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AFFILIATIONS

Researcher. Center of Plant, Soil Interaction and Natural Resources Biotechnology BIOREN-UFRO, Universidad de La Frontera

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ACADEMIC DEGREES AND PROFESSIONAL STUDIES

2014 Doctor in Natural Resource Sciences. Facultad de Ingeniería Ciencias y Administración, Universidad de la Frontera, Temuco, Chile.

2007 Forest Engineer. Facultad de Ciencias Forestales, Universidad Austral de Chile, Valdivia, Chile.

DOCTORAL THESIS

2010-2014. "Formation, functioning and effect on some chemical and biochemical rhizosphere properties of cluster roots of a south American Proteaceae: *Embothrium coccineum*". Doctoral Program of Natural Resource Sciences. Universidad de la Frontera, Temuco, Chile. Supervisor: Prof. Fernando Borie.

POSTDOCTORAL RESEARCH

"Strategies for uptake and use of phosphorus in species of the Proteaceae family of southern Chile". Posdoctoral FONDECYT Project N°3150187 (announcement 2015) 2015-2017.

RESEARCH VISITS

August 2012 – April 2013. School of Biological Sciences. University of Western Australia, Perth, Australia. Prof. Hans Lambers. Scholarship CONICYT N° 75120038.

RESEARCH LINES

Ecophysiology of native plants

Plant nutrition

Plant-soil interactions

PUBLICATIONS

Zúñiga-Feest A., Sepúlveda F., **Delgado M.**, Valle S., Muñoz G., Pereira M., Reyes-Díaz M. 2020. Gevuina avellana and Lomatia dentata, two Proteaceae species from evergreen temperate forests of South America exhibit contrasting physiological responses under nutrient deprivation. Accepted in Plant and Soil.

Bertin-Benavides A., Bascuñán-Godoy L., Mardones C., **Delgado M.**, Burgos C.F., Ávila-Valdés A., Valdebenito F., Bravo S., Rubilar R., Hasbún R., Zúñiga-Feest A. 2020. Contrasting responses of cluster roots formation induced by Phosphorus and Nitrogen supply in Embothrium coccineum populations from different geographical origin. Accepted in Plant and Soil.

Delgado M., Valle S., Barra P.J., Reyes-Díaz M., Zúñiga-Feest A. 2019. New aluminum hyperaccumulator species of the Proteaceae family from southern South America. Plant and soil. Doi: 10.1007/s11104-019-04289-2

Barra P.J., Pontigo S., **Delgado M.**, Parra-Almuna L., Duran P., Valentine A.J., Jorquera M.A., Mora M de la L. 2019. Phosphobacteria inoculation enhances the benefit of P-fertilization on Lolium perenne in soils contrasting in P-availability. Soil Biology and Biochemistry. Doi: 10.1016/j.soilbio.2019.06.012

Delgado M., Valle S., Reyes-Díaz M., Barra P., Zúñiga-Feest A. 2018. Nutrient Use Efficiency of Southern South America Proteaceae Species. Are there General Patterns in the Proteaceae Family? Frontiers in Plant Science Doi: 10.3389/fpls.2018.00883

Delgado M., Zúñiga-Feest A., Piper, F. 2018. Does carbon storage confer waterlogging tolerance? Evidence from four evergreen species of a temperate rainforest. Australian Journal of Botany 66: 74-84. Doi: 10.1071/BT17104

Zúñiga-Feest, A., Muñoz, G., Bustos-Salazar, A., Ramírez, F., **Delgado, M.**, Valle, S., & Díaz, L. 2018. The nitrogen fixing specie Sophora cassioides (Fabaceae), is nutritionally favored and their rhizosphere bacteria modified when is co-cultivated with the cluster root forming Embothrium coccineum (Proteaceae). Journal of soil science and plant nutrition. Doi: 10.4067/S0718-95162018005001801

Zúñiga-Feest A, **Delgado M**, Bustos A, Ochoa V. 2015. The southern South American Proteaceae, *Embothrium coccineum* exhibits intraspecific variation in growth and cluster-root formation depending on climatic and edaphic origins. *Plant and Soil* 396:201–213 DOI 10.1007/s11104-015-2574-6

Delgado M, Zúñiga-Feest A., Borie F. 2015. Ecophysiological role of *Embothrium coccineum*, a Proteaceae species bearing cluster roots: increasing P availability in their rhizosphere. *Journal of soil science and plant nutrition*. 15 (2), 307-320.

Delgado M, Zúñiga-Feest A, Almonacid L, Lambers H, Borie F. 2015. Cluster roots of *Embothrium coccineum* (Proteaceae) affect enzyme activities and phosphorus lability in rhizosphere soil. *Plant and soil*. 395: 189 – 200 DOI 10.1007/s11104-015-2547-9

Delgado M, Suriyagoda L, Zúñiga-Feest A, Borie F, Lambers H. 2014. Divergent functioning of Proteaceae species: the South American *Embothrium coccineum* displays a combination of adaptive traits to survive in high-phosphorus soils. *Functional Ecology*, 28: 1356–1366. doi: 10.1111/1365-2435.12303.

Delgado M, Zúñiga-Feest A, Alvear M, Borie F. 2013. The effect of phosphorus on cluster-root formation and functioning of *Embothrium coccineum* (R. et J. Forst.). *Plant and soil*. 373: 765-773. doi: 10.1007/s11104-013-1829-3.

Zúñiga-Feest A, **Delgado M**, Alberdi M. (2010) The effect of phosphorus on growth and cluster-root formation in the Chilean Proteaceae: *Embothrium coccineum* (R. et J. Forst.). *Plant and soil*. 334:113–121. Doi: 10.1007/s11104-010-0419-x

Delgado M.; Cuba M.; P. Hechenleitner, O. Thiers (2008) Propagación vegetativa mediante esquejes de Taique (*Desfontainia spinosa*) y Tepa (*Laureliopsis philippiana*) con fines ornamentales. *Bosque*. 29(2):120-126.

CHAPTER BOOKS

Kleinert A, Benedito V, Morcillo R, Dames J, Cornejo-Rivas P, Zuniga-Feest A, **Delgado M**, Muñoz G (2018) Morphological and Symbiotic Root Modifications for Mineral Acquisition from Nutrient-Poor Soils. *Root Biology*. Springer. 85-142 p.

Zúñiga-Feest A., **Delgado M.** and Bustos A. 2014. Root Engineering: Basic and Applied Concepts (*Soil Biology*, Volume 40), Asunción Morte and Ajit Varma (Eds), Springer-Verlag, Berlin, Heidelberg. 353-367 p.

RESEARCH PROJECTS

Programa de cooperación internacional (PCI) de CONICYT convocatoria 2017 REDI170334. Apoyo a la formación de redes internacionales para investigadores(as) en etapa inicial. "Biofertilizer proteomics network, understanding the mechanisms of plant-bacteria interaction in acid soils through proteomic techniques" 2017-2019. Co-researcher.

Initiation FONDECYT project N° 11170368 (announcement 2017) "Revealing the mechanisms of aluminum accumulation and phosphorus solubilization by a species from temperate rainforest of Southern Chile: *Gevuina avellana*. Is this species playing a role in helping other neighboring plants? 2017 – 2020. Responsible researcher.

PRESENTATION AT NATIONAL/INTERNATIONAL CONGRESSES

Delgado M., Zúñiga-Feest A., Reyes-Díaz M., Barra P.J.; Jiménez J., Cáceres C., Valle S. Proteaceae species: Al hyperaccumulators and P solubilizing species. What do we have to learn from them?. 7th International Workshop in Advances in Science and Technology of Bioresources. 02 to 04 December, 2019. Universidad de La Frontera, Pucón, Chile.

Delgado M., Reyes-Díaz M., Ruiz S., Bertin A., Lambers H., Valle S., Zúñiga-Feest A. Evaluation of colonizing ability of five temperate rainforest proteaceae species growing in young volcanic substrate. Rhizosphere 5 conference. 7-11 July 2019. Saskatoon, Saskatchewan, Canada.

Barra P.J., **Delgado M.**, Duran P., Pontigo S., Parra L., Jorquera M., Mora M.L. Phosphobacteria and triple superphosphate downregulate phosphate transporter and superoxide dismutase gene expression in *Lolium perenne*. Rhizosphere 5 conference. 7-11 July 2019. Saskatoon, Saskatchewan, Canada.

Delgado M., Valle S., Barra P., Reyes-Díaz M., Zúñiga-Feest A. Prospecting for metal hyperaccumulation in the Proteaceae family from Southern South America. XIV summer colloquium on plant ecophysiology. 20-23 January 2019, Parque Katalapi, Puerto Montt, Chile.

Barra, PJ; Pontigo, S; Parra, L; **Delgado, M**; Jorquera, MA; Duran, Paola; Mora, M. de la L. Growth and molecular responses of ryegrass (*Lolium perenne*) grown in two Andisols to the inoculation with phosphobacteria along with phosphate fertilization. 6th Symposium on Phosphorus in Soils and Plants. 10 – 13 September 2018, Leuven, Belgium.

Delgado M., Zúñiga-Feest A., Piper, F. "Increased waterlogging tolerance in shade tolerant evergreen species compared to light-demanding counterparts". XII Summer Colloquium on Plant Ecophysiology. 19-21 January 2017- Parque Katalapi, Puerto Montt, Chile..

Delgado M., Valle, S., Zúñiga-Feest, A. Does phosphorus and nitrogen resorption during leaf senescence in southern South American Proteaceae depend on nutrient availability in the soil?. XVIII International Plant Nutrition Colloquium 19-24 august 2017. Copenhagen, Denmark

Delgado, M., Muñoz, G., Ávila, A., Ramírez, F and Zúñiga-Feest, A. Effect of root exudates of *Embothrium coccineum* on microbial abundance in two soils with contrasting nutritional characteristics. 3° Taller latinoamericano sobre Rizobacterias Promotoras del Crecimiento Vegetal - 1° Congreso Nacional de Fijación Biológica de Nitrógeno - 3° Simposio Internacional de Suelo-Planta-Microorganismos. Universidad de la Frontera, sede Pucón, Región de la Araucanía, Chile. Noviembre 28 a diciembre 02 del 2016.

Bertin, A., Valdebenito, F., Mardones, C., Bravo, S., **Delgado, M.**, Ávila, A., Zúñiga-Feest, A. Responses of two populations of *Embotrium coccineum* J.R. et g. Forster to limitation and co-limitation of phosphorus and nitrogen. XI Reunion de Biología Vegetal. Chillán, Chile. 28 noviembre – 1 de diciembre, 2016.

Renderos L., Zúñiga-Feest A., **Delgado M.**, Carú M., Orlando J. Las raíces proteoideas de *Embothrium coccineum* (Proteaceae) dan forma a la estructura metabólica de las comunidades bacterianas del suelo. XI Reunión de Biología Vegetal. Chillán, Chile. 28 noviembre – 1 de diciembre, 2016.

Renderos L., Zúñiga-Feest A., **Delgado M.**, Carú M., Orlando J. *Embothrium coccineum* (Proteaceae) influences the metabolic structure of the soil bacterial communities. 1^{er} Encuentro de jóvenes investigadores en ciencias suelo. Universidad Austral de Chile, Valdivia, Chile. 28 – 30 septiembre, 2016.

Delgado, M., Ávila, A., Ruiz, S., Zúñiga-Feest A., Valle S. Physiological ontogenetic variation of *Embothrium coccineum* growing in two soils with contrasting nutritional characteristics. 1^{er} Encuentro de jóvenes investigadores en ciencias suelo. Universidad Austral de Chile, Valdivia, Chile. 28 – 30 septiembre, 2016.

Sepúlveda F., **Delgado M.**, Zúñiga-Feest A. Effect of nitrogen and phosphorus efficiency on cluster roots formation and function of three south american proteaceae species growing in volcanic soils. 1^{er} Encuentro de jóvenes investigadores en ciencias suelo. Universidad Austral de Chile, Valdivia, Chile. 28 – 30 septiembre, 2016.

Zúñiga-Feest, A. **Delgado M.**, Avila A, Piper F, Valle S, Martínez O. 2016. Ecological significance of cluster roots functioning, a radicular adaptation of *Embothrium coccineum* (Proteaceae), on young volcanic soils in Southern South America. **VIII Southern Connection Congress**, Punta Arenas, Chile, January 18 – 23, 2016

Delgado M., Shane M., Valle, S., Ramirez, F., Zúñiga-Feest, A. 2015. Phosphorus resorption efficiency during leaf senescence in Chilean Proteaceae is modulated by acid phosphatase activity depending on the nutrients availability in the soil. X Reunión de Biología Vegetal, Valdivia, December 1-4, 2015

Delgado M., Zúñiga-Feest A, Almonacid L, Lambers H, Borie F. 2015. Cluster roots of *Embothrium coccineum* (Proteaceae) affect enzyme activities and phosphorus lability in rhizosphere soil. Rhizosphere 4, Maastricht, The Netherlands 21-25 june 2015

Zúñiga-Feest A., Valle S., Bustos A., **Delgado M.**, Piper F. Positive interactions between a P-mobilizing (*Embothrium coccineum*) and a N-fixing species (*Sophora microphylla*) on young volcanic soils in Southern South America. Rhizosphere 4, Maastricht, The Netherlands 21-25 june 2015

Vicencio I., Fernández R., Shane M., **Delgado M.**, Zúñiga-Feest A. Actividad de fosfoenolpiruvato carboxilasa (PEPC) en raíces proteoideas de dos Proteaceae que difieren en su biomasa de raíces: *Embothrium coccineum* (Notro) vs. *Gevuina avellana* (Avellano). LVII Reunión anual de la sociedad de Biología de Chile, Puerto Varas, Chile, November 25-27, 2014

Zúñiga-Feest A., Avila A., **Delgado M.**, Lambers H. "Functioning of cluster roots from southern South American Proteaceae on young volcanic soils". XIII Mediterranean ecosystems international conference: "Crossing Boundaries across Disciplines and Scales", Olmué, Chile, October 4 -9, 2014

Delgado M., Suriyagoda L., Zúñiga-Feest A, Borie F., Lambers H. *Embothrium coccineum*, a South American Proteaceae species, displays a novel combination of adaptive traits playing a key role in survival at high phosphorus levels. "4th International Workshop, Advances in Science and Technology of Bioresources", Pucón, Chile, December 4-6, 2013

Delgado M., Zúñiga-Feest A, Borie F. Cluster roots of *Gevuina avellana* (South American Proteaceae) affect chemical properties, biomass and microbial activity associated to rhizosphere soil. Combio 2013, Perth, Australia, September 29-October 3, 2013

Delgado M., Zúñiga-Feest A., Borie F., Shane M.W., Lambers H. *Embothrium coccineum* (R. et J. Forst.) regulates its phosphorus (P) uptake at high P levels, avoiding severe symptoms of P toxicity. XIV Congresso Brasileiro de Fisiologia Vegetal, Poços de Caldas, Brasil, September 9-12, 2013

Delgado M., Zúñiga-Feest A, Alvear M, Borie F. The effect of phosphorus on cluster-root formation and functioning of *Embothrium coccineum* (R. et J. Forst.). Japan-Australia Symposium on Plant Sciences for Agriculture IV. Murdoch University, Perth, Australia, December 11-12, 2012

Delgado M., Zúñiga-Feest A, Borie F. Phosphorus in seeds of *Embothrium coccineum* (R. et J. Forst.) growing in soils from different locations. 3th International Workshop 2011 Universidad de La Frontera, Pucón, Chile, November 2-4, 2011

Delgado M., Zúñiga-Feest A, Borie F. Seasonal variation in acid phosphatase in root exudates *Embothrium coccineum*. **Rhizosphere 3 International Conference 2011** Burswood Convention Centre Perth, Western Australia September, 25 – 30, 2011

Delgado M., Zúñiga-Feest A, Morales A, Borie F 2010. Acid phosphatase and organic acid exudation by cluster roots of *Embothrium coccineum* (R. et J. Forst.) seedlings. 2nd International Workshop. Advances in Science and Technology of Natural Resources, Universidad de La Frontera, Pucón, Chile, October 27-29, 2010

Bustos AL, Zúñiga-Feest A, **Delgado M.**, Ochoa-Hinrichsen V. 2010. Crecimiento y desarrollo de raíces proteoideas en plántulas de *Embothrium coccineum* de procedencias contrastantes. X Congreso Latinoamericano de Botánica, Chile, La Serena, Chile 4 - 10 octubre 2010.

Zúñiga-Feest A., **Delgado M.**, Reyes-Díaz y Ochoa V. 2009. Variación estacional del crecimiento, contenido interno de fósforo y exudación de ácidos en raíces proteoideas en la especie pionera, *Embothrium coccineum* (r. et j. forst.) proteaceae. XI Congreso Nacional de la Ciencia del Suelo. Universidad de Concepción, Campus Chillán. Chile 24- 26 agosto 2009.

Delgado, M., Zúñiga-Feest, A, Alberdi, M. Efecto del anegamiento y la sequía en la sobrevivencia, crecimiento y eficiencia fotoquímica del PSII en especies del bosque templado. XX Reunión Anual de la Sociedad de Botánica de Chile, Olmué, septiembre 2008.

Zúñiga-Feest, A, **Delgado, M.**, Zúñiga R., Morales V, Alberdi, M. Efecto del riego sin fósforo y/o con aluminio en el crecimiento y formación de raíces proteoideas (RP) en plántulas de *Embothrium coccineum* (Proteaceae). XX Reunión Anual de la Sociedad de Botánica de Chile, Olmué, septiembre 2008.

Vera A., Zúñiga-Feest, A, **Delgado, M.**, Saldaña A., Alberdi, M., Donoso P. Variación ontogénica de la sombratolerancia en dos especies siempreverdes: *Aextoxicon punctatum* (olivillo) y *Laureliopsis philippiana* (tepa). XX Reunión Anual de la Sociedad de Botánica de Chile, Olmué, septiembre 2008.

Zúñiga-Feest A, Y Quitral, **Delgado M.**, P Vásquez, M Alberdi. "Mecanismos fisiológicos implicados en la tolerancia al anegamiento en dos especies arbóreas siempreverdes con tolerancia contrastante: *Nothofagus nitida* y *N.dombeyi*. XIX Reunión de la Sociedad de Botánica de Chile, 2007.

Delgado M., Hechenleitner P. Follaje Ornamental Nativo. Desarrollo sustentable, un desafío pendiente. Simposio de Horticultura Ornamental. Universidad Austral de Chile, Valdivia. 29 y 30 de septiembre de 2005.

ACADEMIC ACTIVITIES

Collaborating profesor in theoretical-practical classes of the Physiology course (ICQ-353) of the Biochemistry career. Universidad de la Frontera. Second semester 2018-2019.

Adjunct Professor Ad-honorem, Instituto de Ciencias Ambientales y Evolutivas de la Facultad de Ciencias, Universidad Austral de Chile. Participation in practical classes of the course of plant physiology and biochemistry (CAEV 138), 2015 -2016-2017

SUPERVISOR OF UNDERGRADUATE THESIS

Jordan Jiménez. Título: Respuestas morfológicas, químicas y moleculares a la toxicidad por aluminio y bajo abastecimiento de fósforo de una especie del bosque templado lluvioso del sur de Chile *Gevuina avellana* Mol. Tesis para optar al grado de Bioquímico. Universidad de la Frontera, Temuco, Chile. Agosto 2019