possible relationships between these two antagonistic processes, which both require low oxygen conditions (microoxia). My contributions have also helped to the better understanding of the molecular mechanism of FixK₂, a CRP/FNR-transcription factor which plays a key role for the microoxic, denitrifying and symbiotic lifestyles of *B. diazoefficiens*, with a special emphasis on the discovery of its posttranslational control by oxidation and proteolysis. The FixK₂ structure in complex with DNA, which is the first known



structure of oxygen-sensitive CRP/FNR-type proteins, serves as model to understand the molecular mechanism of other members of this family, such as the denitrification regulator NnrR. Lately, we unraveled the discriminatory determinants of protein-DNA interaction for FixK₂-mediated regulation in response to microoxia. Our research has also allowed the identification of a link between FixK₂ and the polyhydroxybutyrate metabolism in *B. diazoefficiens*, through the interplay with the global carbon metabolism regulator PhaR. The function and discovery of novel substrates for the Clp chaperone-proteases of *B. diazoefficiens* is another focus of our research.

In summary, my research records sum up to 34 SCI articles, 9 book chapters and 93 contributions to International Conferences. I have also participated in the supervision of 6 doctoral Theses (two ongoing), 9 Master Theses, 4 Grade Theses and 4 Semester Theses as well as in teaching activities at ETH-Zurich and the University of Granada.

Part C. RELEVANT MERITS (*sorted by typology*)

C.1. Publications (30 original articles, 4 reviews, one non SCI article, and 9 book chapters. A selection of those published since January, 1st, 2012 [23 publications] is indicated. Shown is also a brief summary of the 6 most related to the topic of the current research lines. The number of citations excludes self-citations. Asterisk denotes corresponding author.

Parejo, S., J. J. Cabrera, A. Jiménez-Leiva, L. Tomás-Gallardo, E. J. Bedmar, A. J. Gates, and **S. Mesa***. 2022. Fine-tuning modulation of oxidation-mediated posttranslational control of *Bradyrhizobium diazoefficiens* FixK₂ transcription factor. Int. J. Mol. Sci. 23:5117. DOI: 10.3390/ijms23095117. Impact factor (IF): 6.208 (Journal citation reports, JCR 2021). Citations: 0.

Cabrera, J. J., A. Jiménez-Leiva, L. Tomás-Gallardo, S. Parejo, S. Casado, M. J. Torres, E. J. Bedmar, M. J. Delgado, and **S. Mesa***. 2021. Dissection of FixK₂ protein-DNA interaction unveils new insights into *Bradyrhizobium diazoefficiens* lifestyles control. Environ. Microbiol. 23:6194-6209, DOI: 10.1111/1462-2920.15661. IF: 5.476. Citations: 0.

This study revealed the molecular determinants at protein and DNA levels for the control mediated by FixK₂ under microoxic conditions based on protein-DNA interaction studies, and activation of transcription of targets, both *in vitro* and *in vivo*. Interestingly, a single nucleotide at the DNA recognition site was crucial to change FixK₂ specificity, thus triggering direct transcription activation and expression of the *norCBQD* genes, coding for the denitrifying nitric oxide reductase, in response to microoxia, which are usually not controlled by FixK₂. So, this is an example how a single nucleotide exchange at the DNA recognition site changes specificity of a bacterial transcription factor in response to a certain signal.

Tortosa G*, P. J. Pacheco, A. Hidalgo-García, A. Granados, A. Delgado, **S. Mesa**, E. J. Bedmar, and M. J. Delgado*. 2020. Copper modulates nitrous oxide emissions from soybean root nodules. Environ. Exp. Botany 180:104262. DOI: 10.1016/j.envexpbot.2020.104262. IF: 5.545. Citations: 1

Jiménez-Leiva, A., J. J. Cabrera, E. Bueno, M. J. Torres, S. Salazar, E. J. Bedmar, M. J. Delgado*, and **S. Mesa***. Expanding the regulon of the *Bradyrhizobium diazoefficiens* NnrR transcription factor: New insights into the denitrification pathway Front. Microbiol. 10:1926. DOI: 10.3389/fmicb.2019.01926. IF: 4.236. Citations: 4

The transcriptional profiling of a *nnrR* mutant strain in comparison with the wild type both grown under denitrifying conditions allowed to define a group of novel targets for the NnrR regulator. In particular, the product of one its targets, the soluble cytochrome *CycA* resulted to be involved in the electron transfer to the nitrous oxide reductase enzyme, which mitigates the greenhouse gas nitrous oxide (N₂O). Further, we identified both *cycA* and *nnrR* genes as direct targets for the FixK₂ regulator.

Fernández, N., J. J. Cabrera, A. R. Varadarajan, S. Lutz, R. Ledermann, B. Roschitzki, L. Eberl, E. J. Bedmar, H. M. Fischer, G. Pessi, C. H. Ahrens*, **S. Mesa***. 2019. An integrated approach unveils new aspects of microoxia-mediated regulation in *B. diazoefficiens*. Front. Microbiol. 10:924. DOI: 10.3389/fmicb.2019.00924. IF: 4.236. Citations: 11

In this publication, an integrated OMICS approach (proteogenomics, comparative transcriptomics) was applied for the identification of genes/proteins involved in the adaptive response of rhizobia to the microoxic environment of the nodules using as model organism *B. diazoefficiens*. This study also unveiled a deletion of about 202 kb in the genome of the 110*spc4* strain which did not affect its symbiotic performance with different host plants. Further, we identified a set of protein/genes potentially subjected to posttranscriptional control, similar to that observed for *fixK₂*. This hypothesis was verified for several targets (HemA, HemB, and ClpA) by immunoblot analysis.



Torres, M. J., E. Bueno, A. Jiménez-Leiva, J. J. Cabrera, E. J. Bedmar, **S. Mesa**^{*}, and M. J. Delgado^{*}. 2017. FixK₂ is the main transcriptional activator of *Bradyrhizobium diazoefficiens* nosRZDYFLX genes in response to low oxygen. *Front. Microbiol.* 8:1621. DOI: 10.3389/fmicb.2017.01621. IF: 4.019. Citations: 8

Bueno, E., E. F. Robles, M. J. Torres, T. Krell, E. J. Bedmar, M. J. Delgado^{*}, and **S. Mesa**^{*}. 2017. Disparate response to microoxia and nitrogen oxides of the *Bradyrhizobium japonicum* napEDABC, nirK and norCBQD denitrification genes. *Nitric oxide Biol. Chem.* 68:137-149. DOI: 10.1016/j.niox.2017.02.002. IF: 4.367. Citations: 10

This study revealed that the napEDABC, nirK and norCBQD genes, implied in N₂O production in *B. japonicum*, are differentially controlled by the two CRP/FNR transcription factors FixK₂ and NnrR, in response to microoxia and nitrogen oxides, respectively. Further, by performing isothermal calorimetry under anoxic conditions, we identified the norCBQD gene cluster as the first direct target for NnrR.

Quelas, J. I., **S. Mesa**, D. Jendrossek, and A. R. Lodeiro^{*}. 2016. Regulation of polyhydroxybutyrate synthesis in the soil bacterium *Bradyrhizobium diazoefficiens*. *App. Env. Microbiol.* 82:4299-4308. DOI: 10.1128/AEM.00757-16. IF: 3.807. Citations: 33

Fernández N., J. J. Cabrera, S. Salazar, S. Parejo, M. C. Rodríguez, A. Lindemann, M. Bonnet, H. Hennecke, E. J. Bedmar, and **S. Mesa**^{*}. 2016. Molecular determinants of negative regulation of the *Bradyrhizobium diazoefficiens* transcription factor FixK₂. In F. González-Andrés, and E. James (ed.), *Biological Nitrogen Fixation and Beneficial Plant-Microbe Interactions*. Springer International Publishing Switzerland. DOI: 10.1007/978-3-319-32528-6. ISBN 978-3-319-32526-2

This book chapter revised the different mechanisms at transcriptional, posttranscriptional and posttranslational levels involved in the negative feedback of the FixK₂ transcription factor of *B. diazoefficiens* (Mesa et al., 2009. *Proc. Natl. Acad. Sci. USA.* 106:21860-21865; Reutimann et al., 2010. *Mol. Genet. Genomics* 284:25-32; Bonnet et al., 2013. *FEBS Lett.* 587:88-93). This study also analyzed the putative function of two regulatory genes: i.e., bll2109 and bll3466 in the self-repression of fixK₂ gene expression, which still remains enigmatic.

Bonnet, M., M. Kurz, **S. Mesa**, C. Briand, H. Hennecke, and M. G. Grütter^{*}. 2013. Structure of *Bradyrhizobium japonicum* transcription factor FixK₂ unveils sites of DNA binding and oxidation. *J. Biol. Chem.* 288:14238-14246. DOI: 10.1074/jbc.M113.465484. IF: 4.6. Citations: 12

The structure of the FixK₂-DNA complex is the first of oxygen-sensitive CRP/FNR-type proteins, and allowed to identify the different domains of FixK₂ (dimerization, DNA binding, cavity for a putative cofactor) as well as it unveiled the molecular basis for its posttranslational control by oxidation and proteolysis. The functional characterization of FixK₂ based on its structure, not only helps to understand its own molecular mechanism but it also can be applied as a model for other CRP/FNR family members. Thus, it expands the spectrum how the activity of these proteins can be modulated.

C.2. Research projects (12 I+D+i projects, 6 as PI. Shown are those, whose execution period is extended beyond January, 1st, 2012)

September 2021-August 2024: Cross-regulation insights of nitrogen fixation and denitrification in the soybean endosymbiont and model organism *Bradyrhizobium diazoefficiens* (PID2020-114330GB-I00). Ministerio de Ciencia e Innovación. Principal Investigator (PI): Dra. **M^a Socorro Mesa Banqueri** (CSIC). Funding: 133,100 EUR

January 2020-June 2023: “Estudio integrado de los mecanismos que afectan a la producción de gases de efecto invernadero por bacterias endosimbióticas de leguminosas” (P18-RT-140). “Programa de ayudas del PAIDI, Junta de Andalucía” (Spain). PIs: Dras. M^a Jesús Delgado Igeño/M^a **Socorro Mesa Banqueri** (CSIC). Funding: 106,224 EUR

January 2016-March 2021: Dissection of the regulatory network which controls *Bradyrhizobium diazoefficiens* FixK₂, an key transcription factor of genes for symbiosis (AGL2015-63651-P). Ministerio de Economía y Competitividad (MINECO), Spain. Extended by “Ayuda extraordinaria” (CSIC) (2019AEP193). PI: **Dra. M^a Socorro Mesa Banqueri** (CSIC). Funding: 150,236.45 EUR

May 2014-February 2019: “Emisión de óxido nitroso por suelos cultivados con leguminosas y hortalizas de interés agrícola” (P12-AGR-1968). “Proyecto Motriz de la Junta de Andalucía”. PI: **Prof. Eulogio J. Bedmar Gómez** (CSIC). Funding: 189,894 EUR. Participation: Investigator

January 2012-December 2015: Molecular mechanism of FixK₂: A key regulatory protein for the symbiosis *Rhizobium*-leguminous plants (AGL2011-23383). MINECO (Spain). PI: **Dra. M^a Socorro Mesa Banqueri** (CSIC). Funding: 121,000 EUR



Junio 2009-May 2012: Regulación por óxidos de nitrógeno y caracterización de un activador transcripcional de la desnitrificación en la bacteria simbiótica *Bradyrhizobium japonicum* (P07-CVI-3177). Junta de Andalucía (Spain). PI: **Prof. Eulogio J. Bedmar Gómez** (CSIC). Funding: 198,000 EUR. Participation: Investigator

C.3. Contracts, technological or transfer merits

January 2014-December 2015: Emisión de óxido nitroso por suelos cultivados con leguminosas y hortalizas de interés agrícola y biodiversidad bacteriana asociada a la fertilización nitrogenada (902022130007). Contrato dentro del convenio MINECO-CSIC Recupera 2020. PI: **Prof. Eulogio J. Bedmar Gómez** (CSIC). Funding: 212,072.52 EUR. Participation: Investigator

C.4. International Scientific Cooperation Projects (*4 projects since 2017, 2 as IP*)

January 2021-December 2022: “Estudio integrado de los factores que modulan el balance de polihidroxibutirato en *Bradyrhizobium diazoefficiens* para su uso como inoculante más competitivo en soja y como productor de bioplásticos” (COOPB20505). “Programa de Cooperación Científica para el Desarrollo” (I-COOP+), CSIC (Spain). PI: **Dra. M^a Socorro Mesa Banqueri** (CSIC). Funding: 23,980.72 EUR

January 2018-December 2019: “Mecanismos de regulación del balance de polihidroxibutirato en *Bradyrhizobium diazoefficiens* para su utilización como inoculante más efectivo en soja y como productor de plásticos biodegradables” (COOPB20268). I-COOP+, CSIC (Spain). PI: **Dra. M^a Socorro Mesa Banqueri** (CSIC). Funding: 18,223 EUR

C.5. Excellence networks

December 2015-November 2018: “Iniciativa española de investigación sobre eficiencia de N en agrosistemas” (AGL2015-68881-REDT). MINECO (Spain). PI: Prof. Miguel Quemada Sáenz Badillos (Polytechnic University of Madrid). Funding: 47,000 EUR. Participation: Investigator

C.6. Contributions to Conferences and Scientific Meetings

80 contributions to Conferences and Workshops 56 (international) since January, 1st 2012

C.7. Teaching activities (*since January, 1st, 2012*)

Academic committee member (since 2020), professorship member (since 2013), and coordinator (2020) of the subject “Biodiversidad Microbiana” of Master “Investigaciones y Avances en Microbiología”. University of Granada

Professorship member of the International Course on Edaphology and Plant Biology (AECID/CSIC), EEZ-CSIC, Granada (Spain). Since 2010

Supervision of 4 Bachelor Thesis (Raquel Terriente Hidalgo, 2022; Daniel Chaves Collantes, 2016; Sergio Parejo Treviño, 2015; M^a Carmen Rodríguez López, 2015) and 7 Master Thesis (Raquel A. Juárez Martos, 2022; Pedro J. Jabalera Ortiz, 2020; Belén Fernández Melero, 2018; Blanca de Alarcón Gómez, 2017; Sergio Parejo Treviño, 2016; M^a Carmen Rodríguez López, 2016; Sara Casado Ramos, 2015). University of Granada

C.8. Awards

2013 Antonio Palomares Award (SEFIN) for young investigators

2009 Swiss Society for Microbiology Encouragement Award for young investigators

C.9. Others (*a selection is indicated*)

Member of the local organizing Committee of the 20th International Conference on Nitrogen Fixation, Granada, Spain, September 2017

Member of several advisory panels of Doctoral Thesis and selection Proceedings of CSIC Technical and Scientific personnel

Referee of peer-review articles for scientific journals of Microbiology and Biochemistry