

Contents

Part A Introduction to the European Transect

1	The Carbon and Nitrogen Cycle of Forest Ecosystems	
E.-D. Schulze	3	
1.1	Introduction	3
1.2	The Carbon and Nitrogen Cycles	3
1.3	The NIPHYS/CANIF Project	8
1.4	Experimental Design	10
1.5	Conclusions	11
References	11	
2	Experimental Sites in the NIPHYS/CANIF Project	
T. Persson, H. van Oene, A.F. Harrison, P.S. Karlsson, G.A. Bauer, J. Cerny, M.-M. Coûteaux, E. Dambrine, P. Höglberg, A. Kjøller, G. Matteucci, A. Rudebeck, E.-D. Schulze, and T. Paces	14	
2.1	Site Description. The NIPHYS/CANIF Transect	14
2.2	Soil Characteristics	26
2.3	Ecosystem C and N Pools	36
2.4	Database	39
2.5	Conclusions	42
References	46	

Part B Plant-Related Processes

3	Tree Biomass, Growth and Nutrient Pools	
G. Scarascia-Mugnozza, G.A. Bauer, H. Persson, G. Matteucci, and A. Masci	49	
3.1	Introduction	49
3.2	Experimental Background	50
3.3	Biomass	52
3.4	Forest Productivity	54
3.5	Carbon and Nutrient Pools	56
3.6	Allometric and Functional Relations	58
3.7	Conclusions	60
References	62	

4	Linking Plant Nutrition and Ecosystem Processes	
G.A. Bauer, H. Persson, T. Persson, M. Mund, M. Hein, E. Kummetz, G. Matteucci, H. van Oene, G. Scarascia-Mugnozza, and E.-D. Schulze	63	
4.1 Introduction	63	
4.2 Experimental Approach	64	
4.3 Nutrient Concentrations	65	
4.4 Nutrient Contents	73	
4.5 Nitrogen Partitioning in Different Tree Compartments	82	
4.6 Ecosystem C and N Pools	88	
4.7 Conclusions	95	
References	95	
5	Root Growth and Response to Nitrogen	
C. Stober, E. George, and H. Persson	99	
5.1 Introduction	99	
5.2 Approaches to the Study of Root Growth	100	
5.3 Root Growth Measurements Obtained by Soil Coring	105	
5.4 Root Growth Measurements Obtained by Root Windows	107	
5.5 Root Growth Measurements Obtained by In-Growth Cores	113	
5.6 Root Growth at Different European Forest Sites	116	
5.7 Conclusions	118	
References	119	
6	Nitrogen Uptake Processes in Roots and Mycorrhizas	
T. Wallenda, C. Stober, L. Högbom, H. Schinkel, E. George, P. Höglberg, and D.J. Read	122	
6.1 Introduction	122	
6.2 Approaches to Study Different Aspects of the N Uptake Process	123	
6.3 Studies with Excised Roots and Mycorrhizas	125	
6.4 Field-Based Experiments	135	
6.5 Conclusions	139	
References	141	
7	The Fate of ^{15}N-Labelled Nitrogen Inputs to Coniferous and Broadleaf Forests	
G. Gebauer, B. Zeller, G. Schmidt, C. May, N. Buchmann, M. Colin-Belgrand, E. Dambrine, F. Martin, E.-D. Schulze, and P. Bottner	144	
7.1 Introduction	144	
7.2 Sites of Investigation	145	
7.3 Approaches to Study the Fate of ^{15}N -Labelled Nitrogen Inputs	147	
7.4 N Release and Tree Uptake from ^{15}N -Labelled Decomposing Litter in a Beech Forest in Aubure	150	
7.5 Ecosystem Partitioning of ^{15}N -Labelled Ammonium and Nitrate on the Sites in the Fichtelgebirge and Steigerwald	157	
7.6 Conclusions	166	
References	168	

8	Canopy Uptake and Utilization of Atmospheric Pollutant Nitrogen	
	A.F. Harrison, E.-D. Schulze, G. Gebauer, and G. Bruckner	171
8.1	Introduction	171
8.2	Atmospheric Nitrogen Pollutants	172
8.3	Pathways for Canopy Uptake of Nitrogen	174
8.4	Approaches to the Determination of Canopy Uptake of Nitrogen	175
8.5	Review of Research	177
8.6	Role in the Critical Load	182
8.7	Ecophysiological Consequences of Canopy N Uptake	182
8.8	Conclusions	183
8.9	Way Forward	183
8.10	Policy Implications	184
	References	184
9	Biotic and Abiotic Controls Over Ecosystem Cycling of Stable Natural Nitrogen, Carbon and Sulphur Isotopes	
	G.A. Bauer, G. Gebauer, A.F. Harrison, P. Höglberg, L. Högbom, H. Schinkel, A.F.S. Taylor, M. Novak, F. Buzek, D. Harkness, T. Persson, and E.-D. Schulze	189
9.1	Introduction	189
9.2	Approaches to the Study of Stable Isotopes in the Field	189
9.3	$\delta^{15}\text{N}$ of Ammonium and Nitrate in Wet Deposition	191
9.4	Stable Isotope Signatures in Different Ecosystem Compartments	197
9.5	$\delta^{15}\text{N}$ Signatures as Indicators of N Saturation in Forest Ecosystems	207
9.6	Conclusions	211
	References	213
Part C Heterotrophic Processes		
10	Soil Respiration in Beech and Spruce Forests in Europe: Trends, Controlling Factors, Annual Budgets and Implications for the Ecosystem Carbon Balance	
	G. Matteucci, S. Dore, S. Stivalotto, C. Rebmann, and N. Buchmann ...	217
10.1	Introduction	217
10.2	Approaches to Measuring Soil Respiration	218
10.3	Daily and Seasonal Trends in Soil Respiration and Climatic Variables	221
10.4	Factors Controlling Soil Respiration	226
10.5	Comparison of Chamber Measurements with the Eddy Covariance Measurements Below the Canopy	230
10.6	Annual Budgets of Soil Respiration	231
10.7	Conclusions	233
	References	234

11	Annual Carbon and Nitrogen Fluxes in Soils Along the European Forest Transect, Determined Using the ^{14}C-Bomb	
	A.F. Harrison, D.D. Harkness, A.P. Rowland, J.S. Garnett, and P.J. Bacon	237
11.1	Introduction	237
11.2	Forests, Sampling Procedure and Analysis	239
11.3	Model Description	241
11.4	Estimations of C and N Pools and Fluxes	242
11.5	Pools and Distribution of Carbon and Nitrogen in Soil Profiles	243
11.6	Variations in the Carbon Age and Mean Residence Times (MRTs)	246
11.7	Annual Carbon and Nitrogen Fluxes	248
11.8	General Discussion	252
11.9	Conclusions	253
	References	255
12	Carbon Mineralisation in European Forest Soils	
	T. Persson, P.S. Karlsson, U. Seyferth, R.M. Sjöberg, and A. Rudebeck	257
12.1	Introduction	257
12.2	Experimental Background	257
12.3	C Mineralisation in the North-South Transect	260
12.4	Long-Term Fertilisation Experiments	269
12.5	Mean Residence Time	271
12.6	Comparison of Intact and Sieved Soil Cores	271
12.7	Conclusions	274
	References	275
13	Litter Decomposition	
	M.F. Cotrufo, M. Miller, and B. Zeller	276
13.1	Introduction	276
13.2	Factors Affecting the Decomposition Process	276
13.3	Enzymatic Activity	278
13.4	Nitrogen Dynamics in Decomposing Litter	279
13.5	Decomposition Studies in Europe: from DECO, VAMOS, MICS to CANIF	280
13.6	Decomposition Studies Within a Latitudinal Transect of European Beech Forests	281
13.7	Conclusions	292
	References	293
14	Soil Nitrogen Turnover – Mineralisation, Nitrification and Denitrification in European Forest Soils	
	T. Persson, A. Rudebeck, J.H. Jussy, M. Colin-Belgrand, A. Priemé, E. Dambrine, P.S. Karlsson, and R.M. Sjöberg	297
14.1	Background and Aim of the Study	297
14.2	Methods Used to Study N Turnover	299

14.3	Net N Mineralisation Based on Laboratory Studies	304
14.4	Net Nitrification Based on Laboratory Studies	307
14.5	Manipulation of pH, N Availability and Nitrifier Density in the Laboratory	312
14.6	Autotrophic Versus Heterotrophic Nitrification	314
14.7	Net N Mineralisation and Nitrification in N-Fertilisation Experiments	316
14.8	Comparison of N Turnover in Similar Soils at Different Climate	318
14.9	Comparison of N Turnover in Sieved and Intact Soil Cores	319
14.10	In Situ Mineralisation Studies at Aubure	321
14.11	Comparison of in Situ and Laboratory-Based Mineralisation Studies	323
14.12	Denitrification	324
14.13	Final Discussion	326
14.14	Conclusions	328
	References	329
15	Nitrogen and Carbon Interactions of Forest Soil Water	
	B.R. Andersen and P. Gundersen	332
15.1	Introduction	332
15.2	Approaches to Studying the Forest Soil Waters	333
15.3	Soil Water Concentrations of Nitrogen and Carbon	334
15.4	Correlation Between Dissolved Organic Nitrogen and Carbon	337
15.5	Conclusions	340
	References	340

Part D Diversity-Related Processes

16	Fungal Diversity in Ectomycorrhizal Communities of Norway Spruce [<i>Picea abies</i> (L.) Karst.] and Beech (<i>Fagus sylvatica</i> L.) Along North-South Transects in Europe	
	A.F.S. Taylor, F. Martin, and D.J. Read	343
16.1	Introduction	343
16.2	Analysis of Ectomycorrhizal Community Structure and Diversity	344
16.3	ECM Communities of Spruce Forests	347
16.4	ECM Communities of Beech Forests	353
16.5	Genetic Diversity Within a Population of <i>Laccaria amethystina</i>	353
16.6	Isolation and Growth of ECM Fungal Isolates on an Organic N Source	357
16.7	Comparative Evaluation of Ectomycorrhizal Diversity	358
16.8	Conclusions	362
	References	363
17	Diversity and Role of the Decomposer Food Web	
	V. Wolters, A. Pflug, A.R. Taylor, and D. Schroeter	366

17.1	Introduction	366
17.2	Approaches to Investigating Decomposer Communities	368
17.3	The Microflora	369
17.4	The Soil Fauna	372
17.5	Contribution of the Decomposer Food Web to C and N Flows	376
17.6	Conclusions	378
	References	379

18 Diversity and Role of Microorganisms

A. Kjøller, M. Miller, S. Struwe, V. Wolters, and A. Pflug	382
18.1 Introduction and Background	382
18.2 Experimental Background	383
18.3 Community of Microfungi in Beech Forests	385
18.4 Functional Diversity of Bacteria in the Litter of Coniferous Forests ...	393
18.5 Conclusions	399
References	400

Part E Integration

19 Spatial Variability and Long-Term Trends in Mass Balance of N and S in Central European Forested Catchments

E. Dambrine, A. Probst, D. Viville, P. Biron, T. Paces, M. Novak, F. Buzek, J. Cerny, M. C. Belgrand, and H. Groscheova	405
19.1 Introduction	405
19.2 Approaches to Studying Long-Term Changes in Watersheds	405
19.3 Temporal Variations and Trends	407
19.4 Budgets	415
19.5 Biological Cycling of Sulphur	416
19.6 Conclusions	417
References	418

20 Model Analysis of Carbon and Nitrogen Cycling in *Picea* and *Fagus* Forests

H. van Oene, F. Berendse, T. Persson, A.F. Harrison, E.-D. Schulze, B.R. Andersen, G.A. Bauer, E. Dambrine, P. Höglberg, G. Matteucci, and T. Paces	419
20.1 Introduction	419
20.2 Model Description	420
20.3 Input Data and Parameter Values	427
20.4 Model Calibration and Comparison with Measured Data	431
20.5 Model Analysis	442
20.6 Conclusions	462
References	463

21	Interactions Between the Carbon and Nitrogen Cycle and the Role of Biodiversity: A Synopsis of a Study Along a North-South Transect Through Europe	
	E.-D. Schulze, P. Högberg, H. van Oene, T. Persson, A.F. Harrison, D. Read, A. Kjøller, and G. Matteucci	468
21.1	Introduction	468
21.2	Change of Ecosystem Processes Along the European Transect	468
21.3	What Limits the C and N Fluxes in These Forest Ecosystems?	472
21.4	What Are Net Ecosystem Productivity (NEP) and Net Biome Productivity (NBP) and How Do They Relate to Ecosystem Parameters?	477
21.5	Are There Thresholds and Non-Linearities?	482
21.6	What Role Does Biodiversity Play in Ecosystem Processes?	483
21.7	Conclusions	487
	References	488
	Subject Index	493
	Species Index	499

CD-ROM containing the database of this volume enclosed at the end of the book