

Contents of Volume I

Part I The Natural Environment and Its History

1 Environmental and Historical Influences on the Vegetation of Central Europe.....	3
1.1 The Climate and Phytogeography of Central Europe	3
1.2 An Overview of the Geology and Soils of Central Europe.....	10
1.3 Historical Influences on the Vegetation of Central Europe	13
2 Life Forms and Growth Types of Central European Plant Species	23
2.1 Life Forms	23
2.2 Endogenous Rhythms.....	26
2.3 Plant Anatomy and Morphology	27

Part II The Role of Man

3 The Central European Vegetation as the Result of Millennia of Human Activity	31
3.1 Phases of Forest Clearance.....	31
3.2 The Effects on the Vegetation of Low-Intensity Grazing and Woodland Use.....	40
3.2.1 The Opening Up and Destruction of the Forest	40
3.2.2 The Spread of Pasture Weeds	45
3.2.3 Soil Degradation Through Low-Intensity Grazing	47
3.3 From Coppiced Woodlands to Modern Forestry	52
3.3.1 Coppicing With and Without Standards	52
3.3.2 High Forest Management	58
3.4 The Development of Arable Cultivation and Arable Weeds	60
3.4.1 Pre-industrial Agriculture.....	60
3.4.2 The Effects of Technological Advances on Crop Fields and Low-Intensity Pastures	64

3.5	The Development of Meadows, Intensive Pastures and Other Grassland	65
3.5.1	Straw and Fodder Meadows	65
3.5.2	Continuous and Rotational Grazing	67
3.5.3	Agricultural Biocide Use, Energy Use and Crop Yield....	69
3.6	Changes in Landscape Hydrology	71
3.6.1	Modifications of River Valley Landscapes.....	71
3.6.2	The North Sea Dykes and Their Consequences	74
3.6.3	The Destruction of Mires, and Attempts to Restore Them	77
3.6.4	Increasing Exposure of the Vegetation to Drought	79
3.7	Chemical Pollution of the Environment and Its Impact on the Vegetation	79
3.7.1	Long- and Short-Range Effects of Chemical Pollutants ..	79
3.7.2	Nutrient Enrichment of Soils and Water Bodies	80
3.7.3	Acid Deposition	90
3.7.4	Sulphur Dioxide and Ozone Emissions.....	92
3.7.5	Emissions of Heavy Metals and Other Substances	98
3.8	Changes in Game Densities and Their Effect on the Vegetation....	104
3.9	Introduction of Non-native Plant Species	105
3.10	Recent Species Losses and Impoverishment of Plant Communities.....	106
3.11	The Effects of Recent Climate Change on the Vegetation	108

Part III General Ecology of Central European Forests

4	Abiotic Conditions, Flora, Ecosystem Functions and Recent Human Influence	119
4.1	The Flora of Central European Forests	119
4.2	The Geographic Distribution of Forest Vegetation	119
4.2.1	Zonal, Extrazonal and Azonal Forest Vegetation	119
4.2.2	The Potential Natural Vegetation of Central Europe.....	123
4.2.3	Altitudinal Belts of Forest Vegetation	124
4.2.4	Water and Temperature Limitations of Forest Growth	125
4.3	Environmental Conditions and Forest Habitat Classification	127
4.3.1	The Climate of the Forest Interior.....	127
4.3.2	Soil Water Regime.....	134
4.3.3	Soil Chemical Properties.....	141
4.4	Comparative Ecology of Central European Tree Species	150
4.4.1	Important Characteristics of Crown Structure	151
4.4.2	Traits Related to Productivity and Stress Tolerance.....	151
4.4.3	Nitrogen Acquisition	165
4.4.4	Stress Tolerance.....	166
4.4.5	Litter Quality and Tree Species Effects on the Soil	179
4.4.6	Competitive Abilities of the Tree Species	182

4.4.7	The Effects of Elevation on Tree Growth.....	188
4.4.8	The Influence of Climate on Elevational Changes in Tree Species Composition.....	191
4.4.9	Forest Cover in Central Europe and the Current Coverage of Major Tree Species	194
4.5	Forest Floor Plants and Shrubs of the Forest Interior: Ecological Niches and Ecological Grouping	196
4.5.1	Niches of Forest Shrubs	196
4.5.2	Ecology of Forest Floor Plants.....	207
4.5.3	The Ecological Grouping of Herbaceous Plants in Central European Broadleaved Forests	243
4.6	Population Ecology of Forest Floor Plants	245
4.6.1	Phenology.....	245
4.6.2	Life Cycles	249
4.7	Productivity and Cycling of Water and Nutrients	252
4.7.1	The Biomass and Productivity of the Tree Layer.....	252
4.7.2	The Biomass and Productivity of the Herb Layer.....	266
4.7.3	Ecosystem Carbon Cycling.....	270
4.7.4	Water Cycling.....	272
4.7.5	Nutrient Cycling.....	283
4.8	Vegetation Dynamics	298
4.8.1	Tree Layer Dynamics	298
4.8.2	Fluctuations and Succession in the Herb Layer	298
4.9	Recent Human Influence	300
4.9.1	Forest Damage in the Past and the Present	300
4.9.2	Anthropogenic Changes in Forest Soil Conditions.....	301
4.9.3	Recent Tree Damage and Its Potential Causes.....	310
4.9.4	Anthropogenic Changes in the Herb Layer and in the Cryptogam and Fungal Flora of Forests.....	324
4.9.5	Conservation and Restoration of Forests	337

Part IV Forest and Shrub Formations

5	Beech and Mixed Beech Forests	351
5.1	The Classification of Hardwood Broadleaved Forests	351
5.2	The Classification of Beech Forests in Central and Western Europe.....	356
5.3	Beech Forests on Rendzina and Pararendzina.....	361
5.3.1	Mesic Limestone Beech Forests (Hordelymo-Fagetum).....	361
5.3.2	Mull Beech Forests Rich in Wild Garlic	366
5.3.3	Sedge Beech Forests on Dry Slopes (Carici-Fagetum)	368
5.3.4	Beech Forests Without a Herb Layer (Fagetum nudum).....	372

5.3.5	Yew-Beech and Seslerio-Fagetum Forests on Steep Slopes	375
5.3.6	Montane Beech and Fir-Beech Forests	379
5.3.7	Subalpine Sycamore-Beech Forests (Aceri-Fagetum)	388
5.4	Beech and Mixed Beech Forests on Moderately Fertile Cambisols	391
5.4.1	The Galio odorati-Fagetum and Related Communities	391
5.4.2	Mixed Beech Forests on Moist Soil	399
5.4.3	Beech and Mixed Beech Forests Rich in Ferns.....	403
5.4.4	Beech Forests Rich in <i>Festuca altissima</i>	408
5.5	Beech and Oak-Beech Forests on Highly Acidic Soils	409
5.5.1	Moder Beech Forests (LUZULO-FAGENION)	409
5.5.2	Climatic and Edaphic Forms of Moder Beech Forests and Oak-Beech Forests	416
5.5.3	Acid Beech Forests on Limestone.....	421
5.6	A Comparison of the Habitats of Beech Forest Communities	422
5.7	Beech Forest Dynamics.....	424
5.7.1	The Inter- and Post-Glacial Development of Beech Forests	424
5.7.2	Patch Dynamics of Beech Forests	429
6	Mixed Broadleaved Forests Poor in Beech Outside of Floodplains or Mires.....	443
6.1	Maple- and Ash-Rich Mixed Forests	443
6.1.1	Habitat Classification of Maple and Ash Forests	443
6.1.2	The Fraxino-Aceretum	446
6.1.3	The Aceri-Fraxinetum	450
6.1.4	The Carici remotae-Fraxinetum	452
6.2	Mixed Lime Forests	454
6.2.1	The Asperulo taurinae-Tilietum in the Alps.....	454
6.2.2	Mixed Tilia cordata Forests Outside of the Alps.....	456
6.2.3	Thermophilic Mixed Large-Leaved Lime-Maple Forests (Aceri platanoidis-Tilietum platyphylli)	457
6.3	An Overview of the Mixed Oak Forests of Central Europe.....	459
6.4	Thermophilic Mixed Oak Forests (QUERCETALIA PUBESCENTIS)	461
6.4.1	'Relict' Submediterranean Downy Oak Forests and Continental Steppe Forests	461
6.4.2	The QUERCETALIA PUBESCENTIS ACROSS a West-East Climatic and Floristic Gradient	466
6.4.3	The Subcontinental Potentillo-Quercetum.....	474
6.5	Mixed Oak Forests on Acid Soils.....	476
6.5.1	The Betulo-Quercetum and Related Communities in Central Europe.....	476

6.5.2	Thermophilic Acid Oak Forests and Sweet Chestnut Coppices in Southern Central Europe	490
6.6	Oak-Hornbeam Forests (<i>CARPINION BETULI</i>).....	494
6.6.1	Thermophilic Subcontinental Oak-Hornbeam Forests (<i>Galio-Carpinetum</i>)	494
6.6.2	Moist Subatlantic Oak-Hornbeam Forests (<i>Stellario-Carpinetum</i>)	497
6.6.3	Beech-Rich Oak-Hornbeam Forests	502
6.6.4	Lime-Hornbeam Forests (<i>Tilio-Carpinetum</i>) Outside the Range of Beech.....	508
6.6.5	A Comparison of the Environmental Conditions in Oak-Hornbeam Forests.....	518
7	Pure and Mixed Coniferous Forests	521
7.1	The Role of Conifers in the Forests of Central Europe.....	521
7.2	The Systematic Classification of Conifer Forest Communities	525
7.3	Silver Fir Forests	526
7.3.1	The Unique Position of Fir Communities in Central European Forests	526
7.3.2	Fir Forest Communities of the Alps and Their Foothills	529
7.3.3	Fir Forests of Low Mountain Ranges and Lowlands	537
7.4	Spruce Forests	541
7.4.1	The Natural Range and Habitats of Spruce Forests in Central Europe.....	541
7.4.2	The Systematic Classification of Spruce-Rich Conifer Forests	545
7.4.3	Montane and Subalpine Spruce Forests	549
7.4.4	The Role of Spruce in Lowland Areas	556
7.4.5	Environmental Conditions in Various Spruce Forest Communities	558
7.5	Subalpine Larch-Swiss Stone Pine Forests and Larch Forests	560
7.5.1	Environmental Conditions of Larch and Swiss Stone Pine Forests in the Central Alps.....	560
7.5.2	Larch-Swiss Stone Pine Forests in the Alps and the Tatra	565
7.5.3	Larch Forests of the Southern Alps and Non-Alpine Larch Stands.....	570
7.6	Mountain Pine Stands Outside of Mires	571
7.6.1	Erect Mountain Pine Communities	571
7.6.2	Dwarf Mountain Pine Scrub Under Different Environmental Conditions.....	574

7.7	Pine Forests Outside of Mires and Floodplains	581
7.7.1	Central European Scots Pine Forests: Variation with Environmental Conditions.....	581
7.7.2	Scots Pine and Black Pine Communities in the Alps	585
7.7.3	A Comparison of Pine and Mixed Oak Forests in the Pleistocene Lowlands.....	590
7.8	Conifer Forest Dynamics	598
7.8.1	Conifer Regeneration	598
7.8.2	Stand Dynamics	600
8	Forest Plantations and Clearings.....	607
8.1	Plantation Communities in Comparison to Semi-natural Forest Communities	607
8.1.1	Types of Plantation Vegetation.....	607
8.1.2	Conifer Monocultures in Broadleaved Forest Habitats	622
8.1.3	The Vegetation of Clearings and Burnt Areas.....	626
9	Woody Vegetation of Floodplains and Swamps.....	633
9.1	Flora and Origins.....	634
9.2	Habitat Conditions and Classification.....	636
9.2.1	Floodplain Morphology and Local Climate.....	636
9.2.2	Soil Chemistry and Nutrient Supply	640
9.2.3	Discharge Regime, Flooding Frequency and Soil Moisture	644
9.2.4	Stagnant and Flowing Groundwater.....	648
9.3	Vegetation.....	652
9.3.1	Woody Vegetation of Floodplains and Riverbanks	652
9.3.2	Swamp and Mire Forests.....	688
9.4	Adaptations to the Environment.....	700
9.4.1	Flood Tolerance of Floodplain Species.....	700
9.4.2	Summer Drought Stress in Floodplains	705
9.4.3	Willows as Characteristic Species of Floodplains and Swamps	706
9.5	Population Biology and Community Ecology	708
9.5.1	Phenology.....	708
9.5.2	River Valleys as Migration Routes for Mountain Species.....	709
9.5.3	Regeneration and Population Dynamics in Floodplain Forests.....	712
9.6	Productivity and Cycling of Water and Nutrients	715
9.6.1	Forest Structure, Biomass and Productivity	715
9.6.2	Water and Nutrient Cycling.....	716
9.7	Vegetation Dynamics	718
9.7.1	Dynamics of Floodplain Vegetation	718

9.7.2	Succession Following Disturbance	721
9.8	Human Influence	722
9.8.1	Exploitation, Drainage and Destruction of Floodplain Forests.....	722
9.8.2	Conservation and Restoration of Floodplain Forests	726
10	Epiphyte Vegetation	729
10.1	Tree Bark as an Epiphyte Substrate	730
10.2	Epiphytic Algal, Lichen and Bryophyte Communities	731
10.2.1	Alga-Rich Epiphyte Communities	732
10.2.2	Lichen-Rich Epiphyte Communities.....	733
10.2.3	Bryophyte-Rich Epiphyte Communities.....	734
10.3	Adaptations to the Environment.....	737
10.3.1	Important Ecological Properties of Epiphytic Cryptogams	737
10.3.2	Carbon Assimilation as a Function of Moisture, Light Intensity and Temperature	738
10.3.3	Chemical and Physical Properties of the Substrate.....	740
10.3.4	The Effects of Toxic Substances and the Role of Epiphytes as Indicators	741
10.3.5	The Importance of Stand Structure and Stand Age.....	742
10.4	Recent Changes in Epiphyte Communities.....	743
11	Forest Edges, Scrub, Hedges and Their Herb Communities	747
11.1	Flora and Development	747
11.2	Environmental Conditions and Habitat Classification	750
11.3	Vegetation.....	756
11.3.1	Forest Edges, Scrub and Hedges.....	756
11.3.2	Herb Fringe Communities.....	763
11.4	Adaptations to the Environment, Population Biology and Vegetation Dynamics	768
11.5	Human Influence	771
11.5.1	Decline and Destruction of Hedges.....	771
11.5.2	The Importance of Hedges for Agriculture and Agricultural Landscapes	773
12	Syntaxonomic Overview of the Vascular Plant Communities of Central Europe: Forest and Scrub Formations	775
Erratum		E1
References		781
Index		891