Stefan Fränzle

Chemical Elements in Plants and Soil: Parameters Controlling Essentiality



Contents

1	The		ical System of Elements	1				
	1.1	Princi	ples of Element Distribution in Plants	1				
		1.1.1	Distribution Patterns of Chemical Elements in Plants	1				
		1.1.2	,					
			of Enzymatic Reactions	4				
		1.1.3	Soil and Geochemistry: Support and Storage/Buffer					
			System for Biology	6				
	1.2		odology of Inquiries into the Biological System					
		of Ele	ments	11				
		1.2.1	Correlation Analysis of Element Distribution					
			in Multiple Plant Species	11				
		1.2.2	Fundamentals of the Correlation-Chemical					
			Analysis of Element Abundances	12				
		1.2.3	Stoichiometric Network Analysis	13				
_								
2		Autocatalytic Processes and the Role of Essential Elements						
			rowth	17				
	2.1		ass Stability in the Light of Gibbs's Phase Rule	17				
	2.2		lination-Chemical Control of Element Uptake	19				
		2.2.1	Metal Complexes in Biology: Definition of Complex					
			Formation Constants	19				
		2.2.2	Electrochemical Parameters of Biologically	20				
			Relevant Ligands	20				
		2.2.3	A Method to Calculate Metal-Ligand					
			Association Equilibria	21				
		2.2.4	How Does the Electrochemical Ligand Parameter					
			Influence Real Versus Possible Hapticity of Some					
			Polydentate Ligand?	30				
		2.2.5	Translating Complex Stabilities into Bioconcentration					
			Factor (BCF) Data: The k' Term of Element					
			Fractionation	40				
		2.2.6	Binding Stability of Substrates and Products					
			in Catalytic Cycles: How Does Ligand Sensitivity					
			Influence Reaction Kinetics?	41				
		2.2.7	The Electrochemical Ligand Parameter,					
			Metal Affinities and Chemical Ecology	52				
		2.2.8	Implications of Some Theorems from Stoichiometric					
			Network Analysis (SNA) with Respect to Stability					
			and Function Biochemical Systems	67				

		2.2.9	Matter (Flow) Balance, Metabolic Strategy and Estimation of Loss Processes (Exit Order)					
			Within Autocatalytic Biochemical Cycles	72				
		2.2.10	The Topology of Autocatalytic Feedback Patterns					
			in Living Systems.	85				
		2.2.11	SNA and Metal Transport in Terrestrial Plants	88				
		2.2.12	Stoichiometry of Terrestrial Plants and Its Implications					
			According to SNA	95				
		2.2.13	A Comprehensive Analysis of Autocatalytic Processes					
			Within Some Photosynthetic Plant	110				
	2.3	Some F	Remarks on Chemical Ecology	118				
		2.3.1	Constraints of Essentiality Caused by Consumers	118				
		2.3.2	Trophic Nets	121				
		2.3.3	Succession and Ecological Stoichiometry Including					
			Intermetal Ratios	124				
		2.3.4	A Corollary on Bioindication	129				
3	A C	A Causal Model of Biochemical Essentiality						
	3.1		ce of Intrinsic Bonding Stability and Ligand					
			vity on the Biocatalytic Properties of Metal Ions	131				
	3.2		ex Stability in Relation to Other Bioorganic					
		_	eters	134				
	3.3	Phase S	Structures and Histology Revisited	145				
	3.4	Scope of	of the Essentiality Model	149				
4	The	he Evolution of Essentiality						
	4.1							
	4.2		e-Step-Model for Uptake and Functionalization					
			al Ions Enforced by Chemical Evolution					
			Bootstrap)	155				
		4.2.1	Fractionation of Chemical Elements in and by Polymeric					
			Antecessors of Biomass During Chemical Evolution	161				
	4.3	The Th	ree-Functions-Rule as a Controlling Factor					
		in the C	Origins of Essentiality	163				
	4.4	Biogeo	chemical Fractionation Processes and Essentiality					
		Pattern	s in Different Taxa Under Changing Biogeochemical					
		Bounda	ary Conditions	168				
Re	eferer	nces		181				
In	dex			191				