Part 1	Fund	Iamentals of Plant Water Relations 1   Preface 2
	A.	The Structure of Water in the Biological Cell
		G. PESCHEL
	I.	Introduction
	II.	Evidence for Structured Aqueous Boundary Layers 7
	III.	Thermal Anomalies in Biological Tissues
	IV.	Properties of Aqueous Electrolyte Layers
	V.	Conclusions
		References
	B.	The States of Water in the Plant—Theoretical Consideration
		J. J. OERTLI
	I.	Introduction
	II.	Physiological Importance of Processes and Properties
		Involving Water
	III.	Metabolism and Water Relations
	IV.	Conclusions
		References
	C.	The Soil-Plant-Atmosphere Continuum
		J. J. OERTLI
	I.	Introduction
	II.	Description of the Turgor Pressure as a Function of
		Environmental Variables
	III.	Water Flow in the SPAC as a Link Between Plant and
		Environment
	IV.	The Solute-free Transport System
	V.	Effects of Solutes in the SPAC
	VI.	Changes in Resistances or Potential Differences
	VII.	Conclusions
		References
	D.	The Water Status in the Plant—Experimental Evidence
		H. RICHTER
	I.	Introduction

	П.	Current Methods for the Determination of Total Water	
		Potential and Its Components	43
	III.	The Range of Water Potentials Hitherto Determined and the	
		Continuum Conditions Favoring Extreme Values	46
	IV.	The Component Potentials Adjusting Total Water Potential in	
		the Plant Body: Ranges and Changes	51
	V.	Why does Water Potential in a Plant Change?	53
	VI.	Conclusions	54
		References	55
Part 2	Wata	er Uptake and Soil Water Relations	59
i ait 2	, , a (	Preface.	
			00
	A.	Root Extension and Water Absorption	
		M. M. Caldwell	63
	I.	Introduction	63
	П.	Water Movement Through the Soil-Plant-Atmosphere	
		Continuum: Limitations in the Liquid Phase	63
	Ш.	Root Extension and Facilitation of Water Uptake in	
		Unexplored Soil Regions	64
	IV.	Root Extension Within the Rooted Zone: A Case for	0.
	•••	Avoidance of Localized Rhizospheric Resistances	67
	V.	Conclusions	82
	••	References	
	B.	Resistance to Water Flow in the Roots of Cereals	
	D.	E. L. GREACEN, P. PONSANA, and K. P. BARLEY	86
	I.	Introduction	86
	II.	Anatomy of Cereal Roots	
	III.		
	IV.	Forces Causing Flow of Water	
	V.	Resistance to Flow	
	VI.	Effect of Root Resistance on Withdrawal of Water from the	
	۷1.		
	VП	Soil	95
	v 11	. Conclusions	98 99
	C.	Soil Water Relations and Water Exchange of Forest Ecosystems	
		P. BENECKE	101
	Ι.	Introduction	
	П.	Water Balance	
	III.		120
	IV.	Simulation of Evapotranspiration and Percolation	120
	V.	Conclusions	
		References	120

Part 3	Tran	spiration and Its Regulation   133     Preface   134
	А.	Energy Exchange and Transpiration
	<b>~</b> 1.	D. M. Gates
	I.	Introduction
	II.	Gas Diffusion
	III.	Energy Balance
	IV.	Transpiration
	V.	Wind Speed Influence
	VI.	Leaf Temperature Affected by Transpiration
		Conclusions
	v 11.	References
	Б	
	B.	Water Permeability of Cuticular Membranes
	T	J. SCHÖNHERR
	I.	Introduction
	II.	Cuticular Transpiration—Early Observations and Hypotheses 149
	III.	The Concept of the Polar Pathway Through Lipid Membranes 150
	IV.	Conclusions
		References
	C.	Physiological Basis of Stomatal Response
		J. LEVITT
	I.	Introduction
	II.	Biochemical Processes Leading to Movement
	III.	Conclusions: Ability of the Mechanism to Explain the Known
		Facts
		References
	D.	Current Perspectives of Steady-state Stomatal Responses to
		Environment
		A. E. HALL, ED. SCHULZE, and O. L. LANGE
	I.	Introduction
	II.	Measurement of Stomatal Responses to Environment 170
	III.	Steady-state Stomatal Responses to Environment 171
	IV.	Stomatal Responses to Diurnal Changes in Environment 183
	V.	Conclusions and Future Research Directions
		References
	E.	Water Uptake, Storage and Transpiration by Conifers:
	E.	A Physiological Model
		R. H. WARING and S. W. RUNNING
	I.	Introduction
	т. II.	Description of the Model
	II. III.	Applications
	III. IV.	Conclusions
	1 V.	References

Part 4	Dire	ct and Indirect Water Stress	203
		Preface	204
	A.	Water Stress, Ultrastructure and Enzymatic Activity	
		J. VIEIRA DA SILVA	
	I.	Introduction	
	II.	Effects of Water Stress on Hydrolytic Enzymatic Activity.	208
	III.	Effects of Water Stress on the Ultrastructure of the Cell	212
	IV.	Relationships of Ultrastructural Alteration and Hydrolytic	
		Enzyme Decompartmentation and Activation, with Alteration	
		of Chloroplasts and Mitochondria Metabolism	217
	V.	Conclusions	
	••	References	
	B.	Water Stress and Hormonal Response	
		C. ITAI and A. BENZIONI	
	I.	Introduction	
	II.	Endogenous Hormonal Changes Due to Water Stress	
	III.	The Physiological Significance of Hormonal Effects	232
	IV.	A Hypothetical Model for the Role of Hormones in Plant	
		Adaptation to Water Stress	238
	V.	Conclusions	238
		References	240
	C.	Carbon and Nitrogen Metabolism Under Water Stress	
	C.	M. KLUGE	243
	I.	Introduction	
	II.	Carbon Metabolism Under Water Stress	
	III.	Nitrogen Metabolism Under Water Stress	
	IV.	Biochemical Aspects of Desiccation Resistance	
	V.	•	
	۷.		
		References	250
	D.	Water Stress During Freezing	
		U. HEBER and K. A. SANTARIUS	253
	I.	Introduction	253
	Π.	Frost Injury	
	111.	Frost Resistance.	
	IV.	Conclusions	265
		References	
	E.	Call Darmashility and Water St	
	L.	Cell Permeability and Water Stress	_
	T	O. Y. LEE-STADELMANN and E. J. STADELMANN.	268
	I.	Introduction	268
	II.	Principles of Cell Permeability	269
	III.	Quantitative Determination of Permeability	270
	IV.	Alterations of Cell Permeability by the Plant Water Deficit .	272

	V.	Possible Mechanisms for Changes in Cell Permeability by Plant	
		Water Stress	7
	VI.	Conclusions	
		References	9
	F.	Water Stress and Dynamics of Growth and Yield of Crop Plants	
		T.C. HSIAO, E. FERERES, E. ACEVEDO, and D.W. HENDERSON 28	1
	I.	Introduction	1
	II.	Overview of Growth and Yield as Affected by Water 28	2
	III.	Some Behavior Observed in the Field	
	IV.	Concluding Remarks	1
		References	
D 4 5			-
Part 5	wate	er Relations and CO <sub>2</sub> Fixation Types	
		Preface	5
	A.	Crassulacean Acid Metabolism (CAM): CO <sub>2</sub> and Water	
		Economy	
		M. Kluge	3
	I.	Introduction	
	II.	Carbon Metabolism of CAM Plants	
	III.	Gas Exchange of CAM Plants	
	IV.	Ecological Aspects of CAM.	
	V.	Conclusions	
	۷.		
		References	J
	B.	Balance Between C <sub>3</sub> and CAM Pathway of Photosynthesis	
		K. WINTER and U. LÜTTGE	3
	I.	Introduction	
	II.	Adaptation to Salinity	
	III.	Environmental Control of Photosynthetic Pathways 32	
	IV.	Regulation of the Balance between $C_3$ and CAM 32	
	V.	Ecological Aspects.	
	•.	References	
	С.	$C_4$ Pathway and Regulation of the Balance Between $C_4$ and $C_3$	
		Metabolism	_
		W. HUBER and N. SANKHLA	
	I.	Introduction	
	II.	Carbon Metabolism of $C_4$ Plants	
	III.	General Characteristics of C <sub>4</sub> Plants	
	IV.	Factors Affecting Shift	
	V.	Natural $C_3 - C_4$ Intermediates	2
	VI.	Ecological Implications	4
	VII.	Conclusions	6
		References	7

	D.	Ecophysiology of C <sub>4</sub> Grasses
		M. M. LUDLOW
	I.	Introduction
	П.	Environmental Conditions
	III.	Physiological Responses to Environmental Conditions 366
	IV.	Ecological Implications
	V.	Conclusions: Future Research
		References
Part 6	Wat	er Relations and Productivity
		Preface
	A.	The Use of Correlation Models to Predict Primary Productivity
		from Precipitation or Evapotranspiration
	_	Н. LIETH
	I.	Introduction
	II.	Construction of Correlation Models and Geographical Patterns
		(Surfaces)
	HI.	Some Examples of Correlation Models of Net Primary
		Productivity versus Water Factor
	IV.	Accuracy of Correlation Models
	V.	Conclusions
		References
	B.	The Use of Simulation Models for Productivity Studies in Arid
		Regions
		H. VAN KEULEN, C. T. DE WIT, and H. LOF
	I.	Introduction
	II.	The Structure of the Model
	III.	Description of the Model ARID CROP
	IV.	Validation of the Model
	V.	Application of the Model
	VI.	Conclusions
		References
	C.	Irrigation and Water Use Efficiency
		J. F. BIERHUIZEN
	I.	Introduction
	II.	Efficiency of Water Supply
	III.	
	IV.	Some Agronomic Aspects
	V.	Conclusions
		References
	D.	Estimating Water Status and Biomass of Plant Communities by
		Remote Sensing
		B. G. DRAKE
	I.	Introduction

	II. III. IV.	Water Stress, Reflectance, and Temperature of Single Leaves. Reflectance and Biomass of Communities.	434
		References	437
	Е.	<b>Plant Production in Arid and Semi-Arid Areas</b> M. Evenari, ED. Schulze, O. L. Lange, L. Kappen, and	
		U. Buschbom	439
	I. II.	Introduction	439
	111	Production of Some Main Vegetation Units of the Globe	440
	III.	Phytomass and Production of Some Arid and Semi-Arid Vegetation Units and their Annual Fluctuations	441
	IV.	Permanent Phytomass	
	V.	Potential Production	
	VI.	Recovery	
		Conclusions	
		References	
	F.	Water Content and Productivity of Lichens	
		G. P. HARRIS	
	I.	Introduction	
	II.	Productivity of Lichens	
	III.	Water Relations of Lichens	
	IV.	Thallus Water Content and Physiological Response	
	V.	Conclusions: Water Relations and Productivitya Synthesis References	
Part 7	Wat	er and Vegetation Patterns	469
		Preface	470
	А.	Water Relations and Alpine Timberline	. – •
		W. TRANQUILLINI	
	I.	Introduction	
	II.	Water Relations of Trees at the Timberline	
	III.	Causes of Winter Desiccation of Trees at Timberline	478
	IV.	Conclusions: Ecophysiological Analysis of the Alpine Timberline and its Dynamics	487
		References	
	B.	The Water Factor and Convergent Evolution in Mediterranean-	
		type Vegetation E. L. Dunn, F. M. Shropshire, L. C. Song, and	
		H. A. MOONEY	492
	I.	Introduction	492
	ı. II.	Environmental Stresses in Mediterranean-type Climates	493
	III. III.	Ecological Significance of Leaf Structure	496
	IV.	Seasonal Patterns of Photosynthesis, Water Relations and	
		Productivity	498

V.	Evolutionary Consequences of Mediterranean-type
	Environmental Stresses
VI.	Conclusions
	References
C.	The Water-Photosynthesis Syndrome and the Geographical Plant Distribution in the Saharan Deserts
	O. STOCKER
Ι.	Introduction
11.	The Floristic and Physiognomic Aspects of the Sahara 506
III.	The Water-Photosynthesis Syndrome in the Northern and in
	the Southern Sahara
IV.	Holarctic and Palaeotropic Constitution Types
V.	Conclusions
	References
Index of Plar	nt Species
Subject Index	<b>x</b>

XVI