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ENZYMES AND ECOSYSTEMS-WHERE DO THEY OVERLAP?

Roy, Jacques, and Eric Garnier (eds.). 1994. A whole-plant perspective on carbon-nitrogen interactions. SPB Academic Publishing, The Hague, The Netherlands. 314 p. *$74.00,* ISBN: 90-5 103-086-X.

The whole plant is not the sum of its enzyme systems. This book demonstrates the importance of whole-plant physiology by examining carbon-nitrogen interactions and how these interactions are influenced by demands of the whole plant. In some aspects it is a timely response to the current, strong reductionist trends in plant physiology associated with advances in molecular biology and instrumental technology. Enzyme systems and their associated genetic controls are modulated by feedback systems associated with the functional equilibrium that exists among all plant organs. Major factors in control of this functional equilibrium are carbon-nitrogen metabolism and transport.

The book is well organized for efficient information transfer. An introduction for each section contains a brief summary of the previous section, describes the relationship between the previous and current sections, and notes the major points covered in the current section. In addition, each paper contains an abstract and conclusions. This format helps the reader quickly obtain the important information contained in each section without detailed analyses of each paper. The authors of the introductions and the individual papers also point out the limits of current knowledge and important directions for future whole-plant carbon-nitrogen research. The book, written for a scientific audience to foster physiological research at the whole-plant level, should also be useful to a wider readership. Overall, the book is an excellent literature review and source of information with as many as 50 to 70 references cited by some authors. The review of European literature provides researchers in the United States with information not readily accessible.

The book's few weaknesses do not significantly detract from its usefulness. Some papers are obtuse and difficult to follow, particularly Roy's final summary. Moreover, the focus on nitrate uptake and metabolism is too great. The focus on nitrate is understandable because much of the available information comes from research with crop plants, but NH, is more important for plants in most natural systems where nitrogen availability is limited and nitrification is inhibited by low pH. Although the importance of NO_3 vs. NH, metabolism is addressed by several authors and discussed in the Gojon et al. paper on the location of nitrate reductase within plants, the uptake of organic forms of nitrogen is not mentioned.

Part 1 of the book addresses the molecular aspects of nitrogen uptake, carbon assimilation and photosynthesis, respiration, and biomass construction costs. The authors of papers in this section point out that many aspects of carbon-nitrogen uptake, metabolism, and allocation are controlled by feedback and feedforward reactions. These reactions are associated with whole-plant growth and maintenance of functional equilibrium rather than the potential activity of various enzyme systems or nitrogen uptake capacity of roots. Organic acids and amino acids associated with nitrogen uptake and metabolism circulating within the plant are important for internal pH control and may be important for plant functional equilibrium.

Poorter considers the construction costs of different plant tissues. Contrary to expectations and published information, Poorter's detailed analysis of the literature indicates that construction costs (grams of glucose per gram dry weight) of leaves differ little among different species or among groups of species from contrasting environments. Because leaves are more expensive to construct than stems or roots, overall costs of woody plants may be less than herbaceous plants. The time required for a leaf to fix enough carbon to cover its own construction costs (payback time) may vary among contrasting species. However, miscalculations of payback time often occur because the relative value of carbon fixed at different times during the life of the leaf and the associated costs of stem and roots that support leaf function are not considered.

Part 2 of the book addresses carbon and nitrogen transport, storage, and control of allocation. The functioning, location, carbon costs, and energetics of the nitrate reductase (NR) system have been the focus of many studies in crop plants and associated weeds. However, relatively little information is available for woody plants and natural herbaceous vegetation. The assimilation of NO, or NH,. the reduction of NO, in roots or leaves, and the kinds of associated transport and storage compounds involved for a particular species have important ecological and energetic implications. Gojon et al., comparing two woody and two herbaceous species at low rates of NO, supply, found that NO, was reduced primarily in roots of woody species and shoots of herbaceous species. This difference appeared to be related to the low capacity for NO_3 uptake by woody plant roots. High concentrations of available NO, saturated root NR, increased NO, movement in xylem, and shifted reduction to shoots in woody plants.

Heilmeier and Monson discuss the variohs aspects of carbon and nitrogen storage in herbaceous and woody perennials, short-term diurnal storage in leaves, and long-term seasonal storage patterns of stems, roots, and rhizomes. They argue that defining several categories of storage would improve cost and benefit calculations of different allocation patterns for plants with different adaptation and growth strategies. Körner elaborates and uses examples of several plant life-forms to argue that the usual definition of plant compartments based on recognized morphological attributes such as leaf, stem, or roots, and shoot to root ratios is inadequate. Definitions should be based on functional criteria of leaves (photosynthesis, diurnal carbon storage), flowers and fruits (reproductive systems), stem and large roots (storage and transport), and fine roots (absorption of water and nutrients). Compartments based on functional criteria should help in comparing plant growth in different environments. However, defining and separating functional compartments for analysis may prove difficult.

What controls these different carbon and nitrogen allocation patterns, relative growth rates among fast- and slow-growing species, and carbon and nitrogen storage patterns? Inherited genetic programs, of course, but what are the signals used by plants to control this functional equilibrium? Various plant growth regulators (e.g., cytokinins, ABA) act as signals from roots to shoots that control stomata1 aperture and leaf expansion. Hydraulic signals generated by small changes in water potential within the plant have also been implicated. Other potential signals may be the differential synthesis, transport, and storage of sugars, organic acids, and amino acids. Van Bel and Visser suggest that interplant differences in the structural and physiological properties of the phloem control allocation patterns of organic materials and relative growth rates.

Part 3 of the book deals with carbon and nitrogen effects on plant development and their ecological significance. External environmental factors such as temperature. light, water availability, and mineral nutrients influence plant development. The external supply of C and N may also significantly affect plant development, but little is known about internal factors that influence development. Rooney concludes that the internal pools of C and N or C/N ratios are determined primarily by tissue type (meristematic tissue has a higher N concentration than mature tissue) but evidence that these internal pools influence development is meager.

In the only paper that addresses the growth response of plants to CO_2 enrichment, Stulen et al. use response diagrams to synthesize the many layers of information. They conclude that the effects of CO_2 enrichment on carbon allocation depend on plant species and experimental conditions, and that CO_2 stimulates relative growth rate and decreases plant N concentration, although the decrease in N concentration may be an artifact of increased starch concentration. They make a strong case for using growth analysis methods in conjunction with information on nutrient economy to link the functioning of the shoot and root to whole plant growth. Their integrated approach and method of diagramming numerous plant growth responses simultaneously will ultimately help improve understanding of 1) the maintenance of photosynthetic responses to N or C enrichment over time, 2) the capacities of the plant to acquire enough N or C to balance the increased availability of other elements, 3) the plasticity of response to N or C enrichment, and 4) the interspecific and ontogenic variabilities of responses to enrichment.

The final paper of the book will surely be used in graduate student comprehensive exams and defenses. Garnier and Freijsen provide a comprehensive assessment of the validity of making ecological inferences from laboratory experiments. After contrasting many parameters, the authors concluded that most observed differences between laboratory and field grown plants can be attributed to the different nutritional and climatic conditions in the two settings. Thus, potential relative growth rates measured in the laboratory are not representative of plant growth in the field. However, a good understanding of physiological mechanisms is required to interpret plant response to environmental stresses in the field. This understanding can be obtained more efficiently with studies in a controlled environment where some of the conclusions drawn are valid for field grown plants.

We highly recommend this book to plant physiologists, geneticists interested in evaluating the potentials of genetically modified plants, and ecologists who are evaluating the consequences of environmental change on plants. Although the theme of the book is carbon-nitrogen interactions, the book effectively demonstrates the relevance and importance of the whole plant approach in solving the questions asked in many scientific disciplines.

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MODERN MOLECULAR APPROACHES IN ECOLOGY AND EVOLUTION

Schierwater, B., B. Streit, G. P. Wagner, and R. DeSalle (eds.). **1994. Molecular ecology and evolution: approaches and applications.** Birkhäuser Verlag, Boston, Massachusetts. xi + 622 p. $165.00, ISBN: O-8176-2942-4 (acid-free paper).

The rapid development of molecular techniques in the past two decades has provided ecologists and evolutionary biologists with a host of exciting new tools. Schierwater, Streit, Wagner, and DeSalle provide a general overview of the impact that molecular techniques have had oh the disciplines of ecology and evolution. including historical views, current studies, and possible future applications of molecular techniques. The book contains 36 chapters organized into four sections: each section contains a short introduction that places each chapter within the larger context.

Part one, "DNA fingerprinting and behavioral ecology," includes reviews of common DNA fingerprinting techniques and their applications in studies of plants, insects, and birds. I was struck by how relevant these reviews were to the other sections of the book. Smith and Williams, Caetano-Anollés and Gresshoff. and Weising et al. specifically discuss the applications and limitations of various DNA fingerprinting techniques in population and phylogenetic studies. Westneat and Webster provide an excellent review of molecular studies