

Table of contents

Preface	2
Chapter 1	9
Introduction	9
1.1 Soil free-living and root-associated fungi in the temperate forests: an overview 10	
1.2 The role of saprotrophic and mycorrhizal fungi in the ecosystem	15
1.3 The importance of ectomycorrhizal functional traits in the biodiversity-ecosystem functioning relationships	21
1.4 The assembly of root-associated fungal communities	25
1.5 A relevant large-scale and long-term experimental platform in the functional biodiversity research: The Biodiversity Exploratories	26
Chapter 2	29
The goals, hypotheses and structure of the work	29
2.1 Section I Characterization of root-associated fungal communities across environmental gradients -uncovering the relative contribution of deterministic processes to community assembly	32
2.1.1 Assembly processes of trophic guilds in the root mycobiome of temperate forests	33
2.1.2 Soil and root nutrient chemistry structure root-associated fungal assemblages in temperate forests	34
2.1.3 Phylogenetic and functional traits of ectomycorrhizal assemblages in topsoil from different biogeographic regions and forest types	35
2.1.4 Divergent habitat filtering of root and soil fungal communities in temperate beech forests	35
2.1.5 Synopsis and conclusions (Section I)	36
Environmental filtering dominates the root-associated fungal community assembly processes	37
Climate, soil properties, root resource traits, and forest management are the environmental filters of root-associated fungal community assembly	39
Environmental drivers are guild-specific	40

2.2	Section II Estimation of ectomycorrhizal functional traits from mycelium infrared spectral traits	41
2.2.1	Ectomycorrhizal fungal identification in environmental samples of tree roots by Fourier-transform infrared (FTIR) spectroscopy	42
2.2.2	Leaf litter species identity influences the biochemical composition of ectomycorrhizal fungi	43
2.2.3	Synopsis and conclusions (Section II)	44
2.3	Section III Contribution of free-living and root-associated soil fungi to ecosystem services: soil C sequestration, N cycling, and primary production	46
2.3.1	Ectomycorrhizal and saprotrophic soil fungal biomass are driven by different factors and vary among broadleaf and coniferous temperate forests addresses	47
2.3.2	Impact of ectomycorrhizal community composition and soil treatment on inorganic nitrogen nutrition and performance of beech (<i>Fagus sylvatica</i> L.) provenances	49
2.3.3	Nitrogen acquisition in ectomycorrhizal symbiosis	49
2.3.4	Impacts of earthworms on nitrogen acquisition from leaf litter by arbuscular mycorrhizal ash and ectomycorrhizal beech trees	50
2.3.5	Synopsis and conclusions (Section III)	50
Chapter 3		55
	Assembly processes of trophic guilds in the root mycobiome of temperate forests	55
	published as:	55
	Schröter*, Kristina, Bernd Wemheuer*, Rodica Pena*, Ingo Schöning, Martin Ehbrecht, Peter Schall, Christian Ammer, Rolf Daniel, and Andrea Polle. 2018. 'Assembly Processes of Trophic Guilds in the Root Mycobiome of Temperate Forests'. <i>Molecular Ecology</i> 28(2):348-364.	55
Chapter 4		56
	Soil and root nutrient chemistry structure root-associated fungal assemblages in temperate forests	56
	published as:	56
	Dung Quang Nguyen, Dominik Schneider, Nicole Brinkmann, Bin Song, Dennis Janz, Ingo Schöning, Rolf Daniel, Rodica Pena*, Andrea Polle. 2020. 'Soil and root	

nutrient chemistry structure root-associated fungal assemblages in temperate forests'.
Environmental Microbiology: nn. <https://doi.org/10.1111/1462-2920.15037>. 56

Chapter 5 57

Phylogenetic and functional traits of ectomycorrhizal assemblages in top soil from different biogeographic regions and forest types 57

published as: 57

Pena, Rodica, Christa Lang, Gertrud Lohaus, Steffen Boch, Peter Schall, Ingo Schöning, Christian Ammer, Markus Fischer, and Andrea Polle. 2017. 'Phylogenetic and Functional Traits of Ectomycorrhizal Assemblages in Top Soil from Different Biogeographic Regions and Forest Types'. *Mycorrhiza* 27 (3): 233–45. 57

Chapter 6 58

Divergent habitat filtering of root and soil fungal communities in temperate beech forests 58

published as: 58

Goldmann, Kezia, Kristina Schröter, Rodica Pena, Ingo Schöning, Marion Schruppf, François Buscot, Andrea Polle, and Tesfaye Wubet. 2016. 'Divergent Habitat Filtering of Root and Soil Fungal Communities in Temperate Beech Forests'. *Scientific Reports* 6 : 31439. 58

Chapter 7 59

Ectomycorrhizal fungal identification in environmental samples of tree roots by Fourier-transform infrared (FTIR) spectroscopy 59

published as: 59

Pena, Rodica, Christa Lang, Annette Naumann, and Andrea Polle. 2014. 'Ectomycorrhizal Identification in Environmental Samples of Tree Roots by Fourier-Transform Infrared (FTIR) Spectroscopy'. *Frontiers in Plant Science* 5: 229. 59

Chapter 8 60

Leaf litter species identity influences biochemical composition of ectomycorrhizal fungi 60

published as: 60

Yang, Nan, Olaf Butenschoen, Rumana Rana, Lars Köhler, Dietrich Hertel, Christoph Leuschner, Stefan Scheu, Andrea Polle, and Rodica Pena. 2019. 'Leaf Litter Species Identity Influences Biochemical Composition of Ectomycorrhizal Fungi'. *Mycorrhiza* 29 (2): 85–96. 60

Chapter 9 61

Ectomycorrhizal and saprotrophic soil fungal biomass are driven by different factors and vary among broadleaf and coniferous temperate forests addresses ...	61
published as:	61
Awad, Abdallah, Majcherczyk A, Schall P, Schroeter K, Schoening I, Schrupf M, Ehbrecht M, Boch S, Kahl T, Bauhus J, Seidel D, Ammer C, Fischer M, Kües U, Pena R. 2019. ‘Ectomycorrhizal and Saprotrophic Soil Fungal Biomass Are Driven by Different Factors and Vary among Broadleaf and Coniferous Temperate Forests’. <i>Soil Biology and Biochemistry</i> 131: 9–18.....	61
Chapter 10	62
Nitrogen acquisition in ectomycorrhizal symbiosis	62
published as:	62
Pena, Rodica. 2016. ‘Nitrogen Acquisition in Ectomycorrhizal Symbiosis’. In <i>Molecular Mycorrhizal Symbiosis</i> , 179–96. John Wiley & Sons, Ltd.....	62
Chapter 11	63
Impact of ectomycorrhizal community composition and soil treatment on inorganic nitrogen nutrition and performance of beech (<i>Fagus sylvatica</i> L.) provenances	63
published as:	63
Nguyen, Dung Quang, Rodica Pena, and Andrea Polle. 2017. ‘Impact of Ectomycorrhizal Community Composition and Soil Treatment on Inorganic Nitrogen Nutrition and Performance of Beech (<i>Fagus Sylvatica</i> L.) Provenances’. <i>Trees</i> 31 (6): 1891–1904.	63
Chapter 12	64
Impacts of earthworms on nitrogen acquisition from leaf litter by arbuscular mycorrhizal ash and ectomycorrhizal beech trees	64
published as:	64
Yang, Nan, Klaus Schützenmeister, Diana Grubert, Hermann F. Jungkunst, Dirk Gansert, Stefan Scheu, Andrea Polle, and Rodica Pena. 2015. ‘Impacts of Earthworms on Nitrogen Acquisition from Leaf Litter by Arbuscular Mycorrhizal Ash and Ectomycorrhizal Beech Trees’. <i>Environmental and Experimental Botany</i> 120: 1–7.	64
Conclusions.....	65
Acknowledgements	69
References.....	70