

Contents

Introduction	1	1.5	Water Deficiency (Drought) .. 117
		1.5.1	Water Balance of Drought-Stressed
Chapter 1			Cells 119
Stress Physiology	5	1.5.2	Cellular Reactions to Drought Stress 123
		1.5.3	CAM
			(Crassulacean Acid Metabolism) ... 135
1.1 Environment as Stress Factor:		1.5.4	Anatomical-Morphological Adapta-
Stress Physiology of Plants ..	7		tion to Drought 140
1.1.1 Abiotic and Biotic Environments			
Cause Stress	7	1.6	Salt Stress (Osmotic Stress) .. 145
1.1.2 Specific and Unspecific Reactions		1.6.1	Physiological Effects of Salt Stress
to Stress	9		(NaCl) 146
1.1.3 Stress Concepts	11	1.6.2	Adaptive Responses of Plant Cells
1.1.4 Perception of Stress and Creation			to Salt Stress 149
of Signals	13	1.6.3	Avoidance of Salt Stress 171
1.1.5 How to Measure Stress on Plants? ..	16		
1.1.6 Production of Stress-Tolerant Plants		1.7	Heavy Metals 175
by Genetic Engineering?	16	1.7.1	Availability of Heavy Metals 176
1.1.7 Gene Silencing	19	1.7.2	Heavy Metal Deficiency – Example
			Iron 176
1.2 Light	23	1.7.3	Stress by Heavy Metal Ion Toxicity . 182
1.2.1 Visible Light	24	1.7.4	Reaction of Plants to Excess Supply
1.2.2 UV Radiation	37	1.7.5	of Heavy Metals 184
		1.7.6	Heavy Metal Resistance (Tolerance) 191
1.3 Temperature	45		Heavy Metal Extraction and Soil
1.3.1 Temperature Ranges and Tempera-			Decontamination by Plants
tures Limiting Life	45		(Phytomining, Phytoremediation) .. 191
1.3.2 Temperature-Dependent Biochemical			
Processes, Q ₁₀ and Activation Energy	48	1.8	Aluminium 195
1.3.3 Temperature and Stability/Function		1.8.1	Forms of Aluminium Available to
of Biomembranes	49		Plants 196
1.3.4 Heat (Hyperthermy)	50	1.8.2	Aluminium Toxicity 196
1.3.5 Cold	61	1.8.3	Al ³⁺ Resistance 200
1.3.6 Frost	72	1.8.4	Al ³⁺ Tolerance 203
1.3.7 Concluding Comments	94		
1.4 Oxygen Deficiency		1.9	Xenobiotica 207
(Anaerobiosis and Hypoxia) ..	99	1.9.1	Herbicides 210
1.4.1 Energy Metabolism of Plants Lacking		1.9.2	Gaseous Air Pollutants 215
Oxygen	101		
1.4.2 Anatomical-Morphological Changes			
During Hypoxia	105		
1.4.3 Post-anoxic Stress	114		

1.10 Biotic Stress: Herbivory, Infection, Allelopathy	235	3.2 Processes in Stands and Ecosystems	403
1.10.1 Signal Chain in Wounding	235	3.2.1 Self-Thinning	403
1.10.2 Pathogen Attack and Defence	246	3.2.2 Reversible and Irreversible Site Changes Related to Resource Exploitation	406
1.10.3 Allelopathy	250	3.2.3 Complexity and Non-linear Behaviour	409
Chapter 2 Autecology: Whole Plant Ecology ..	253	3.2.4 Number of Species and Habitat Partitioning	411
2.1 Thermal Balance of Plants ..	255	3.2.5 Disturbances	417
2.1.1 The Atmosphere as Habitat	257	3.3 The Biogeochemical Cycles ..	425
2.1.2 Climate of Air Near the Ground ..	263	3.3.1 Water Turnover	426
2.1.3 Energy Balance of Leaves	269	3.3.2 Carbon Turnover	427
2.1.4 Adaptation to Temperature Extremes	270	3.3.3 Nitrogen Cycle	438
2.1.5 Adaptation to Light	271	3.3.4 Cation Turnover	444
2.2 Water Relations of Plants ..	277	3.4 Biodiversity and Ecosystem Processes ..	449
2.2.1 Water as an Environmental Factor ..	277	3.5 Case Studies at the Scale of Ecosystems ..	455
2.2.2 Water Transport in the Plant	283	3.5.1 Soil Acidification and Forest Damage	456
2.2.3 Regulation of Stomata	296	3.5.2 Effect of Deciduous and Coniferous Forests on Processes in Ecosystems ..	460
2.2.4 Transpiration of Leaves and Canopies	303	3.5.3 Plants of Limestone and Siliceous Rocks	462
2.3 Nutrient Relations of Plants ..	313	Chapter 4 Syndynamics, Synchorology, Syncology ..	465
2.3.1 Availability of Soil Nutrients and Ion Uptake	313	4.1 Historic-Genetic Development of Phytocenoses and Their Dynamics ..	467
2.3.2 Nitrogen Nutrition	324	4.1.1 History of Vegetation to the End of the Tertiary	469
2.3.3 Sulfur Nutrition	335	4.1.2 Change of Climate and Vegetation in the Pleistocene	472
2.3.4 Phosphate Nutrition	337	4.1.3 Late and Postglacial Climate and Vegetation History	475
2.3.5 Nutrition with Alkaline Cations ..	338	4.1.4 Changes in Vegetation Because of Human Influence	479
2.4 Carbon Balance ..	347	4.1.5 Basis of General Vegetation Dynamics	507
2.4.1 Net Photosynthesis: Physiological and Physical Basis ..	347	4.1.6 Stability of Plant Communities ..	534
2.4.2 Specific Leaf Area, Nitrogen Content and Photosynthetic Capacity ..	357		
2.4.3 Response of Photosynthesis to Environmental Factors	361		
2.4.4 Growth and Storage	373		
2.4.5 C and N Balance in Different Types of Plants	379		
Chapter 3 Ecology of Ecosystems ..	397		
3.1 The Ecosystem Concept ..	399		
3.1.1 What is an Ecosystem?	400		
3.1.2 Boundaries of Ecosystems	400		
3.1.3 Compartmentalisation	401		
3.1.4 System Characteristics	401		

4.2	Synchorology: Basis of Spatial Distribution of Plants	541	5.2.3	Nitrogen Cycle	636
4.2.1	Distribution of Plants	542	5.2.4	Sulfur Cycle	638
4.2.2	Basis of Spatial Distribution (Phytogeography)	548	5.3	Human Influence on Carbon Balance and Significance for Global Climate	641
4.2.3	Relationship Between Area and Species	555	5.4	Significance of Changes in Land Use for Carbon Cycles ..	649
4.2.4	Biodiversity	562	5.4.1	Land Use and CO ₂ Emissions	649
4.3	Interactions Between Vegetation and Abiotic and Biotic Environments – Syncology ..	579	5.4.2	The Kyoto Protocol: Attempts To Manage the Global Carbon Cycle ..	651
4.3.1	Influences of Vegetation on the Site	580	5.4.3	Importance of Climate Change for Europe	659
4.3.2	Interactions Between Plants and Animals	585	5.5	Influence of Human Activities on Biodiversity	663
4.3.3	Interactions Between Plants	602	5.5.1	Decrease in Biodiversity	663
Chapter 5					
Global Aspects of Plant Ecology ... 623					
5.1	Global Change and Global Institutions	625	5.6	Socio-economic Interactions ..	669
5.2	Global Material Cycles	633	5.6.1	Syndromes	670
5.2.1	Water Cycle	633	5.6.2	Evaluation of Risks to Biodiversity in Ecosystems	673
5.2.2	Carbon Cycle	635	Subject Index	679	