

Review of the roles of soils in biogeochemical cycling

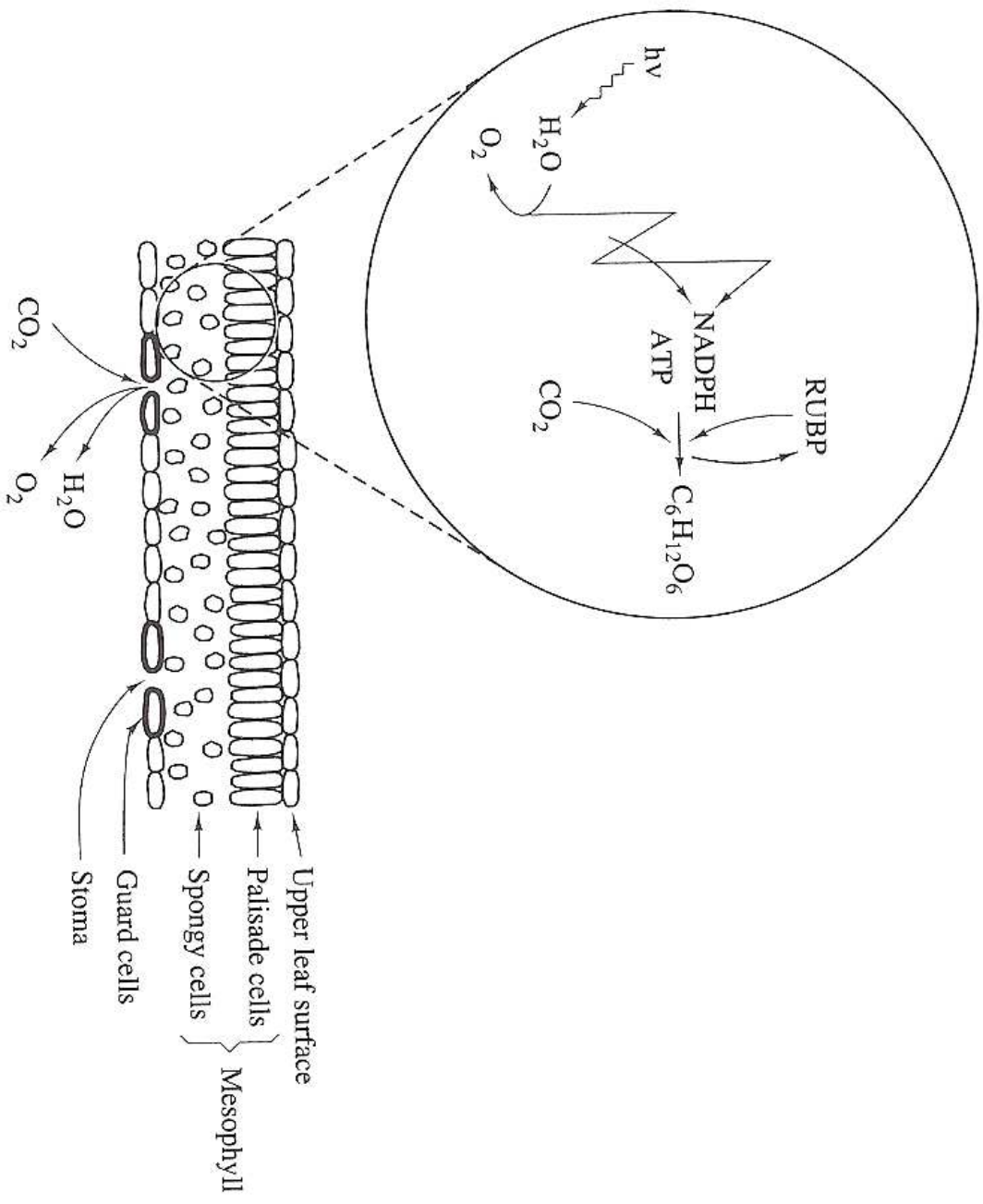
- Reservoir (C, N, P, minerals, H₂O)
- Nutrient supplier
 - moderation by soil texture and SOM
 - uptake as cations in the liquid phase
 - ∅ Enzymatic conversion of NO₃⁻ to NH₄⁺ and “masked” phosphorous into soluble phosphate (e.g. H₂PO₄⁻)
 - ∅ Metabolic energy needed → root respiration
 - uptake of N₂-nitrogen via “fixation”
 - ∅ Symbiosis with root fungi (and bacteria)
- Chemical Reactor (for nutrient turnover)

Table 3 Nutrients required by plants and their major functions.

<i>Nutrient</i>	<i>Role in plants</i>
Macronutrients ^a	Required by all plants in large quantities
<i>Primary</i>	
Nitrogen (N)	Component of proteins, enzymes, phospholipids, and nucleic acids
Phosphorus (P)	Component of proteins, coenzymes, nucleic acids, oils, phospholipids, sugars, starches
Potassium (K)	Critical in energy transfer (ATP) Component of proteins Role in disease protection, photosynthesis, ion transport, osmotic regulation, enzyme catalyst
<i>Secondary</i>	
Calcium (Ca)	Component of cell walls Regulates structure and permeability of membranes, root growth Enzyme catalyst
Magnesium (Mg)	Component of chlorophyll Activates enzymes
Sulfur (S)	Component of proteins and most enzymes Role in enzyme activation, cold resistance
Micronutrients ^b	Required by all plants in small quantities
Boron (B)	Role in sugar translocation and carbohydrate metabolism
Chloride (Cl)	Role in photosynthetic reactions, osmotic regulation
Copper (Cu)	Component of some enzymes Role as a catalyst
Iron (Fe)	Role in chlorophyll synthesis, enzymes, oxygen transfer
Manganese (Mn)	Activates enzymes Role in chlorophyll formation
Molybdenum (Mo)	Role in N fixation, NO ₃ enzymes, Fe adsorption, and translocation
Zinc (Zn)	Activates enzymes, regulates sugar consumption
Beneficial nutrients ^c	Required by certain plant groups, or by plants under specific environmental conditions
Aluminum (Al)	
Cobalt (Co)	
Iodine (I)	
Nickel (Ni)	
Selenium (Se)	
Silicon (Si)	
Sodium (Na)	
Vanadium (V)	

^a Macronutrients: Primary—usually most limiting because used in largest amounts. Secondary—major nutrients but less often limiting.

^b Micronutrients: essential for plant growth, but only needed in small quantities. ^c Beneficial nutrients—often aid plant growth, but not essential.



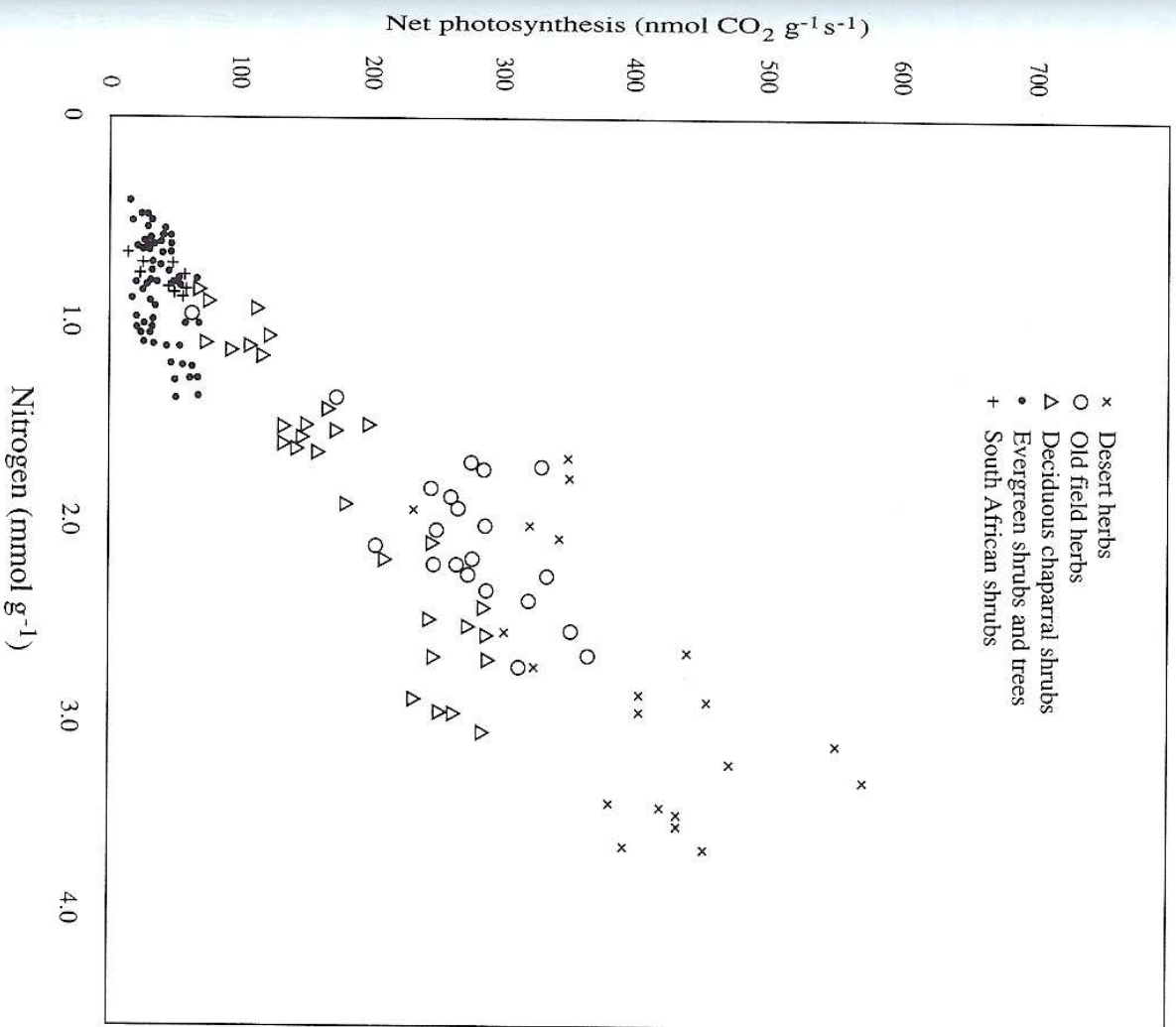


Figure 5.3 Relationship between net photosynthesis and leaf nitrogen content among 21 species from different environments. From Field and Mooney (1986).

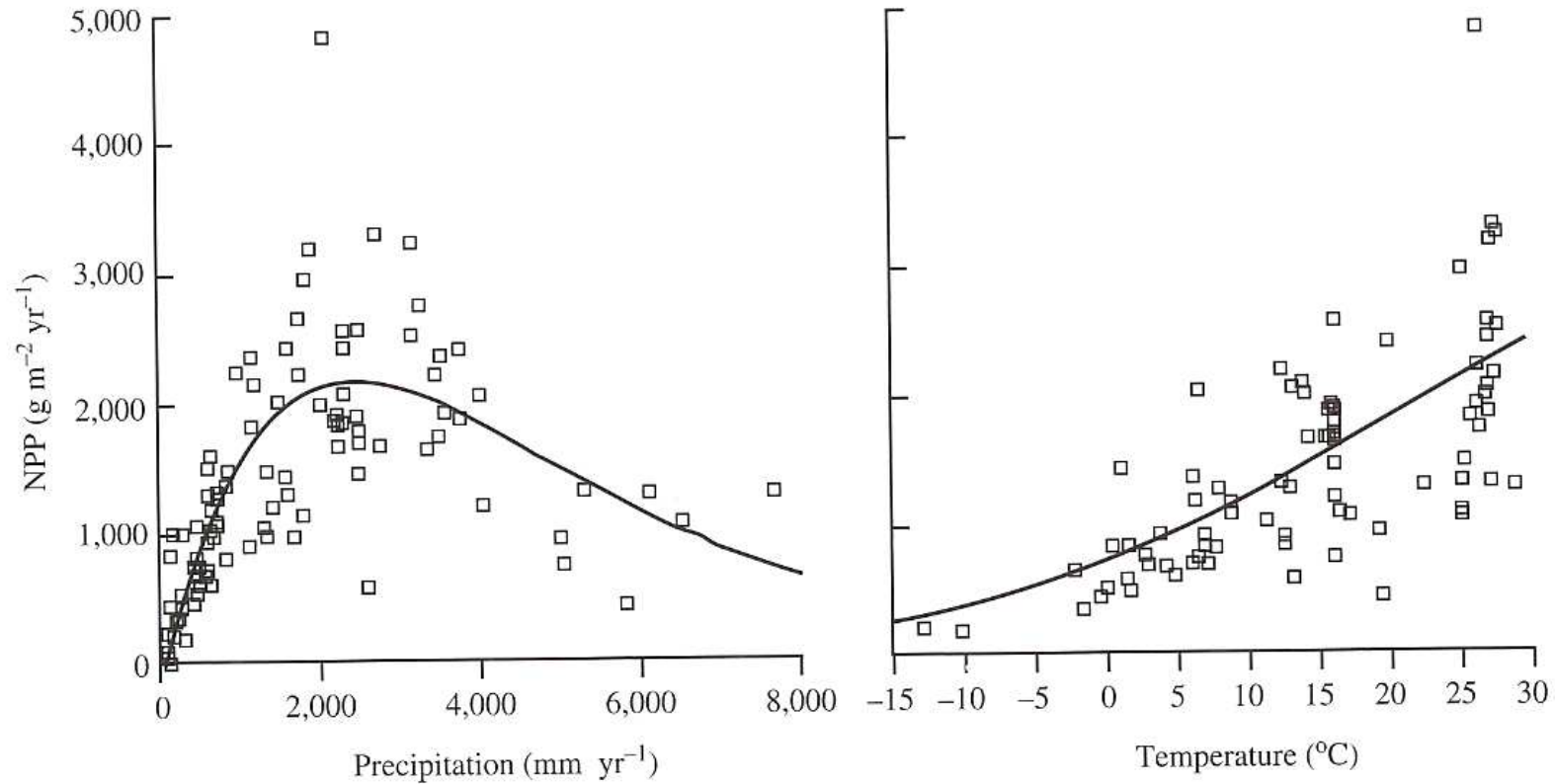


Figure 1 Correlation of NPP (in units of biomass) with temperature and precipitation (Schuur, 2003) (reproduced by permission of Springer from *Principles of Terrestrial Ecosystem Ecology*, 2002).

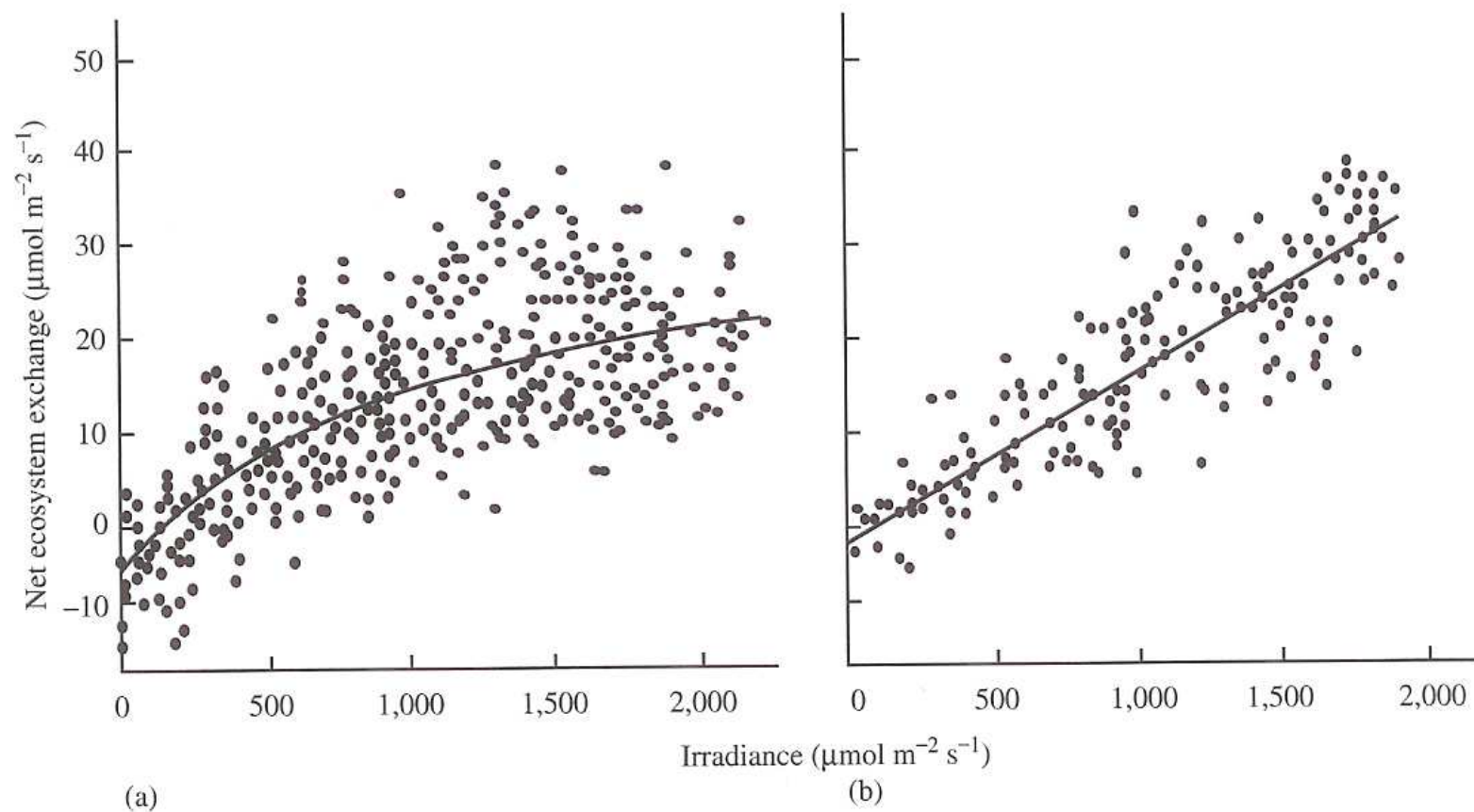


Figure 3 Effect of vegetation and irradiance on net ecosystem exchange in (a) forests and (b) crops (reproduced by permission of Academic Press from *Adv. Ecol. Res.*, 1996, 26, 1–68).