Scientific Service


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Service units, such as the **mass spectrometry lab** for analyzing signaling substances, the **proteomics lab** for identifying gene products, and the **NMR lab** for performing structure elucidation, are essential for research at the institute. Moreover, we provide consulting services for **statistical analyses** and for **high resolution microscopy**, which enables the tiniest structures to be visualized three-dimensionally.

International Doctoral Program

The **International Max Planck Research School** "The Exploration of Ecological Interactions with Molecular and Chemical Techniques" – a joint graduate program for outstanding young scientists – is offered by the MPI for Chemical Ecology and Jena's Friedrich Schiller University. The goal of this graduate program is to study ecological interactions experimentally, under natural conditions. Plants, insects and microorganisms are the focus of investigations. Prospective students from all over the world with degrees in organic chemistry, biochemistry, ecology, entomology, neurobiology, bioinformatics, genetics or molecular biology, as well as a keen interest in ecological interactions, are encouraged to apply. Participants pursue doctoral degrees in an interdisciplinary environment and in the context of a three-year structured training program; excellent research conditions are supplemented by practical courses, lectures, seminars and participation in international conferences.


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Research Coordination:
Dr. Karin Groten
Tel.: +49-3641-571000
kgroten@ice.mpg.de

Public Relations:
Angela Overmeyer
Tel.: +49-3641-572110
overmeyer@ice.mpg.de

IMPRS Coordination:
Dr. Claudia Voelckel
Tel.: +49-3641-571001
cvoelckel@ice.mpg.de

Facts and Figures

- Founded in 1997
- 5 scientific departments
- More than 350 co-workers from more than 25 countries
- International doctoral program, the International Max Planck Research School "The Exploration of Ecological Interactions with Molecular and Chemical Techniques"
- Equipment, instrumentation and research infrastructure, include glasshouses, climate chambers, state-of-the-art NMR and MS techniques for sample analysis, wind tunnels for behavioral assays, and field stations.

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Max Planck Institute
for Chemical Ecology

Chemical Ecology

How organisms communicate with each other via chemical signals

MAX-PLANCK-GESELLSCHAFT

What we are researching

Chemical Ecology is the study of the role, diversity and properties of the chemical signals that mediate interactions between organisms and their environment. The overarching goals of our research are to gain basic insights into the chemical communication between plants, insects and microorganisms, to understand the processes in the brain of insects which control their behavior, and to comprehend how these aspects influence the development of single organisms as well as the evolution of species.


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Because plants are sessile organisms, they need effective strategies to disperse their offspring. We investigate how **plants** best adapt to their respective environments and identify the chemical compounds they produce to attract pollinators, fend off herbivores and pathogens, or keep unpleasant competitors away.

In the course of evolution, **insects** have adapted to the survival strategies of plants. We therefore analyze the genetics, physiology and behavior of herbivorous insects. Insects also make use of plant substances to protect themselves against predators: They sequester toxic compounds; some insects even signal by exhibiting their bright colors that they should better not be eaten


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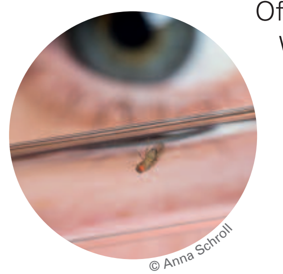
Microorganisms play a crucial role in the fitness of plants and insects. Some are pathogens, others help to supply nutrients or boost the immune system. We want to determine who plays which role.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Of special interest is how insects perceive **odors and tastes**. We investigate how insects "translate" the vocabulary of odors emitted by plants and other insects, how odors influence insects' behavior when they search for food, and how they locate sexual partners and the ovipositing sites where their offspring can thrive.

Chemical Analyses


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We use state-of-the-art analytical methods, such as liquid and gas chromatography coupled with high-sensitivity mass spectrometers and bioinformatics tools, to identify odors, signal molecules and metabolites from plants and animals. Three modern nuclear magnetic resonance spectrometers facilitate the identification and structure elucidation of substances. Laser-assisted techniques are used to visualize the distribution of substances in intact tissue.


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Behavioral Assays

A broad spectrum of methods has been established for behavioral assays, from simple odor traps to highly automated devices for studying the responses of flies to different odors, and large wind tunnels with 3D recording systems for analyzing odor-guided behavior in moths. Resistance tests provide information about how different pest insects resist pesticides or the plant's own defenses.

Microscopy

For neuroanatomic studies, but also to visualize interactions of bacteria with plants or insects, we label individual components with fluorescent dyes and use laser scanning electron microscopy.


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Defense Protection Attraction Deterrence Warning Cry for Help Adaptation Perception Mating Toxins Detoxification Behavior Resistance Digestion Survival Reproduction


© Alexander Haverkamp


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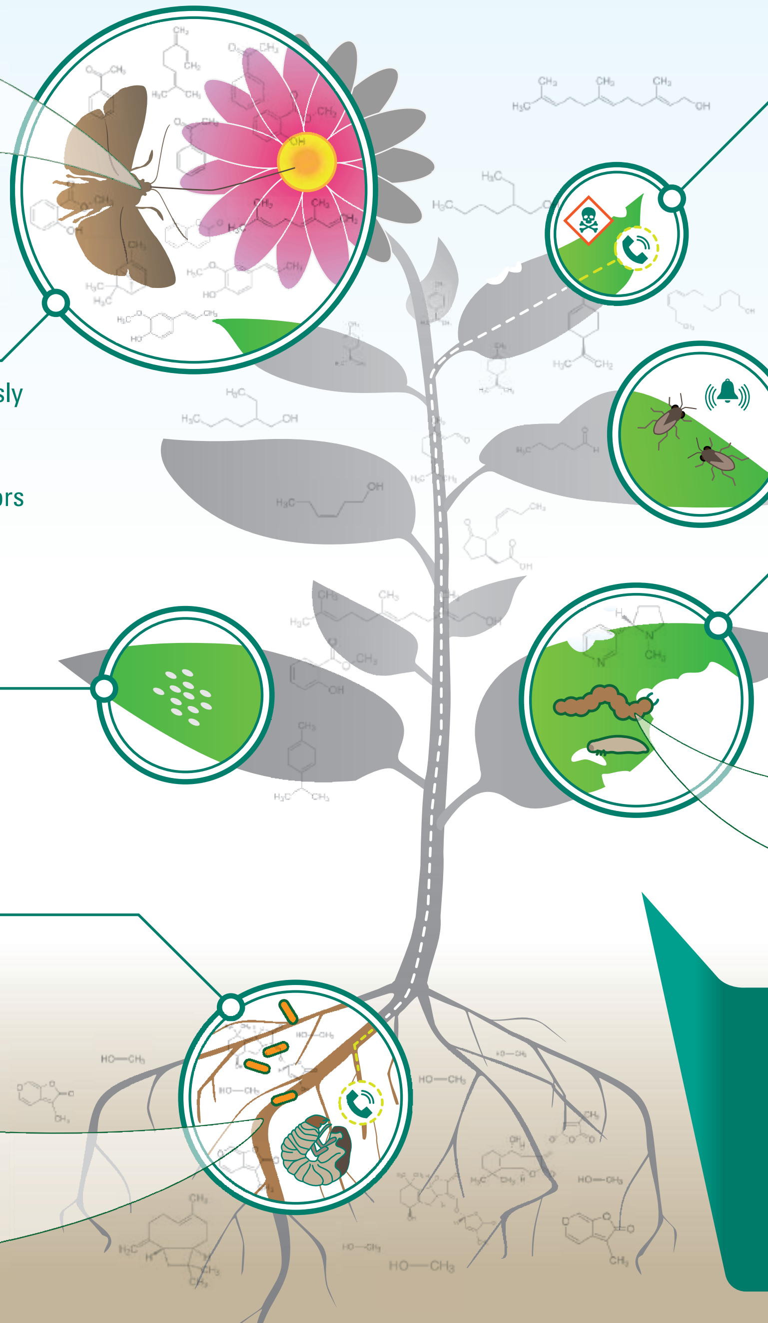


Pollinators and the Pollinated

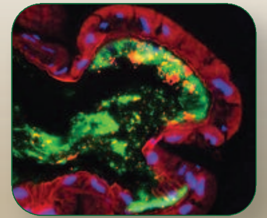
- How do flowers attract pollinators and simultaneously fend off herbivores?
- How do plants select pollen?
- How do insects perceive odors and how are the odors processed in their brains?

Insects: Mating and Ovipositing

- How do insects select the best plants on which to lay their eggs?
- How do male insects find female partners?

Microorganisms

- How do microorganisms influence plant defenses?
- How do plants and insects attract microorganisms?
- How can microorganisms help insects survive?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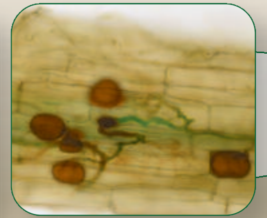
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Plants: Defenses

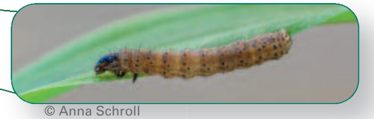
- What signals and substances do plants produce after herbivore attack?
- How and why have plants evolved such a wide variety of plant toxins?
- How are signals exchanged between the shoots and roots of plants?

Predatory Insects

- How do plants attract the enemies of their enemies?
- How do herbivorous insects warn predators of their toxicity?

Herbivores

- How do insects adapt to plant odors and toxins?
- How do insects use plant defenses for their own benefit?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All organisms interact with each other. They communicate by using a common language: chemical substances.

Illustration and Design: pigurdesign

Genetics and Molecular Biology


© Sher A. Khan

For the functional analysis of genes, we use insects and plants that differ in their genetic makeup, for example, through mutation or genetic transformation. Modern methods, such as the gene editing system CRISPR/Cas9 for targeted genome modifications, as well as recombinant inbred lines, are also being used. In different cell lines of insects, plants or yeasts, we create specific proteins and explore their function in the context of interorganismic interactions.


© Sybille Unsicker

Field Experiments

Laboratory and glasshouse experiments are important for studying ecological mechanisms and interactions under controlled conditions. In nature, however, organisms are exposed to an almost unimaginable diversity of environmental factors. Therefore, all departments also conduct field research. We have field stations in Utah and Arizona in the United States where we explore the importance of certain genes for plant defenses and pollination. We study old populations of black poplar in the Oderbruch, along the Oder River separating Germany from Poland, and investigate ants in the Tunisian salt pans. Moreover, we observe and analyze the mating behavior of certain moths in maize fields in the United States and the responses of predators to conspicuous warning signals of insects in Great Britain.


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