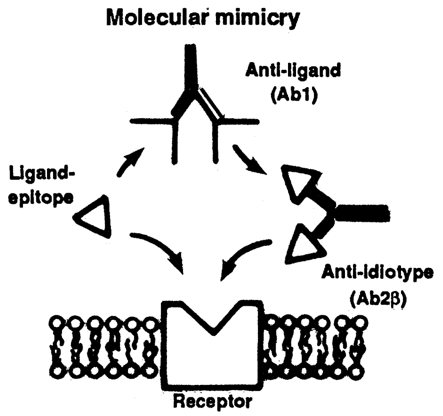


Working model of anti-idiotype mimicry. In this model anti-ligand antibody (Ab1) is equivalent to receptor and anti-idiotype antibody (Ab2β) mimics the original ligand. [Adapted from *Anti-Idiotypes, Receptors, and Molecular Mimicry*]

direct extension of these ideas, Sege and Peterson discussed another level of internal imaging, pointing out that the binding sites of some specific antibodies (Ab1) to ligands such as hormones or drugs might sterically and immunologically resemble the binding sites on their physiological receptors. Accordingly, certain anti-idiotypes (termed Ab2β by Jerne) raised to ligand-binding sites on Ab1 should serve as agonists or antagonists of the physiological receptor, and binding to them should be inhibitable by the original ligand or drug.

This volume of 20 papers explores these essentially quadrilateral relationships among ligand-epitope, physiological receptor, Ab1, and Ab2β at many levels (see illustration). The receptors studied recognize peptides and hormones important in neurologic or cardiovascular function, lymphocyte regulatory molecules, cell growth factors, and neutralization sites on viral envelopes, among others. The common thread in the monograph is the exploration of molecular mimicry by sites on the rather bulky immunoglobulin molecules for the potpourri of generally smaller ligands that bind to a variety of physiological receptors.

Particularly interesting in this respect are the discussions and experiments related to more precisely defining the shape of internal images on the anti-idiotypic Ab2β molecules. While Ab2β and ligand-epitope will compete at the Ab1 receptor site for binding, exactly how similar is the image of Ab2β to that of the epitope, what can be inferred about the shape of the hypervariable determinant regions on Ab1, and what is the energy of interaction between Ab2β and Ab1, compared to that between epitope and Ab1? Glasel's article on opiate receptors is especially illuminating on these questions; it also considers the physical basis for agonist versus antagonist function in Ab2β. Linthicum's group examines several of these issues in its analysis of neuroleptic ligands and their internal images. (A flaw apparent in early chapters and propagated in later ones is lack of uniformity in the definition of idiotypic terms even for basic concepts such as "internal image," which some authors mistakenly define as a structure complementary to the epitope.)

One reason for the considerable interest in the type of biochemical mimicry performed by the immune system lies in exploitation of anti-receptor Ab2β molecules for isolation and study of receptors such as the β-adrenergic receptor that are expressed only in small amounts on the surface of cells. Several contributions (for example, Farid; Sawutz and Homcy; Osheroff) consider the interactions of idiotypic ligands with such receptors as a means for functional characterization of the hormone-receptor system.

At times, viruses can use an unrelated integral membrane receptor as a viral attachment site (for example, the use of the β-adrenergic receptor by reovirus, as described by Gaulton and Greene). The interactions of viral receptors with antigenic retroviruses can become intercalated into the affairs of the idiotypic lymphocyte network (Ardman and Burdette). Ab2β molecules, raised to antibodies specific for viral gp70 determinants in susceptible preleukemic strains, react with gp70-binding sites on leukemic or preleukemic cells, regulating their growth.

For a "pure" immunologist, the crossover of the idiotypic network with the universe of physiological receptors represents a broadening of an already complex system whose rules are still being learned. How heterogeneous are the idiotypic sites recognized by anti-idiotypic antibodies? (Quite.) How frequently do internal image Ab2 appear? (Not very.) Do Ab2 invariably result in the individual from the injection of antigen? (No.) How does the response to antigen compare to the response raised against internal image Ab2β? (A complex issue.) Such questions are raised in many papers, with respect to innocuous as well as potentially pathogenic antigen systems.

An area of great importance, especially in current planning for the use of idiotypic internal image vaccines, is the description of the T-cell epitope content of Ab2β molecules. T-cell collaboration is known to be necessary for B cells to mature to the stage of antibody formation, and other subpopulations of T cells may themselves effect the elimination of the enemy within (infectious agents, tumors, and so forth). In a global consideration of network theory, Cleveland masterfully addresses several broad issues relating to "T cell–stimulating internal images" and their coexistence with "B cell–stimulating internal images," extending this aspect of network theory considerably beyond previous treatments. Although the accelerated march of immunologic research has already rendered certain of Cleveland's concerns obsolete, this thoughtful paper raises many pertinent notions about life in the "society of lymphocytes."

As is evident throughout this interesting volume, members of lymphocyte society perforce must interact within the organism with parallel and diverse cellular populations, decorated with receptors of differing function. The first glimmerings of an appreciation of the immune system's accommodation to its neighbors from other systems can be gleaned from this monograph. It should be accessible not only to immunological sociologists but also to chemists and biologists who are fascinated by the passage of information in discrete systems and by interactions among systems usually considered as totally separate entities.

ELI SERCARZ
Department of Microbiology, University of California, Los Angeles, CA 90024

Plant Interactions

Plant Strategies and the Dynamics and Structure of Plant Communities. DAVID TILMAN. Princeton University Press, Princeton, NJ, 1988. xii, 360 pp., illus. $45; paper, $15.95. Monographs in Population Biology, vol. 26.

The diversity of the earth's vegetation is striking and marvelous. We are in an era when much of plant ecology is dedicated to describing and explaining the diversity, the details that make the responses of each species in each habitat unique. David Tilman's new book goes in the opposite direction, with an attempt to identify and explain some of the functional processes that underlie broad patterns in the structure and dynamics of plant communities. These patterns include evolutionary convergence of vegetation in separate but similar climates and the consistency of vegetation succession on disturbed or bare sites.

Tilman begins from two assumptions. One is that a general theory must be mechanistic, based on quantifiable functional attributes. The second is that a general theory should, at this point, be simple and illustrative, rather than detailed and sophisticated.

Tilman's argument extends groundwork laid in his 1982 book *Resource Competition and Community Structure* (Princeton University Press), where he developed a conceptual-graphical model of competition for multiple resources. After summarizing the conceptual model, the new book identifies the resources most likely to be limiting and discusses how these resources interact. Then, Tilman develops a simulation model of plant community development and compares its predictions with those of the graphical technique. The structure and predictions of the model, ALLOCATE, form the book's intellectual core. ALLOCATE is a model of plant competition for limiting resources among hypothetical plants differing primarily in biomass allocation to leaves, stems, and roots. Tilman uses ALLOCATE to explore transient dynamics that do not appear in the graphical, equilibrium approach and compares its predictions with results from a number of systems, including his own studies of secondary succession on abandoned fields in Minnesota.

As in most models, Tilman's initial propositions are as important and interesting as the conclusions. Four central propositions motivate the structure and control the simplification in the simulation model. The first is that plants interact with each other only through modifying resource levels. This focus eliminates other interesting and potentially important biotic effects, but it may capture the interactions that are functionally most important in most ecosystems.

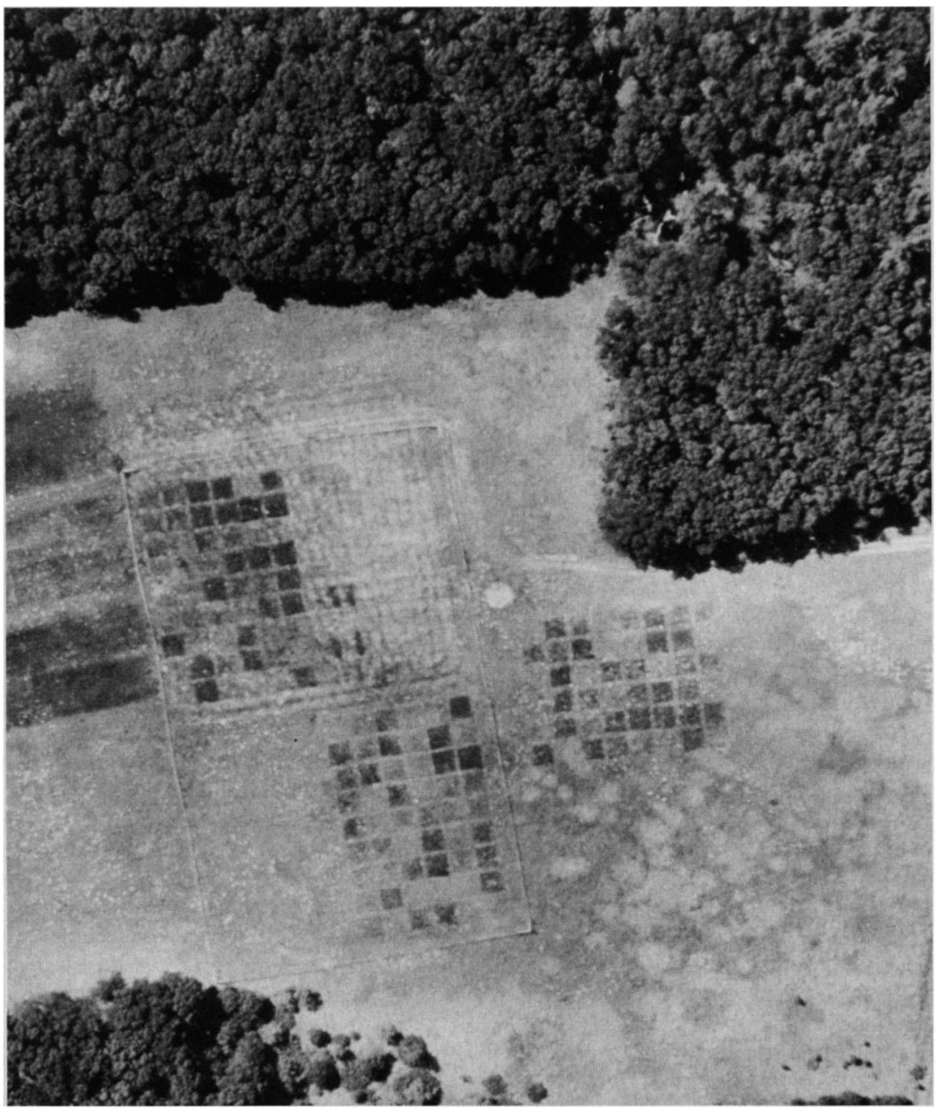
The second key proposition is that two classes of resources—above- and below-ground—shape community structure and development. This proposition is probably valid for Tilman's Minnesota ecosystem, where the only limiting below-ground resource is available nitrogen. In systems where multiple below-ground resources or biotic factors like pollinators or dispersers are limiting, a more complex theory will be necessary.

Tilman's third major proposition is that plants differ mainly in biomass allocation and that differences in biochemistry, physiology, life history, and reproductive allocation are an interesting but relatively unimportant embroidery on the fabric of plant evolution. Though this proposition is sure to be challenged by students of the "unimportant" phenomena, its justifiability undoubtedly increases with the range of life forms under consideration.

The fourth proposition links the others. It is the concept, often stated as the principle of allocation, that biomass invested in one function cannot simultaneously be used for another. Thus materials invested in foraging for below-ground resources are not simultaneously available for foraging above ground.

The conclusions from the simulation modeling fall into two classes. The results that identify mechanisms and patterns of plant community development illustrate the importance of the specific assumptions that accompany each simulation, and several results are very robust. The second class of conclusions sounds a warning about limitations of experimental ecology and emphasizes the need for integrated approaches to understanding competition. Tilman combines results of many simulations to demonstrate that no single morphological or physiological attribute is sufficient for predicting the outcome of competition. He also concludes that no matter how simple a community is, it is impossible to predict the long-term (decades or centuries) outcome of competition from short-term (one or a few years) experiments.

Overall, the book is remarkable for its conceptual completeness. Tilman begins from first principles and methodically explores their implications. Then he compares the predictions from the models against broad patterns in nature. Finding the correspondence good but insufficient for a definitive evaluation, he then tests the predictions against his own field studies, designed specifically for this purpose. Here, the relevance of the empirical evidence is much greater, and the strength of the general support for the theory is evident. However, the empirical data also highlight the complexity of the relationships and emphasize the difficulty of moving from a theory that predicts general



Aerial photograph, taken in 1983, of experimental plots in the 14-year-old field studied by the author of *Plant Strategies and the Dynamics and Structure of Plant Communities*. The smaller plots measure 4 by 4 meters, the larger ones (partly visible in the middle left) 20 by 50 meters. "The main difference among these plots is the rate of nitrogen addition. The two experimental nitrogen gradients discussed in this book are inside the fence. The uppermost set of 54 plots were disturbed in 1982 before being divided into plots and fertilized. The lowermost set of 54 were not disturbed, but were also fertilized starting in 1982. Both sets are fenced to exclude mammalian herbivores. Note that this field is surrounded by forest, but that very few trees have become re-established. . . . The field has, on average, about 40% of the total soil nitrogen of the surrounding, undisturbed forest." [From *Plant Strategies and the Dynamics and Structure of Plant Communities*] trends to one that predicts the distribution and abundance of individual species.

Tilman's approach is powerful and elegantly developed. In describing an approach to plant ecology that is mechanistic rather than descriptive, it outlines a productive new era for the field. The program is incomplete in the sense that it is thin on detail and emphasizes only a few kinds of interactions. However, the simplicity that makes it incomplete also makes it accessible. Ultimately, the book's greatest contribution may be as a model for an approach. As such, it will undoubtedly help shape the field in the years ahead.

CHRISTOPHER B. FIELD
Department of Plant Biology, Carnegie Institution of Washington, Stanford, CA 94305

The Fradkin School

Quantum Field Theory and Quantum Statistics. Essays in Honour of the Sixtieth Birthday of E. S. Fradkin. I. A. BATALIN, C. J. ISHAM, and G. A. VILKOVISKY, Eds. Hilger, Bristol, U.K., 1987 (U.S. distributor, Taylor and Francis, Philadelphia). In two volumes. Vol. 1, Quantum Statistics and Methods of Field Theory. xxii, 697 pp., illus. Vol. 2, Models of Field Theory. xxii, 599 pp., illus. $385.

These two monumental volumes commemorating the 60th birthday of Efim Samoilovich Fradkin contain some 60 papers by more than 90 authors. Among the contributors are many of Fradkin's former students and associates at the Lebedev Physical Institute of the Soviet Academy of Science in Moscow and an even greater number of physicists worldwide. The papers give a vivid representation of the vitality of modern field theory, its virility in cross-fertilizing disciplines, and, above all, the dynamism of one of its leaders: in the words of the editors, they describe "the phenomenon that is Fradkin."

The volumes are successful in conveying a sense of the Fradkin school: how its members select and pursue problems, how they relate one problem to another, how they respond to change. There are, however, shortcomings. The collection was assembled in 1984 and 1985, and many of the papers are now out-of-date. Activity in the area of superstring theories has exploded, and the nature of many of the outstanding issues in supersymmetry and supergravity theories has changed as they have been incorporated into the larger context of superstring theories. Furthermore, the representation of approaches in subfields is incomplete. For example, in the section of conformal field theory (vol. 1, part 3) the important algebraic approaches (using Kac-Moody and Virasoro algebra) are missing, as are their implications for string field theory and two-dimensional statistical models. In the section called "quantum gravity" (vol. 2, part 3) most papers are actually about higher-derivative gravitational theories. Although these are important topics in their own right, the issues of quantum gravity proper are not well represented. On the topic of the quantization of constrained systems, an area in which the Fradkin school (Batalin, Fradkin, Fradkina, Vilkovisky) has made fundamental contributions, one would expect—but does not find—a discussion of Hamiltonian quantum gravity by one of the canonical figures (for example, Kuchař or Ashtekar). In superstring theory an obvious omission is a contribution from the Princeton, Chicago, or Caltech groups, or from the "boys next door," Polyakov and company. Here the viewpoint of the Fradkin school is, perhaps understandably, promoted at the expense of a balanced perspective.

On the other hand, universality is achieved at a global level. The thread of quantum field theory connects the ten parts (not counting the historical and biographical papers) in the two volumes, which encompass quantization of dynamical systems, effective action, conformal field theory, many-body theory and statistics, new approaches, vector guage theory and problems of unification, quantum gravity, supersymmetry and supergravity, quantum anomalies, and superstring theory. Conformal field theory is used to calculate the critical indices in a contribution by Palchik and Zaikin, and quantum field theory is applied to amorphous systems by Parisi, to polymer blends by Edwards and de la Cruz, and to lattice models by Shteingradt. Esposito shows how formal developments such as the spectral density method developed by Fradkin and Kalashnikov can be useful to statistical physics. One also sees how topological, geometric, and group theoretical considerations enter in an essential way into modern quantum field theory, for example through the use of superspace geometry in supersymmetry theory. The use of harmonic superspace to deal with extended supersymmetry and to describe ten-dimensional heterotic superstrings is discussed by Galperin and by Kallosh. Ne'eman derives a geometric model for describing the auxiliary ghost fields introduced to preserve the unitarity of a gauge theory. Quantum anomalies of various kinds (scale, chiral, Lorentz, Schwinger) are known to be related to topological structure of fields. Jackiw discusses the relevance of Chern-Simons terms and cocycles in physics; de Wit and Grisaru address the question whether anomalies affect the gauge-equivalence for theories with compensating fields; and Nepomechie and Zee discuss the phase interaction between extended objects.

These volumes contain new ideas, such as Hawking's proposal to use cosmological boundary conditions to "exorcise the ghosts" in higher-derivative gravity theories and Kaku's random calculus approach to strong gravity. New approaches are also presented in field theory: Efimov's nonlocal field theory, Adler's quaternionic algebra, Klauder's stochastic quantization, and Nambu's intriguing theory of Galois fields. Many of the papers in these volumes will likely become standard references. These include a lucid review of the gauge- and field-reparametrization–invariant effective action by de Witt, a discussion of approximate effective action by Barvinsky and Vilkovisky, and a summary of the field-theory effective-action approach to quantum superstrings by Tseytlin. These summaries of the work of Fradkin and his collaborators on different aspects of field theory, in addition to the extensive overview by Feinberg, will probably be the most useful aspect of these volumes, at least for readers outside of the Soviet Union, because much of the original work has only appeared as reports of the Lebedev Institute or preprints at other institutes (such as the 1977 CERN preprint of Fradkin and Vilkovisky on the quantization of relativistic systems with constraints).

In addition to providing a record of the work of the Fradkin school, these volumes offer the reader a rare chance to examine and appraise Fradkin's life and work. Fradkin's first principle has always been to begin at the foundation and rely on the formal structures of field theory. One already sees this in his early work on functional integral formulation, operator schemes, and Green function techniques. The effective action method has served well in problems old and new—from QED and QCD to GUTs and strings. His work on the quantization of constrained systems has enabled him to consider a full range of basic issues, from Yang-Mills to gravitation theories. His belief in conformal invariance as a fundamental attribute of all forces has led him to pay attention to conformal field theory, conformal higher-derivative gravity theory, and conformal supergravity theory. These viewpoints and outlooks, in combination with his thorough and forceful approach, his keen interest in new developments, and his resilience in preserving old values, have set the course of a luminous scientific career.

B. L. HU
Department of Physics and Astronomy, University of Maryland, College Park, MD 20742