Einführung in die Chemische Ökologie

Franz Hadacek

T H E M E N Ü B E R S I C H T

6. 10. 2005	*Einführung und geschichtlicher Rückblick*
13. 10. 2005	*Diversität des Sekundärstoffwechsel*
20. 10. 2005	*Biosynthesewege und Enzymfamilien*
27. 10. 2005	*Bakterien*
03. 11. 2005	*Pilze*
10. 11. 2005	*Nematoden*
17. 11. 2005	*Insekten und Säugetiere*
24. 11. 2005	*Allelopathie*
1. 12. 2005	*Chemische Verteidigung*
8. 12. 2005	*Feiertag*
15. 12. 2005	*Chemische Anlockung*
12. 01. 2006	*Multitrophische Interaktionen*
19. 01. 2006	*Verflechtung von ober- und unterirdischen Interaktionen*
27. 01. 2006	*Chemische Ökologie und Biodiversität*

Ecology eLearning

VEC - Vienna Ecology Centre

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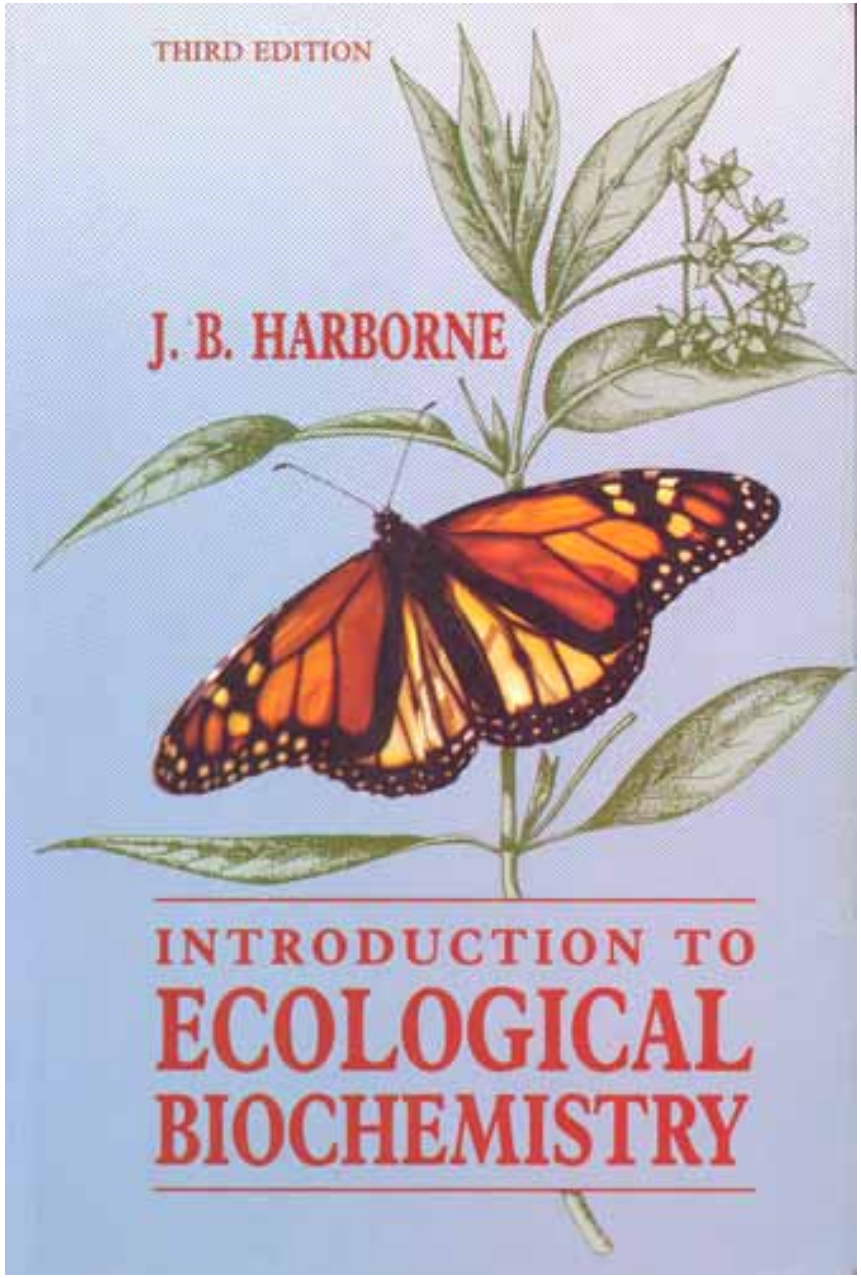
Kategorien

Kategorien

- Chemische Ökologie und Ökosystemforschung (6)
- Pflanzen-Ökopysiologie und funktionelle Anatomie der Pflanzen
- Bodenbiologie/Tierökologie (2)
- Computergestütze Lehre
- Limnology
- Test (1)



Ecological biochemistry concerns the biochemistry of interactions between animals, plants and the environment, and includes such diverse subjects as plant adaptations to soil pollutants and the effects of plant toxins on herbivores.

The ability to isolate trace amounts of a substance from plant tissues has led to a wealth of new research, and the third edition of this well-known text has consequently been extensively revised. The existence of stereo-chemical variants of many plant compounds has been recognised and new or expanded sections deal with much that is new and exciting in ecology. C4 metabolism, cyanogenesis, animal adaptations to high tannin diets and the phenomenon of induced defences in plant leaves are amongst the many topics explored.

Advanced level students and research workers alike will find much of value in this comprehensive text, written by an acknowledged expert on this fascinating subject.

ACADEMIC PRESS
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NEW YORK • BOSTON
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Spektrum Lehrbuch

Jeffrey B. Harborne

Ökologische Biochemie

Eine Einführung

Spektrum

J. B. Harbornes *Ökologische Biochemie* – im angelsächsischen Raum schon lange ein Standardwerk – liegt jetzt endlich auch in deutscher Sprache vor. Das Buch beschreibt didaktisch geschickt und anschaulich die biochemischen Beziehungen zwischen Pflanzen, Tieren und ihrer Umwelt und ist auch für Leser mit geringen Biochemiekenntnissen leicht verständlich.

- Pflanzen und biochemische Adaptation an Umwelt
- Biochemie der Pflanzenbestäubung
- Pflanzentoxine und ihre Wirkung auf Tiere
- Hormonelle Beziehungen zwischen Pflanzen und Tieren
- Nahrungspräferenzen
- Abwehrmechanismen von Pflanzen und Reaktionen der Tiere (Coevolution)
- Pheromone: Biochemische Kommunikation zwischen Tieren
- Biochemische Wechselwirkungen zwischen Pflanzen

»... *Ökologische Biochemie* ist ein exzellentes und faszinierendes Buch! Ich empfehle es sowohl Studenten als auch Wissenschaftlern, die auf dem Gebiet der Biologie, Biochemie, Chemie und Pharmazeutischen Biologie arbeiten.«

Konrad Dettner, *Entomologica Generalis*

J. B. Harborne ist Professor für Botanik an der University of Reading in Großbritannien.

Das Titelbild stellte freundlicherweise Andreas Held zur Verfügung.

ISBN 3-86025-243-3
9 783860 252451

Ecological Relationships of Plants and Animals

Henry F. Howe
Lynn C. Westley

Praise for

Ecological Relationships of Plants and Animals

"H.F. Howe and L.C. Westley set out to create a college-level text covering the ever-growing literature on the ecological and evolutionary consequences of plant-animal interactions. Drawing upon their own considerable expertise and the most recent publications, they have created not only an admirable introduction to the subject, but a well-balanced and extensive review of the current state of the art in this field."

BioScience

"A compactly written introductory text for a subject that is sorely neglected by many standard texts in ecology. . . . Represents one of the most rapidly developing areas in the field."

American Scientist

"Ecologists who would like to see the literature on plant-animal interactions transformed into a useful reference text will welcome the arrival of *Ecological Relationships of Plants and Animals* by Henry Howe and Lynn Westley. Their book presents an interesting synthesis of the empirical research on herbivory and three types of plant-animal nonsymbiotic mutualisms. The book's strength is its ecological focus, although it also discusses the evolutionary relationships between plants and animals. . . . a first-rate resource on the ecology of terrestrial plant-animal interactions."

Ecology

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ISBN 0-19-506314-7

Henry F. Howe & Lynn C. Westley

Anpassung und Ausbeutung

Wechselbeziehungen zwischen Pflanzen und Tieren

Spektrum
Akademischer Verlag

Eine Ameise verteidigt eine Passionsblume – kein seltenes Phänomen: Viele Ameisenarten sind ohne ihre pflanzlichen Partner dem Untergang geweiht, da diese ihnen beispielsweise Nahrung und Nistraum bieten. Doch entschädigen sie ihre Wirte entsprechend? Ziehen auch die Pflanzen einen Nutzen aus diesem Verhältnis? Handelt es sich um eine ausgewogene Beziehung?

Anpassung und Ausbeutung beschreibt die vielseitigen Wechselbeziehungen zwischen Pflanzen und Tieren und erklärt, wie sich die gegenseitigen Abhängigkeiten im Laufe der Evolution herausgebildet haben. Pflanzen nutzen die Energie des Sonnenlichtes, um aus Wasser und Kohlendioxid organische Stoffe aufzubauen. Mittel- oder unmittelbar sind daher alle Tiere, von der Ameise bis zum Elefanten – also auch wir Menschen – auf Pflanzen angewiesen, sei es als Nahrung oder als Baustoff.

Um sich gegen eine Übernutzung zu schützen, haben Pflanzen raffinierte Verteidigungsstrategien gegen ihre Feinde entwickelt. Viele besitzen strukturelle Schutzmechanismen wie Dornen oder Brennhaare; andere wehren sich mit Giftstoffen, zum Beispiel mit Coffein, Nikotin oder Strychnin. Im Gegenzug ist es manchen Tieren gelungen, sich diesen Widrigkeiten anzupassen: Sie haben beispielsweise Verdauungssekrete entwickelt, die pflanzliche Gifte außer Gefecht setzen.

Neben diesen recht einseitigen Beziehungen zwischen Tieren und Pflanzen gibt es aber auch Wechselwirkungen, die für beide Partner von Nutzen sind: Früchtefressende Tiere verteilen quasi als Gegenleistung für den Genuß des Fruchtfleisches den Samen, Nektar- und Pollenfresser transportieren Pollen von einer Pflanze zur anderen und sorgen so für die Bestäubung der Blüten.

Anpassung und Ausbeutung von Henry F. Howe und Lynn C. Westley bietet eine umfassende und durch aktuelle Literatur ergänzte Übersicht über ein Forschungsgebiet, das in vielen anderen Werken vernachlässigt wird. Der Text ist durch die ökologische und volkswirtschaftliche Bedeutung der Thematik eine wichtige Informationsquelle für Biologen, Agrarbiologen, Forstwissenschaftler, Pharmazeuten und Naturstoffchemiker, aber auch eine unterhaltsame Lektüre für naturwissenschaftlich begeisterte Laien.

Das Titelbild wurde freundlicherweise von Michael und Patricia Fogden zur Verfügung gestellt.

Plant Secondary Metabolism

David S. Seigler

Biochemistry/Plant Biology

Plant Secondary Metabolism

This timely reference provides an in-depth and up-to-date study of the most important groups of plant secondary compounds. No other work features such detailed diagrams of the biosynthetic pathways leading to the most important groups of secondary metabolites, as well as the structures of major types of compounds, their distribution in various taxonomic groupings of plants, and the evolutionary and ecological roles of these compounds.

Plant Secondary Metabolism presents a basic understanding of the origin of the compounds, the nature of the precursors involved, and the basic reactions, mechanisms, and stereochemistry. The origin of groups of secondary metabolites is linked to evolutionary principles, and their biological activity is viewed in a context of chemical ecology. Topics are treated comprehensively, enabling the reader to understand not only a particular group of compounds, but also how each group fits into the whole. In addition, the text allows readers to systematically survey various secondary metabolites and gain a quick working knowledge, which can be applied to problems in a particular field.

Those researchers and students who will be most intrigued by this publication's broad overview on plant secondary metabolites come from a diverse range of disciplines, including agronomy, anthropology, biochemistry, biology, botany, chemistry, ecology, entomology, food science, forestry, geology, horticulture, pharmacognosy, plant biology, plant sciences, toxicology, and zoology.

About the author

David Stanley Seigler is a member of the Department of Plant Biology at the University of Illinois, Urbana.

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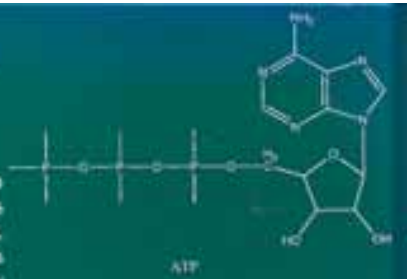
Natural Products from PLANTS

Peter B. Kaufman • Leland J. Cseke
Sara Warber • James A. Duke
Harry L. Brielmann

Pharmacology, Botany, Organic Chemistry



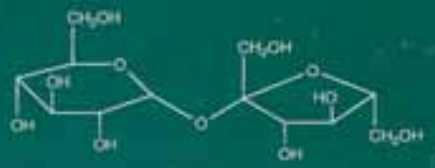
ATP

This new volume fills the need for an authoritative source on natural products and plants, bringing together relevant, practical information about the various types of natural products produced by plants, why they produce them, and their importance in today's world. **Natural Products from Plants** provides examples of how plant products are used to benefit humans through prevention and treatment of diseases, nutritional value, pest control, dyes, fibers, foods and beverages, flavorings and fragrances, and in creating many other novel compounds. It covers potentially harmful compounds as well. Anyone looking for a thorough understanding of the properties of natural plant products—both beneficial and harmful—will find the answers in **Natural Products from Plants.**

β-Carotene

Features

- Broad coverage of natural plant products in an organized, easy-to-understand format
- More than 100 figures illustrating examples of natural plant products
- Discussions of ways in which natural products are extracted from plants and how they are identified and analyzed
- Case studies of traditional uses of natural products from plants
- Strategies for conservation of plants that produce valuable natural products
- An appendix that offers a guide of questions to ask about natural plant products and provides access to website databases on these products
- Indexes of plant names, both common and scientific, and chemical names used in the text



Sucrose

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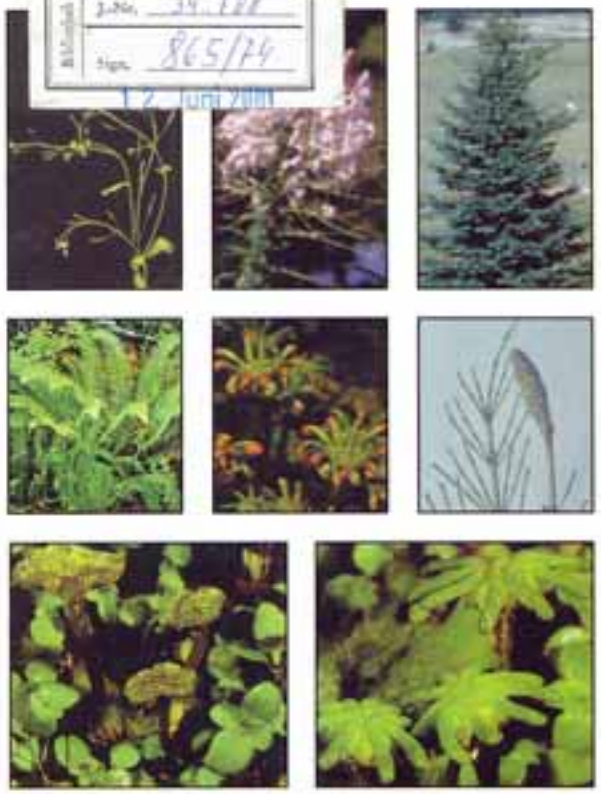
Volume 34 — Romeo, Ibrahim, Varin and De Luca



recent advances in phytochemistry

Evolution of Metabolic Pathways

Evolution of Metabolic Pathways

recent advances in phytochemistry–volume 34

Romeo, Ibrahim, Varin and De Luca

This monograph series is commissioned by the *Phytochemical Society of North America* (PSNA). The volumes in this series contain articles on developing topics of interest to scientists studying the biochemistry, chemistry and molecular biology of plants. Volume 34 covers the evolution of metabolic pathways.

The past decade has seen major advances in the cloning of genes encoding enzymes of plant secondary metabolism. This has been further enhanced by the recent project on the sequencing of the *Arabidopsis* genome. These developments provide the molecular genetic basis to address the question of the *Evolution of Metabolic Pathways*. This volume provides in-depth reviews of our current knowledge on the evolutionary origin of plant secondary metabolites and the enzymes involved in their biosynthesis.

Contributors to this timely volume explore a wide range of topics that include:

- Role of secondary metabolites in evolution
- Evolutionary origin of polyketides and terpenes
- Oxidative reactions and evolution of secondary metabolites
- Evolutionary origin of substitution reactions
- Structure-function relationships in the evolution of steroid sulfonation

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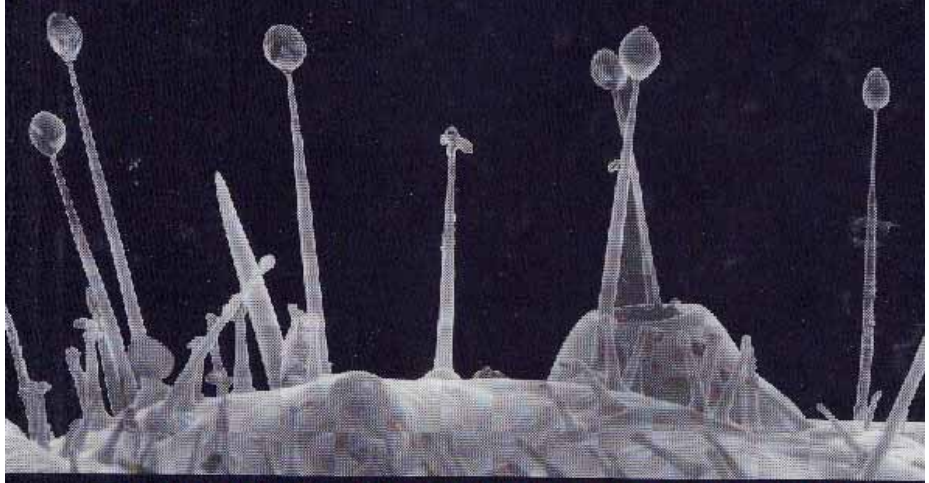
9 780080 438603

Chemical Ecology

The Chemistry of Biotic Interaction

Thomas Eisner and Jerrold Meinwald
Editors



NATIONAL ACADEMY OF SCIENCES

Chemical Ecology

The Chemistry of Biotic Interaction

Chemical signals among organisms form "a vast communicative interplay, fundamental to the fabric of life," in the words of one expert. Chemical ecology is the discipline that seeks to understand these interactions—to use the tools of chemistry and biology in the search for new substances of potential benefit to humankind. This book highlights selected research areas of medicinal and agricultural importance. Leading experts review the chemistry of insect defense and its application to pest control; phyletic dominance—the survival success of insects; social regulation, with ant societies as a model of multicomponent signaling systems: eavesdropping, alarm, and deceit—the array of strategies used by insects to find and lure prey; reproduction—from gamete attraction to courtship and sexual selection; and the chemistry of intracellular immunosuppression. Topics also include the appropriation of dietary factors for defense and communication, the use of chemical signals in the marine environment, the role of the olfactory system in signal analysis, and the interaction of polydnaviruses, endoparasites, and the immune system of their host.

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HOST-PLANT SELECTION BY PHYTOPHAGOUS INSECTS

E.A. Bernays
and
R.F. Chapman

Ecology / Behavior

HOST-PLANT SELECTION BY PHYTOPHAGOUS INSECTS

Contemporary Topics in Entomology 2

This is the first book that focuses on the behavior of host-plant selection by plant-feeding insects. It describes the patterns of host use, the chemical features of plants that determine host selection, the physiology of insect sensory systems, and the insect behaviors, with an emphasis on mechanisms. The book also discusses genetic variability and the effects of experience, and concludes with a review of the evolution of host-plant ranges.

This is a one-of-a-kind book for everyone interested in plant-feeding insects, an important reference for undergraduates, graduate students, research scientists and agriculturalists.

CONTENTS: Introduction. Patterns of host-plant use. Plant chemicals that influence behavior. Behavior: the process of host-plant selection. Behavior: the impact of ecology and physiology. Effects of experience. Genetic variation in host selection. Evolution of host range. Glossary.

E.A. Bernays is in the Department of Entomology at the University of Arizona.
R.F. Chapman is in the Division of Neurobiology, University of Arizona.

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Advances in Insect Chemical Ecology

Edited by **Ring T. Cardé** and **Jocelyn G. Millar**

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Advances in Insect Chemical Ecology

Chemical signals mediate all aspects of insects' lives and their ecological interactions. The discipline of chemical ecology seeks to unravel these interactions by identifying and defining the chemicals involved, and documenting how perception of these chemical mediators modifies behavior, and ultimately reproductive success.

Chapters in this volume consider how plants use chemicals to defend themselves from insect herbivores; the complexity of floral odors that mediate insect pollination; tritrophic interactions of plants, herbivores, and parasitoids and the chemical cues that parasitoids use to find their herbivore hosts; the semiochemically mediated behaviors of mites; pheromone communication in spiders and cockroaches; the ecological dependence of tiger moths on the chemistry of their host-plants; and the selective forces that shape the pheromone communication channel of moths.

Each review is written by an internationally recognized expert and presents descriptions of the chemicals involved, the effects of semiochemically mediated interactions on reproductive success, and the evolutionary pathways that have shaped the chemical ecology of arthropods.

Professors **Ring Cardé** and **Jocelyn Millar** are both based at the University of California, Riverside. Between them, they have written over 300 articles on chemical ecology and have co-edited 6 books.

Cover photograph: Larva of *Cosmosoma myrodora* (courtesy of William Conner).

Cover designed by Zoe Naylor

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Induced Responses to Herbivory

Richard Karban and
Ian T. Baldwin

Science

THE DISCOVERY that plants can respond actively to specific attacks by herbivores and pathogens has opened exciting new avenues of research and has led to an explosion of literature on the topic.

In *Induced Responses to Herbivory*, Richard Karban and Ian T. Baldwin have synthesized this diverse literature to provide a critical overview. Uniting the approaches of biochemical ecology, molecular biology, and population biology, Karban and Baldwin review the many circumstances in which induced responses have been observed. They describe the ways in which plants detect damage and respond to it, and examine the mechanisms responsible for induced resistance and defense. They also discuss the kinds of plants, herbivores, and environments in which induced resistance is found; consider the consequences of induced responses for herbivore life history and population dynamics; propose guidelines for collecting data on the effects of induced resistance on plant fitness; and evaluate evidence for various theories of why selection might favor induced rather than constitutive plant defenses. Finally, Karban and Baldwin present the prospects and problems of developing induced responses for management of agricultural pest populations.

This comprehensive, state-of-the-discipline overview and analysis will be welcomed by a wide variety of theoretical and applied researchers in ecology, evolutionary biology, biochemistry, molecular biology, plant biology, entomology, and agriculture.

"An excellent book. It brings plants to life and is bound to become a classic in the emergent discipline of chemical ecology."—THOMAS EISNER, Cornell University

"Karban and Baldwin's *Induced Responses to Herbivory* provides a very useful, timely, and balanced account of the ecological, chemical, evolutionary, and applied aspects of this rapidly developing field. The book is scientifically acute, and written in an appealing manner so that it serves as a readable introduction to the major issues for students and nonspecialists while still providing much of interest to specialists."—ERKKI HAUKIOJA, University of Turku

RICHARD KARBAN is professor of entomology at the University of California, Davis, and is coeditor of *The Evolution of Insect Life Cycles*. IAN T. BALDWIN is professor of biology at the State University of New York at Buffalo and is founding director of the Max-Planck-Institut für Chemische Ökologie in Jena, Germany.

Interspecific Interactions (II) is a series edited by John N. Thompson.

The University of Chicago Press

Cover illustration by Lynn Adler: A rosebush showing variation in defense. Thorns of rosebushes can be expressed in response to herbivory. In this case we do not know whether herbivory or some related cue caused the shoot on the right to produce thorns. The benefits and costs of having thorns, however, must be roughly equal, because growth and reproduction of the two shoots do not appear different.

ISBN 0-226-42496-0

9 780226 424965 90000

Induced Plant Defenses Against Pathogens and Herbivores

Biochemistry, Ecology, and Agriculture

Edited by
Anurag A. Agrawal, Sadik Tuzun,
and Elizabeth Bent

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9 780890 542422

Communities and Ecosystems

Linking the Aboveground and Belowground Components

David A. Wardle

MONOGRAPHS IN POPULATION BIOLOGY • 34

COMMUNITIES AND ECOSYSTEMS

LINKING THE ABOVEGROUND AND BELOWGROUND COMPONENTS

DAVID A. WARDLE

Most of the earth's terrestrial species live in the soil. These organisms, which include many thousands of species of fungi and nematodes, shape aboveground plant and animal life as well as our climate and atmosphere. Indeed, all terrestrial ecosystems consist of interdependent aboveground and belowground compartments. Despite this, aboveground and belowground ecology have been conducted largely in isolation. This book represents the first major synthesis to focus explicitly on the connections between aboveground and belowground subsystems—and their importance for community structure and ecosystem functioning.

David Wardle integrates a vast body of literature from numerous fields—including population ecology, ecosystem ecology, ecophysiology, ecological theory, soil science, and global-change biology—to explain the key conceptual issues relating to how aboveground and belowground communities affect one another and the processes that each component carries out. He then applies these concepts to a host of critical questions, including the regulation and function of biodiversity as well as the consequences of human-induced global change in the form of biological invasions, extinctions, atmospheric carbon-dioxide enrichment, nitrogen deposition, land-use change, and global warming.

Through additional theoretical synthesis and a tremendous range of examples, Wardle shows that the key biotic drivers of community and ecosystem properties involve linkages between aboveground and belowground food webs, biotic interaction, the spatial and temporal dynamics of component organisms, and, ultimately, the ecophysiological traits of those organisms that emerge as ecological drivers. His conclusions will propel theoretical and empirical work throughout ecology.

"After a long phase of specialization and splinter, ecologists are again converging on the ecosystem. In this book, David Wardle shows that he is qualified by experience and instinct to play a leading role in this exciting quest."

—J. P. Grime, *University of Sheffield*

"Over much of the twentieth century, there has been a disconnect between studies of aboveground and belowground organisms at both the community and ecosystem levels. Many of the belowground studies proceeded in relative isolation or were treated by ecologists at a 'black box' level. David Wardle's new book is truly a quantum leap forward in uniting studies of terrestrial ecosystems. It explains the concepts and mechanisms of community and ecosystem processes within the framework of a masterful review and synthesis of the world literature—leading us toward an ecological 'unified field theory' (pun intended)."

—David C. Coleman, *University of Georgia*

"This book is a benchmark and bellwether for a large volume of science that is being and will be conducted in this decade. It will be of value to both those scientists with casual interests in the topic and to the experts, because it provides short summaries and syntheses of findings as well as an in-depth analysis of available data."

—Timothy Seastedt, *University of Colorado*

David A. Wardle is Professor of Soil and Plant Ecology at the University of Sheffield and has published widely on biotic interactions, biodiversity, and soil biology.

Monographs in Population Biology • 34
Simon A. Levin and Henry S. Horn, Editors
www.pupress.princeton.edu

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Multitrophic Level Interactions

Edited by
Teja Tscharntke
Bradford A. Hawkins

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Multitrophic Level Interactions

The multitrophic level approach to ecology addresses the complexity of food-webs much more realistically than the traditional focus on simple systems and interactions. Only in the last twenty years have ecologists become interested in the nature of more complex systems, including tritrophic interactions between plants, herbivores, and natural enemies. Plants may directly influence the behavior of their herbivores' natural enemies, ecological interactions between two species are often indirectly mediated by a third species, landscape structure directly affects local tritrophic interactions, and below-ground food-webs are vital to above-ground organisms. The relative importance of top-down effects (control by predators) and bottom-up effects (control by resources) must also be determined. These interactions are explored in this exciting new volume by expert researchers from a variety of ecological fields. This book provides a much-needed synthesis of multitrophic level interactions and serves as a guide for future research for ecologists of all descriptions.

TEJA TSCHARNTKE is Professor of Agroecology at the University of Göttingen, Germany. His research focus is on plant–herbivore–enemy interactions including parasitism, predation and pollination, insect communities and food-webs on a landscape scale, and temperate–tropical comparisons. He is editor-in-chief of Basic and Applied Ecology and a member of the editorial board of Oecologia.

BRADFORD A. HAWKINS is an Associate Professor in the Department of Ecology and Evolutionary Biology at the University of California, Irvine. His research focus is on the biology and ecology of insect parasitoids, insect community ecology, food-webs, and energy-diversity theory. He is the author of *Pattern and Process in Host–Parasitoid Interactions* (1994, ISBN 0 521 46029 8), and editor of *Foundations of Ecology* (1994) with William Sheerman and *Theoretical Approaches to Biological Control* (1999, ISBN 0 521 57283 5) with Howard V. Cornell.

Cover photograph: 7-spot ladybird (*Coccinella 7 - punctata*) adult eating aphid. © Paulo de Oliveira, Oxford Scientific Films.

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Allgemeine Phytopathologie

Eckart Schlösser

2. neubearbeitete Auflage

Thieme

Tiere als Pflanzenschädlinge

Ökologische Grundlagen des Schädlingsbefalls an Kulturpflanzen

Bernhart Ohnesorge

2. neubearbeitete und erweiterte Auflage

Thieme

Warum machen Pflanzen sekundäre Pflanzeninhaltstoffe?

- Sie können nicht weglaufen und müssen sich verteidigen.

- Sie haben kein Immunsystem.

Geschichte

Julius von Sachs
(1832-1897)

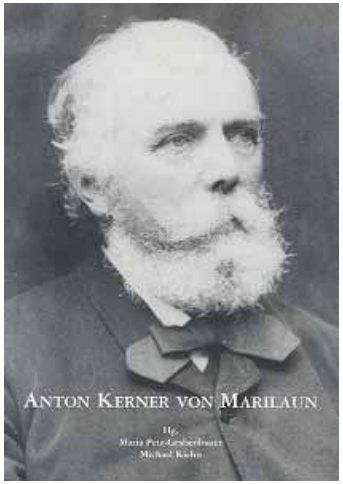
Lehrbuch der Botanik, 1873:

"We can designate as by-products of metabolism such compounds which are formed by metabolism but which are no longer used for the formation of new cells …….
…. Any importance for the inner economy of the plant is yet unknown."

Ernst Stahl, Jena 1888

Investigation of plant defenses against snails

Jenaer Z. Med. Naturwiss. **22**, 557−684



"Plants contain *protective agents* in leaves and roots against animals"

Pflanzenleben, 1890, 400

Albrecht Kossel
Nobel laureate for medicine 1910

"The plant cell contains seemingly nonfunctional compounds that are of secondary relevance …."

(*Arch. Physiol*. 1891,181)

First half of 20th century:
"Secondary metabolites are waste products"

G. S. Fraenkel

This Week's Citation Classic™

CC/NUMBER 11
MARCH 12, 1984

Fraenkel G S. The raison d'être of secondary plant substances. *Science* **129**:1466-70, 1959. [Department of Entomology, University of Illinois, Urbana, IL]

The secondary plant substances (allelochemicals) determine the acceptance of plant food by insects (and other organisms) by acting as repellents or attractants. This at once explains the raison d'être of these myriads of chemically unrelated compounds with no obvious nutritional function, and the specificity of host plants for their insects. [The *SCI*® indicates that this paper has been cited in over 200 publications since 1959.]

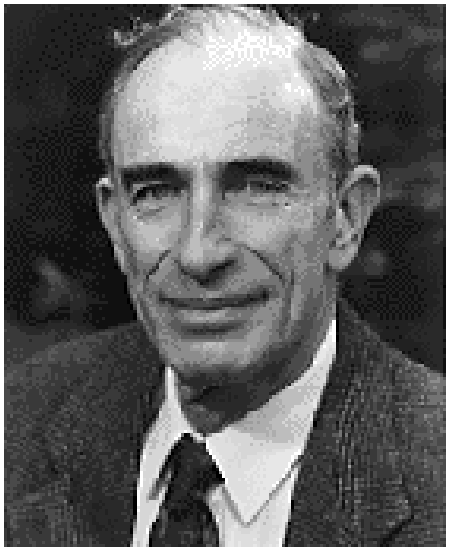
Gottfried Fraenkel
Department of Entomology
University of Illinois
Urbana, IL 61801

November 11, 1983

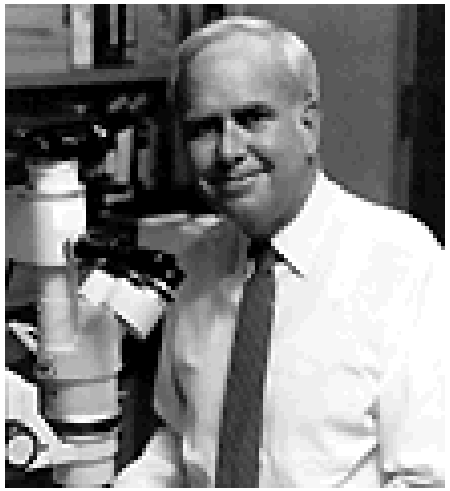
"This paper had a long and varied incubation period. A comprehensive study of the basic food requirements of many insects during the war years convinced me that they were essentially identical, and similar to those of 'higher' organisms. At the same time, I became involved in a study of human nutritional needs which also emphasized the importance of green vegetables in a national diet as seen under conditions of food shortages in wartime Britain. Subsequently, at the entomological congress in Amsterdam, 1951, I presented data to the effect that green leaves contained all the nutrients necessary for their insect predators, in excellent quantities and proportions, and there was no *a priori* reason why insects should not develop on any plant provided they ate them.[1]

"By what now seems a coincidence, during the war a then lieutenant of the Canadian Army turned up in my laboratory in England and became engaged in a PhD thesis on the role of the glucosinolates in cruciferous plants as feeding attractants for certain insects,[2] confirming similar earlier results.[3] Thus we had a situation in which all plants were potentially equally nutritious but were only very selectively eaten, suggesting a role for obviously nonnutritious plant substances in the food selection of certain insects. What could be simpler than putting these two premises together: the enormous variety in the distribution and composition of the secondary plant substances, for which no comprehensive and plausible explanation then existed, accounted for the equally staggering variety of insect/food-plant relationships, by their acting as repellents and attractants for insects (and other organisms). This I first stated in a lecture given at the zoological congress in Copenhagen in 1953.[4] "It took, however, another five years before these ideas found coherent expression in the paper under discussion. The reception of these views, judging by the annual citations (0 in 1959, six in 1960, one in 1961, two in 1962, one in 1963, one in 1964, three in 1965, seven in 1966, ten in 1967, eight in 1968, four in 1969, six in 1970, nine in 1971, six in 1972, seven in 1973, seven in 1974, nine in 1975, 15 in 1976, 24 in 1977, 16 in 1978, 13 in 1979, 14 in 1980, eight in 1981, 13 in 1982, and ten in 1983) now seems surprising —almost icy silence, and what comments there were were mostly negative during the first six years. Then the number of citations increased during the next five years, probably influenced by an important paper by Ehrlich and Raven,[5] but it was not until five years later that the field suddenly broke wide open. Since that time there has been an ever increasing avalanche of papers; almost annually occurring symposia; about 15 full-length books; and the creation of a virtually new discipline (chemical ecology) with its own journal and international society, now forming. Why this long delay in acceptance and prodigious explosion? The delay could not have been caused by a lack of exposure, with the paper in *Science* and a title which should have compelled equally the attention of organic chemists and plant scientists. Perhaps it seemed implausible that such a simple explanation could be virtually new, and at the same time correct."

1. **Fraenkel G.** The nutritional value of green plants for insects. *Transactions of the IXth International Congress of Entomology. Amsterdam. August 17-24. 1951.* The Hague: W. Junk. 1953. Vol. 2. p. 90-100.
2. **Thorsteinson A J.** The chemotactic responses that determine host specificity in an oligophagous insect *(Plutella maculipennis* (Curt.) Lepidoptera). *Can. J. Zool* **31**:52-72. 1953. (Cited 65 times since 1955.)
3. **Verschaeffelt E.** The cause determining the selection of food in some herbivorous insects. *Proc. Acad Sci Amsterdam* **13**:536-42. 1910.
4. **Fraenkel G.** Insects and plant biochemistry. The specificity of food plants for insects. *Proceedings of the XIV International Congress of Zoology. Copenhagen. 5-12 August 1953.* Copenhagen. Danish Science Press. 1956. p. 383-7.
5. **Ehrlich P R & Raven P H.** Butterflies and plants: a study in coevolution. *Evolution* **18**:586-608. 1964. (Cited 275 times.)



Paul Ehrlich



Peter Raven

This Week's Citation Classic™

CC/NUMBER 37
SEPTEMBER 10, 1984

Ehrlich P R & Raven P H. Butterflies and plants: a study in coevolution. *Evolution* **18**:586-608, 1964.
[Department of Biological Sciences, Stanford University, CA]

The relationships of butterflies and their larval food plants were described and the patterns were hypothesized to result from a reciprocal evolutionary process for which the term 'coevolution' was coined. The primary function of secondary plant chemicals was claimed to be defense against herbivores. [The *Science Citation Index*® (*SCI*®) and the *Social Sciences Citation Index*® (*SSCI*®) indicate that this paper has been cited in over 295 publications since 1964.]

Paul R. Ehrlich
Department of Biological Sciences
Stanford University
Stanford, CA 94305

April 16, 1984

"Our work began over the coffee table when I remarked to Peter Raven that it seemed strange that the *Euphydryas* butterflies that were the subject of my ecological research fed on plants of the families Plantaginaceae and Scrophulariaceae. Peter thought that combination not strange at all, and we began to have daily discussions in which I would describe patterns of food-plant use in butterflies, and he would see what sort of botanical 'sense' they made.

"We began ransacking the literature for data on which plants were eaten and for information on the common characteristics of those plants. The diets of butterflies turned out to be better documented than those of any other large group (12,000-15,000 species) of herbivores. Something was known of the food plants of roughly half of the genera, largely because of the interest of amateurs in raising butterflies in order to get perfect specimens for their collections. It was not long before we realized that the so-called 'secondary compounds' of the plants played a major role in the interactions.

"From that point on, it was a matter of brainstorming between two close colleagues, both evolutionists, one with much experience with butterflies and the other with plants. We did the work with a rising sense of excitement, as we suspected that coevolution was generally an underrated process. Zoologists tended to view plants almost as part of the physical environment; too many parasitologists did not consider the evolution of hosts; and so forth.

"I believe that our paper has been so widely cited because it provided for the first time a detailed discussion of the evolutionary relationships between two large, ecologically intimate groups of organisms. While various of the ideas can be found as far back as the writings of Darwin, and other people had suggested the defensive nature of plant chemicals, no one had put the picture together in this way before and discussed its manifold implications.

"The paper certainly helped spark the development of the now vast field of plant-herbivore coevolution and interest in the process of coevolution in general. Some idea of the ways in which this area of population biology has developed over the past two decades can be gained from a perusal of the excellent new volume edited by Futuyma and Slatkin.[1]

"Quite naturally, some of the ideas in our paper have been criticized, and some were probably quite wrong. Nonetheless, it seems to have stimulated the thinking of a great many people. It is probably the most-cited article either Peter or I have ever published, but that is not the thing that interests us most about it. Unlike our other work, it was done entirely around the coffee table and in the library—neither of us looked at an organism, living or dead, in the course of the work. Therefore our advice to young scientists, should they wish to publish a highly cited paper, apparently ought to be 'study books, and not nature!' "

1. **Futuyma D J & Slatkin M,** eds. *Coevolution*. Sunderland, MA: Sinauer Associates, 1983. 555 p.

Harold H. Flor

“gene for gene hypothesis”

virulence and avirulence genes
determine the outcome in
microbial pathogen−host interactions

Annu. Rev. Phytopathology **9**, 275−296 (1971)

Thomas Hartmann

PRIMARY METABOLISM

Growth and development of the individual

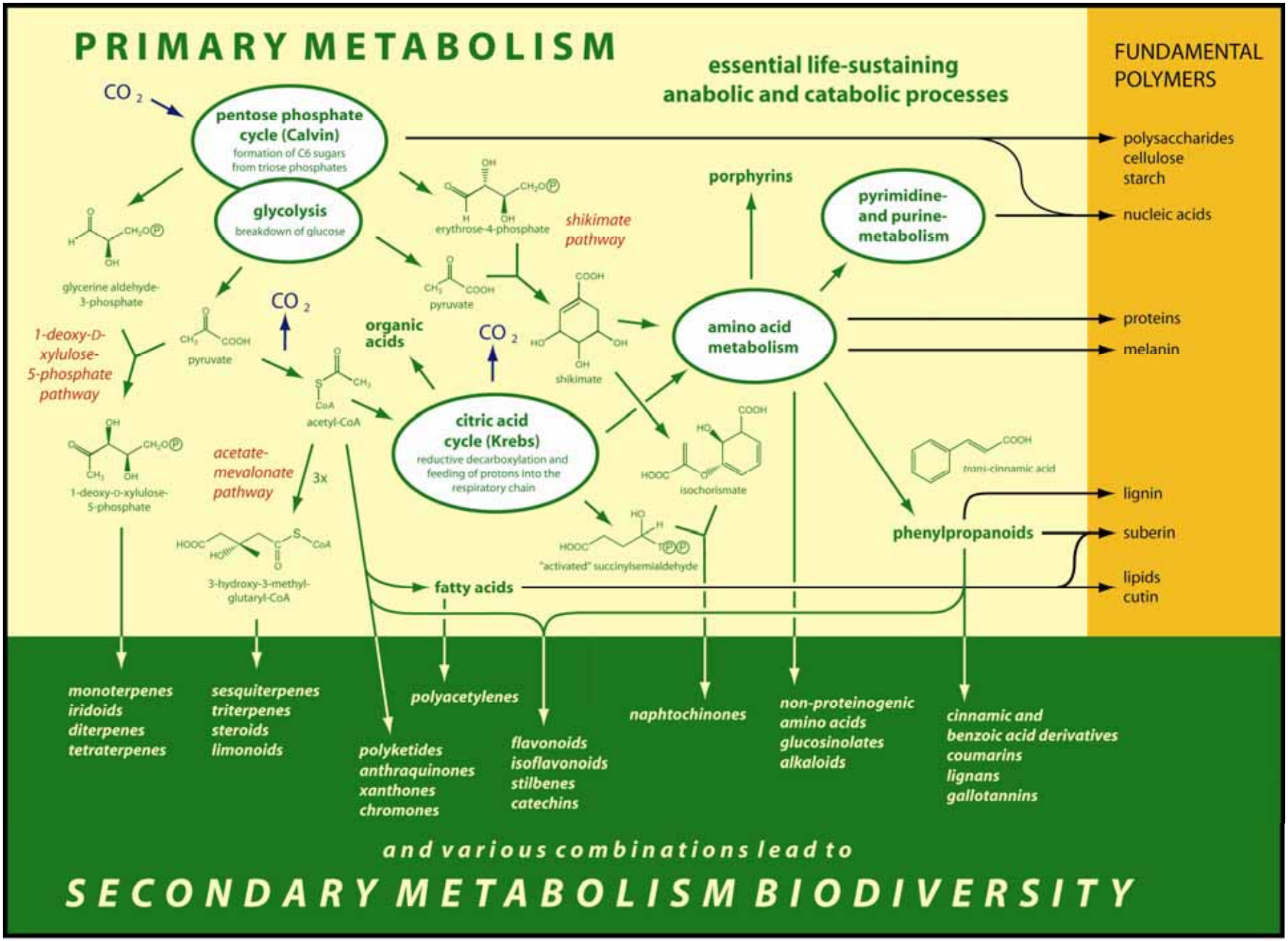
- **indispensable**
- **universal**
- **uniform**
- **conservative**

SECONDARY METABOLISMUS

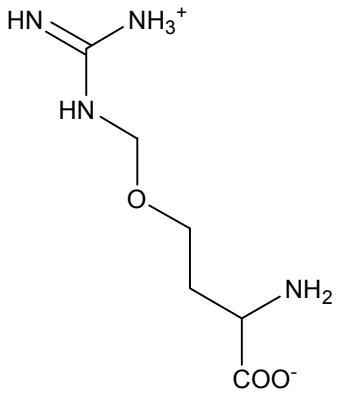
Interaction of the individual with its environment

- **dispensable for growth and development but**
- **indispensable for survival in the environment**
- **unique (restricted occurrence)**
- **diverse**
- **variable**

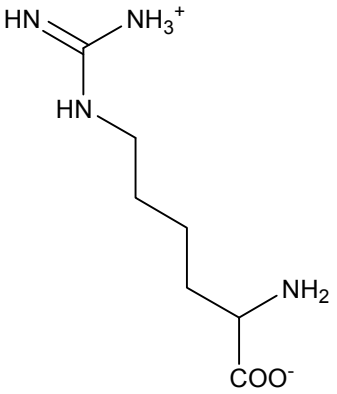
Entomol. Exp. Appl. **80**, 177−188 (1986)


PRIMARY METABOLISM
essential life-sustaining
anabolic and catabolic processes
FUNDAMENTAL
POLYMERS
CO 2
pentose phosphate
cycle (Calvin)
formation of C6 sugars
from triose phosphates
glycolysis
breakdown of glucose
glycerine aldehyde-
3-phosphate
erythrose-4-phosphate
shikimate
pathway
pyruvate
porphyrins
pyrimidine-
and purine-
metabolism
polysaccharides
cellulose
starch
nucleic acids
1-deoxy-D-
xylulose-
5-phosphate
pathway
CO 2
organic
acids
CO 2
amino acid
metabolism
proteins
melanin
pyruvate
acetyl-CoA
shikimate
1-deoxy-D-xylulose-
5-phosphate
acetate-
mevalonate
pathway
3x
citric acid
cycle (Krebs)
reductive decarboxylation and
feeding of protons into the
respiratory chain
isochorismate
trans-cinnamic acid
lignin
phenylpropanoids
suberin
lipids
cutin
3-hydroxy-3-methyl-
glutaryl-CoA
"activated" succinylsemialdehyde
fatty acids
monoterpenes
iridoids
diterpenes
tetraterpenes
sesquiterpenes
triterpenes
steroids
limonoids
polyketides
anthraquinones
xanthones
chromones
polyacetylenes
flavonoids
isoflavonoids
stilbenes
catechins
naphtochinones
non-proteinogenic
amino acids
glucosinolates
alkaloids
cinnamic and
benzoic acid derivatives
coumarins
lignans
gallotannins
and various combinations lead to
SECONDARY METABOLISM BIODIVERSITY

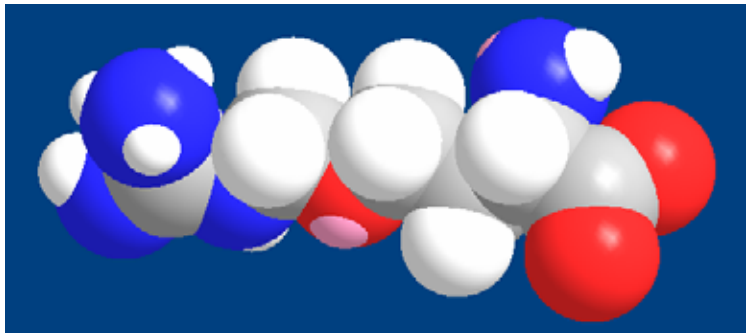
The distinction between a primary metabolite and a secondary metabolite is not always unambiguous.

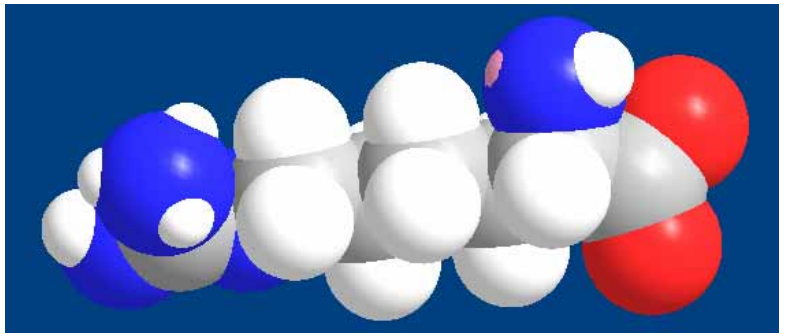


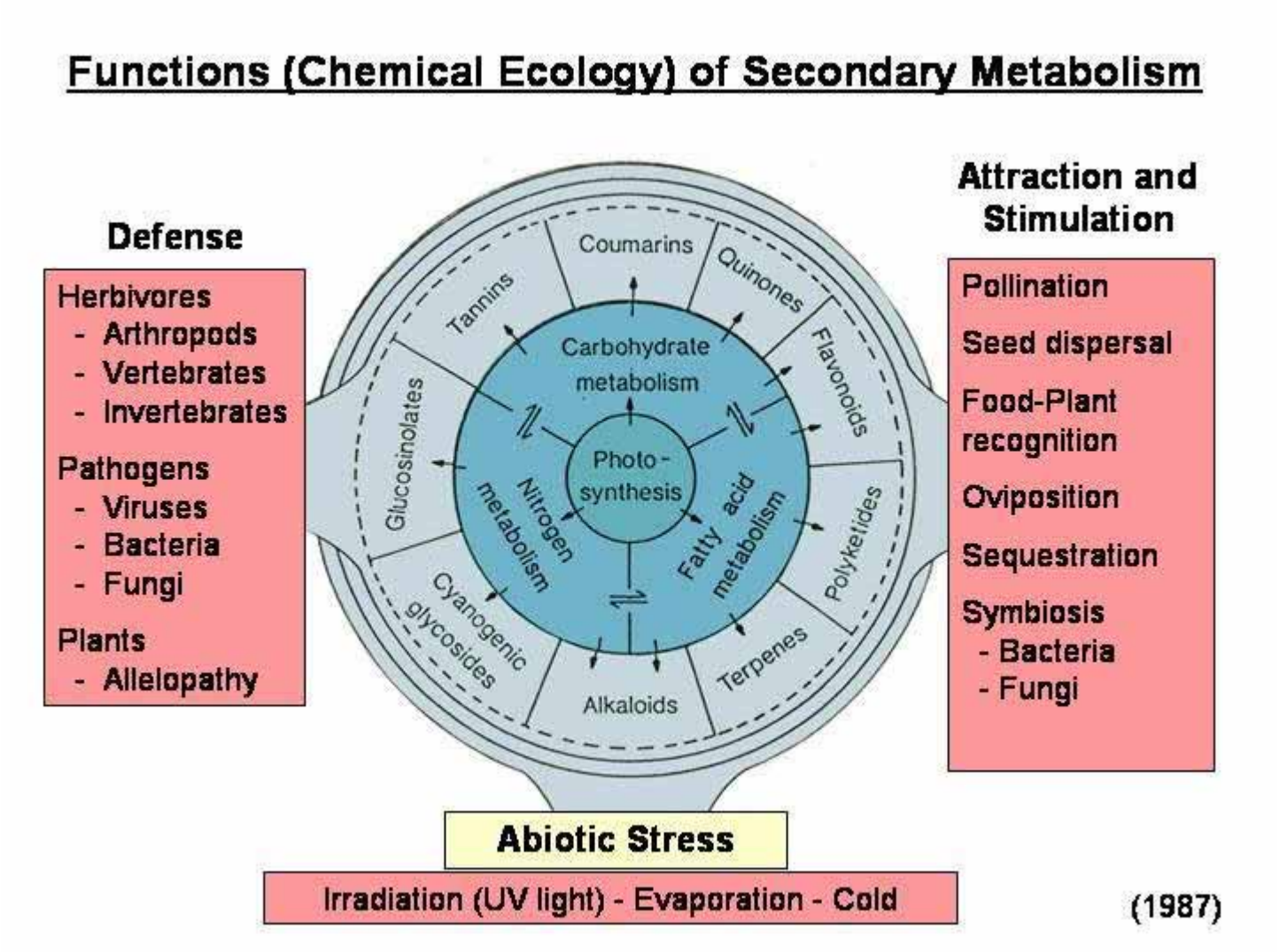
canavanine



arginine

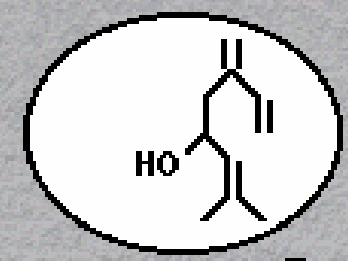






Thomas Hartmann

Entomol. Exp. Appl. **80**, 177−188 (1986)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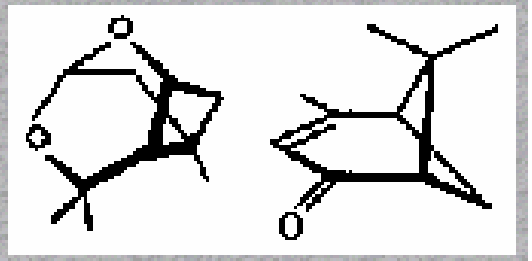

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e-mail webmaster

Chemical ecology came to be recognized as a distinct interdisciplinary research area about three decades ago. It deals with the intriguing chemical mechanisms which help control intra- and interspecific interactions among living beings.

All organisms use chemical signals to transmit information; "chemical languages" are the oldest forms of communication.

Research in the field of chemical ecology is concerned with the identification and synthesis of the substances which carry information, with the elucidation of receptor and transduction systems which recognize and pass on these "semiochemicals", and with the developmental, behavioral, and ecological consequences of chemical signals.

Bakterien

Bacterial infections

Fire Blight

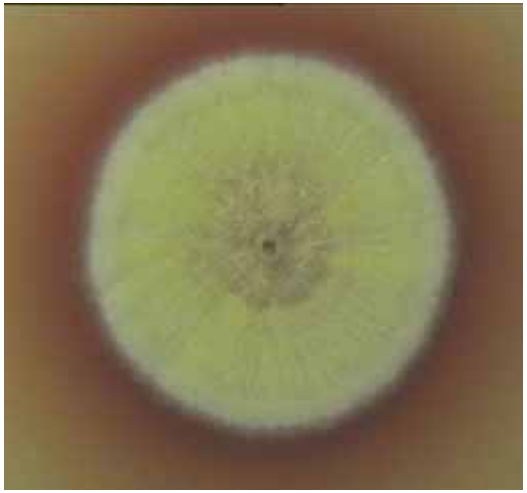
Erwinia amylovora

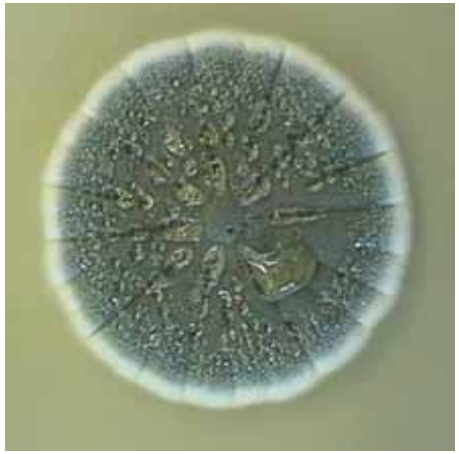
Viren

mosaic and stunt virus

Pilze

fungi on aerial plant parts

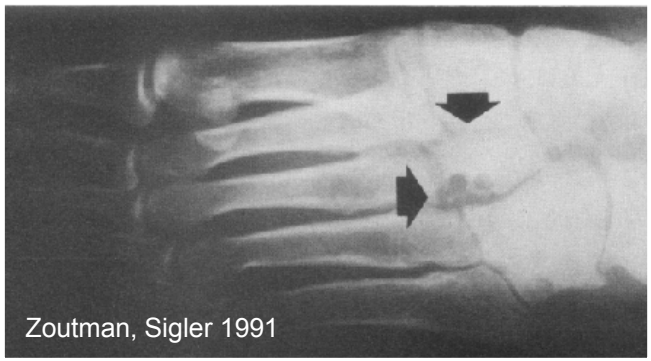


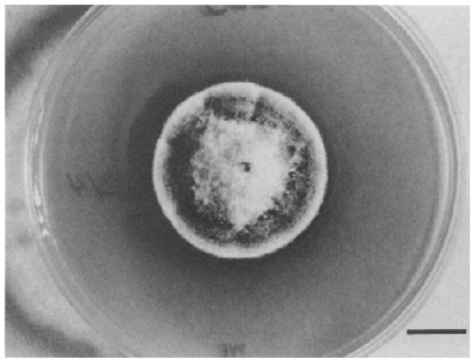
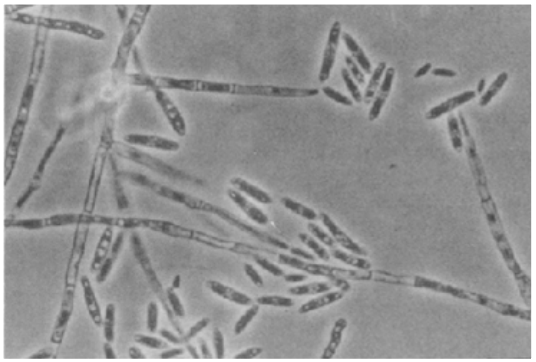


fungi in the rhizosphere



Cylindrocarpon destructans as symptomless endophyte or plant pathogen

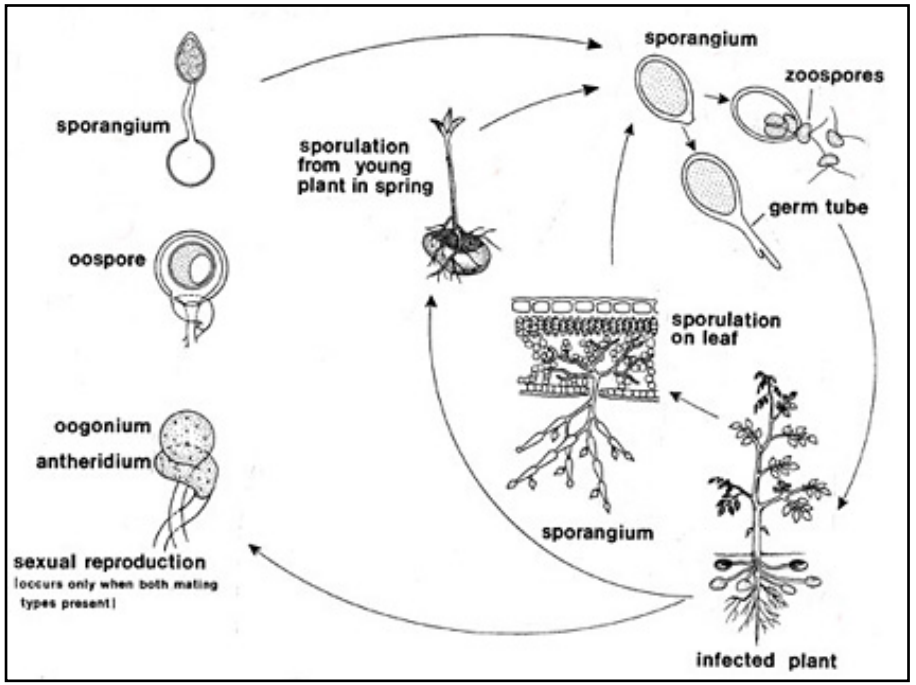


or even as human pathogen (mycetom)

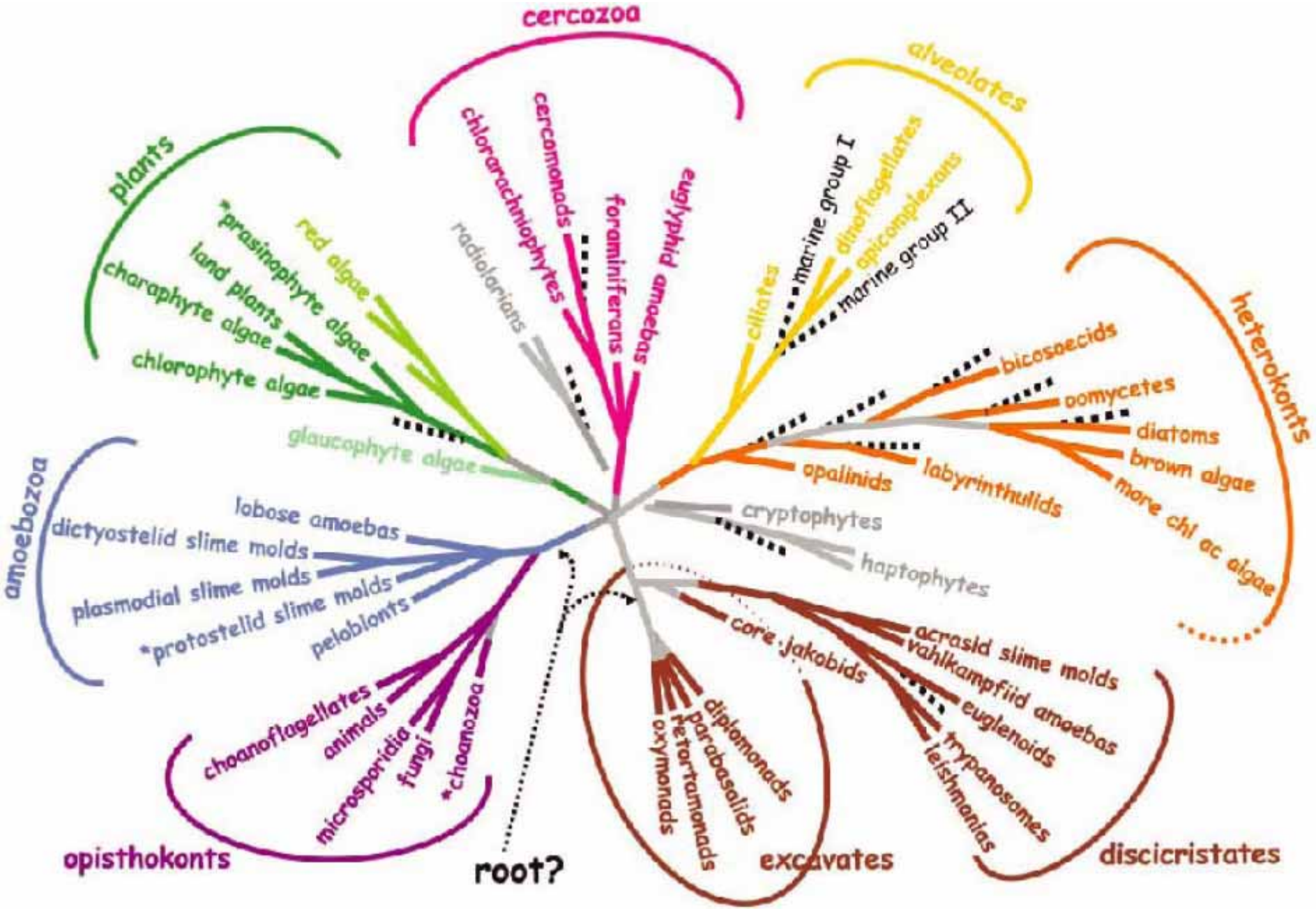
Potato Blight

Phytophthora infestans

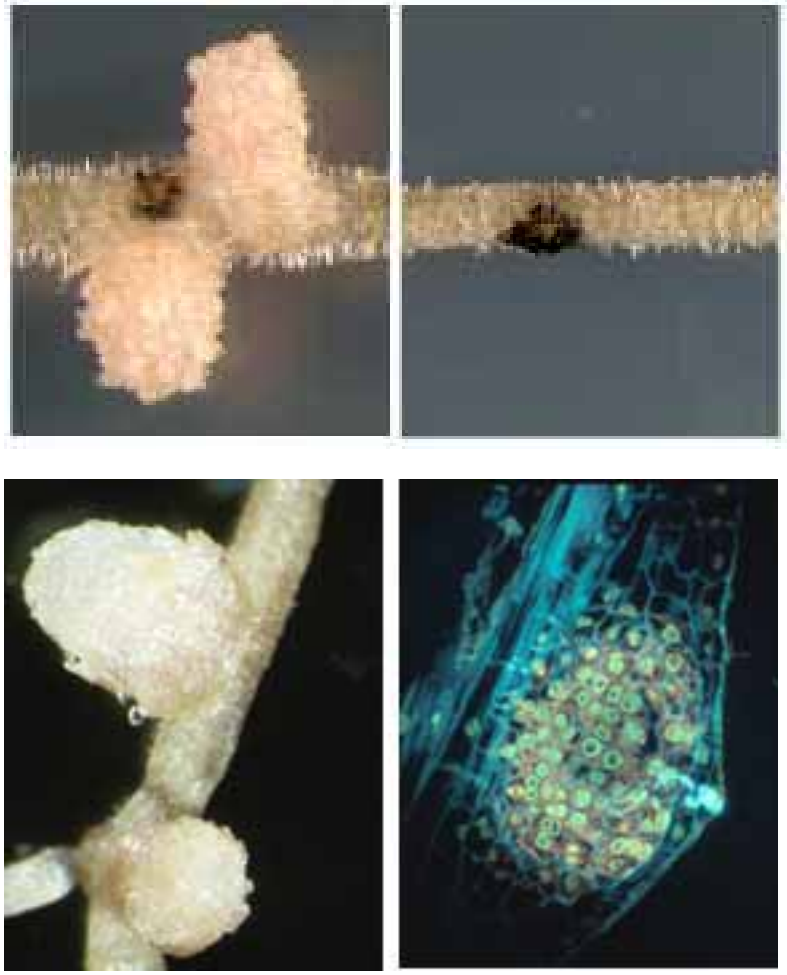


http://www.apsnet.org/online/feature/lateblit/chapter1/epidemic.htm

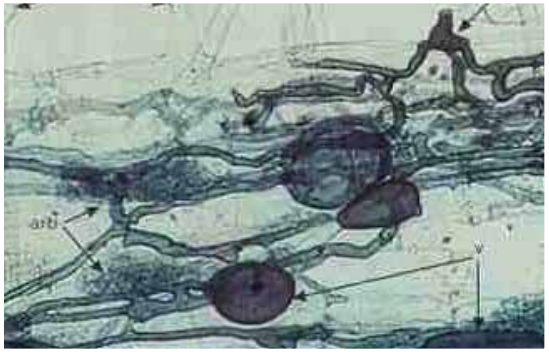
Oomycetes


cercozoa
chlorarachniophytes
cercomonads
foraminiferans
euglyphid amoebas
radiolarians
alveolates
ciliates
marine group I
dinoflagellates
apicomplexans
marine group II
plants
red algae
*prasinophyte algae
land plants
charaphyte algae
chlorophyte algae
glaucophyte algae
heterokonts
bicosoecids
oomycetes
diatoms
brown algae
more chl ac algae
opalinids
labyrinthulids
cryptophytes
haptophytes
amoebozoa
lobose amoebas
dictyostelid slime molds
plasmodial slime molds
*protostelid slime molds
pelobionts
core jakobids
acrasid slime molds
vahlkampfiid amoebas
euglenoids
trypanosomes
leishmanias
diplomonads
parabasalids
hetertramonads
oxymonads
choanoflagellates
animals
microsporidia
fungi
*choanozoa
opisthokonts
root?
excavates
discicristates

Symbiosen

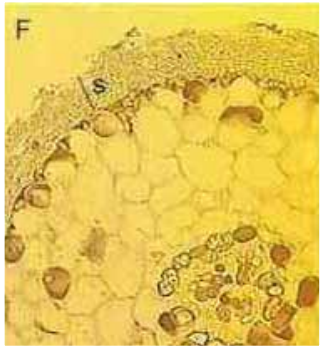


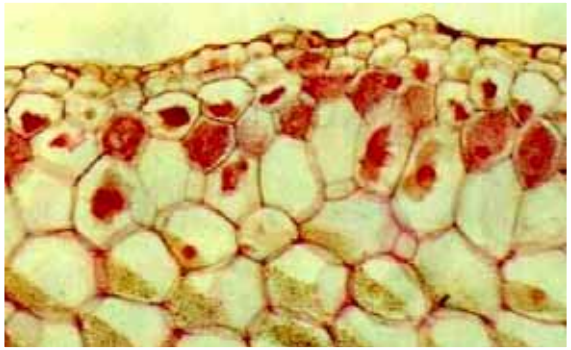
Nodule formation of legume-symbiotic bacteria

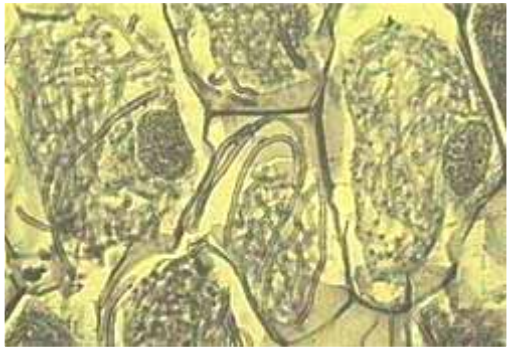


arbuscular mycorrhiza

ectomycorrhiza





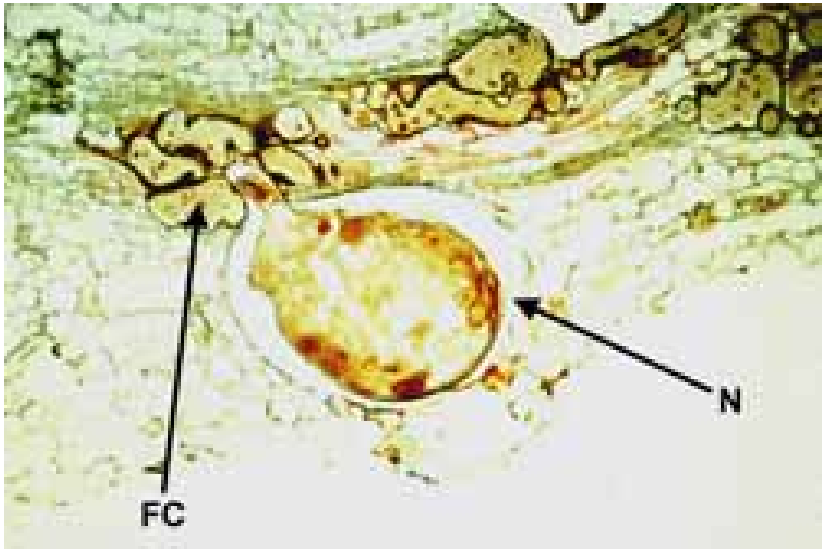


orchid mycorrhiza

http://helios.bto.ed.ac.uk/bto/microbes/index.htm#choice

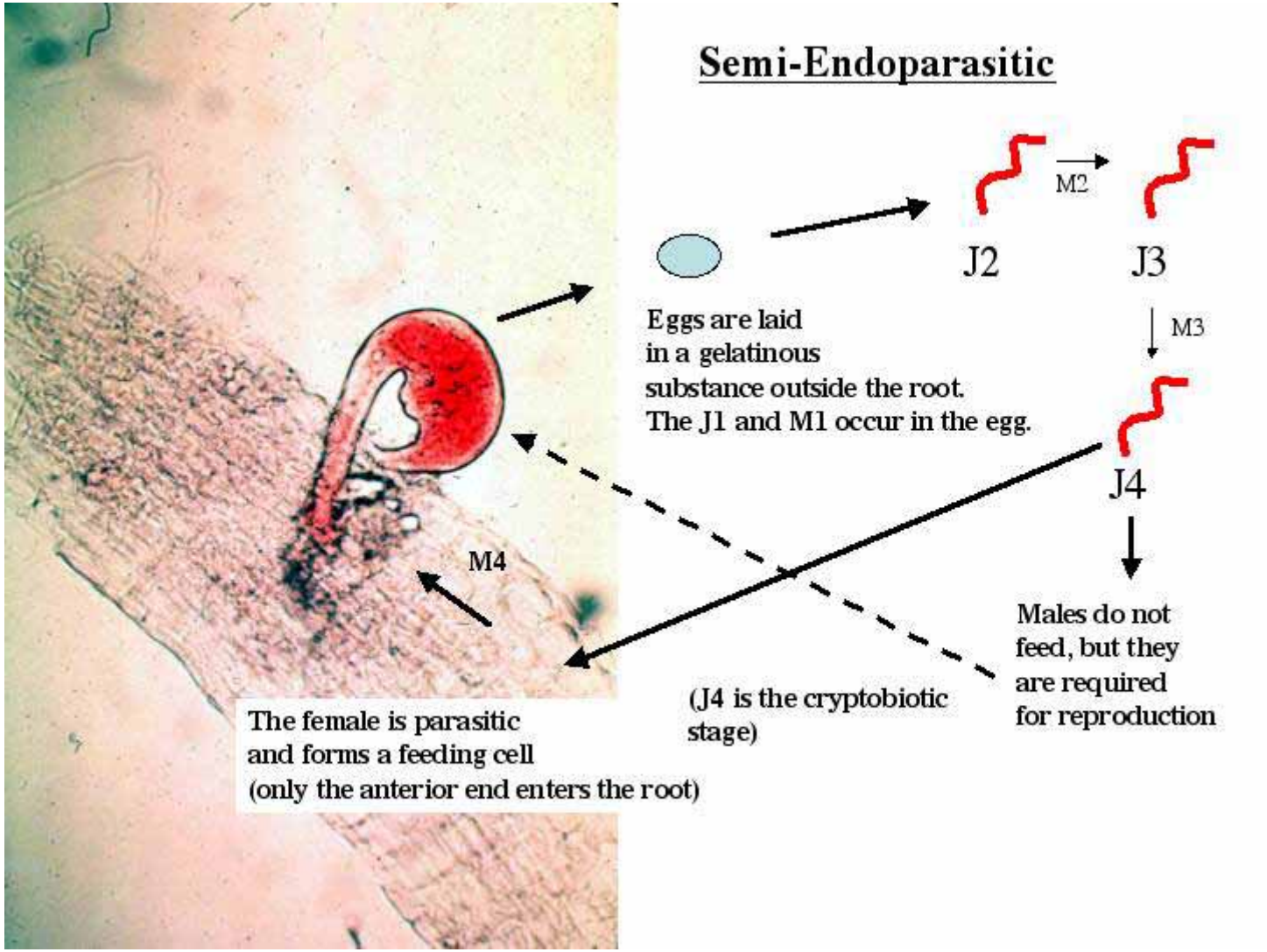
mycorrhiza

Nematoden



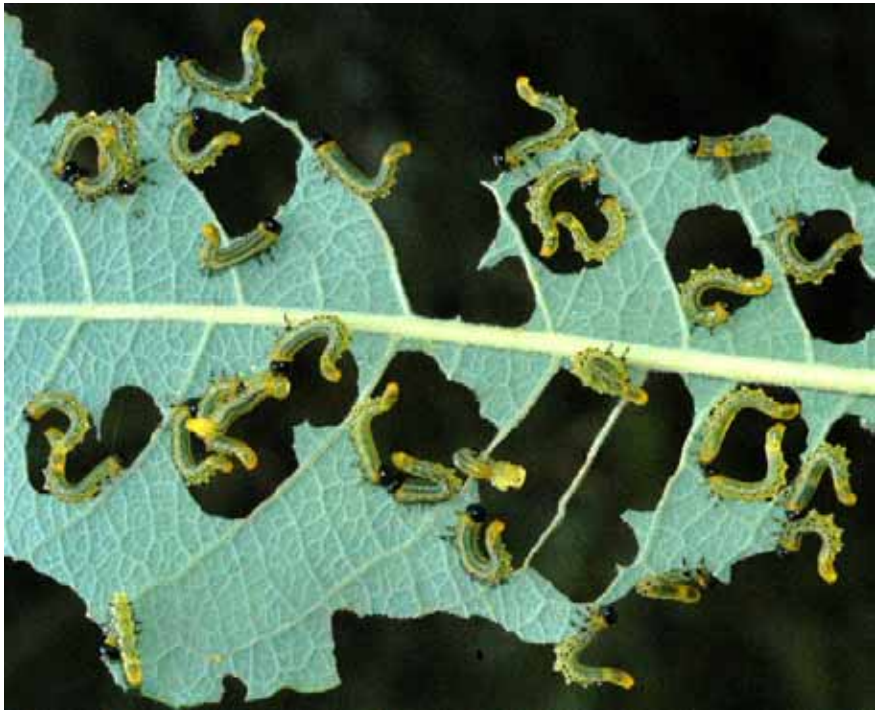
Feeding cell of root-knot nematode *Meloidogyne*

nematodes affect plant roots



Life cycle of the reiniform nematode *Rotylenchus*

Herbivorie



damage caused by of butterfly larvae and leaf wasp larvae

Wirtspflanzenerkennung und Eiablage

Larvae of *Vanessa atlanta* feed only on leaves of *Urtica dioica*

- Specific signals from the host plant induce oviposition
- Plants represent meeting points for reproduction of insects

Sequestrierung

Larvae

Imagines

Bestäubung

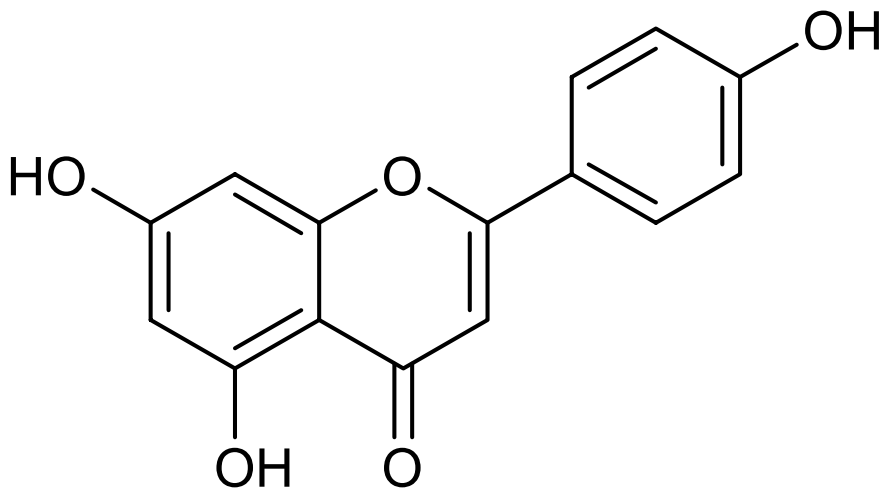
Allelopathie


NW U.S.A. 20 years ago

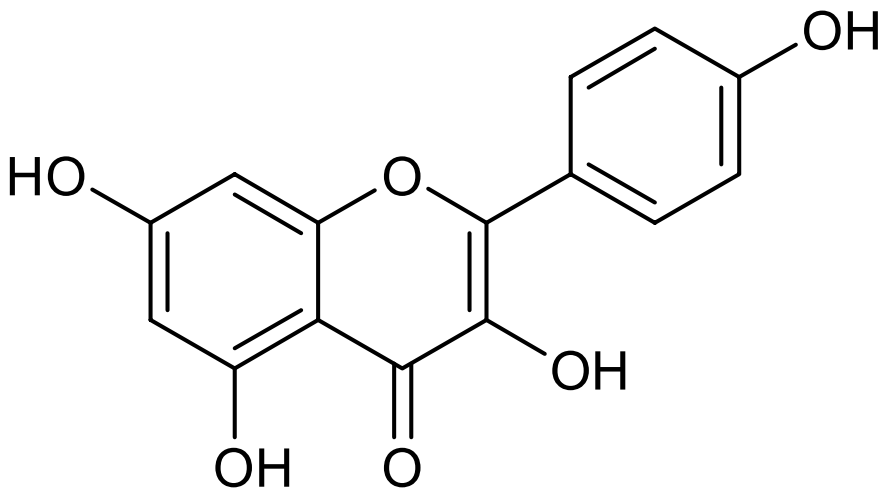

today


Centaurea maculosa

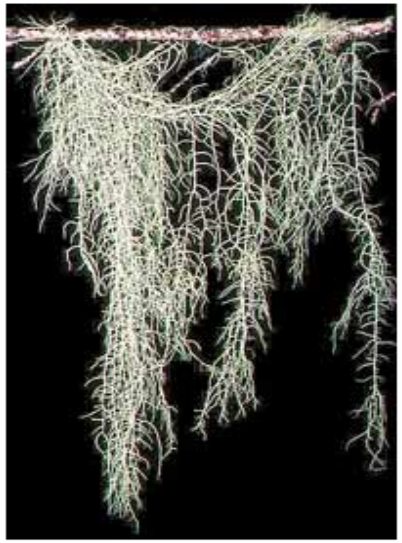
UV Lichtschutz

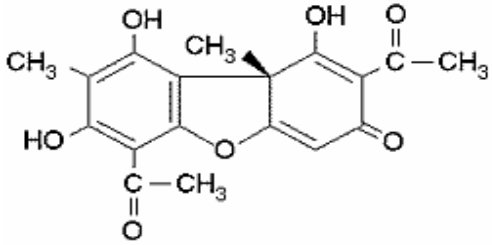


flavone



flavonol





One of the main active ingredients of usnea is the bitter, yellow, polyphenolic acid called usnic acid (structure diagram, left) that makes up about 1% of the crude material. It is thought to protect the lichen from adverse effects of sunlight exposure and deter grazing animals with its bitter taste. Since its first isolation in 1844, usnic acid has become the most extensively studied lichen metabolite and one of the few that is commercially available. It is well known as an antibiotic substance (1) that is also found in many other lichens.