Chapter 1 : What is Chemical Ecology? | CHEMICAL ECOLOGY

The chemical ecology of plant-insect interaction is a significant subfield of chemical ecology. In particular, plants and insects are often involved in a chemical evolutionary arms race.

Lack of a number indicates a combination that was not tested. The mode of action of most plants that reduce nematode numbers is not established, nor is the influence of these plants on nematode chemotaxis. The mechanisms whereby root exudates and plant extracts influence nematodes include allelochemics nematoxic or nemastatic effects , anoxic rhizospheres, disruption of nematode taxis to roots, and disruption of male taxis to females. Christie hypothesized that root diffusates from marigolds might neutralize or mask host diffusates and render infection an inefficient chemokinetic event rather than a chemotactic response. However, toxic thiophenes have been recovered from marigold root extracts and from undisturbed rhizospheres. A variety of allelochemicals from certain plants may be directly toxic to nematodes, although their mode of action against plant-parasitic nematodes has not been clearly established. Allelochemic root exudates have potential use in nematode management programs if they can prevent active stages of nematodes from penetrating host roots. An approach related to selective breeding or genetic engineering of plants is not to alter the horticulturally or agronomically acceptable crop plant, but to develop effective trap plants which may be planted in rotation or interspersed with the main crop. The effectiveness of the trap crop may be expressed in stimulating egg hatch of the target nematode species, or by attraction of nematodes into root tissue which proves unfavorable for completion of their life cycle. Planting an additional crop in rotation, or as a winter cover, simply for nematode control may not be economical in most situations. In a larger systems context, however, there may be many other beneficial effects of the cover crop, including nitrogen fixation associated with legumes, enhanced water penetration during rainfall or irrigation, the creation of refugia for the natural enemies of other pests, and competitive weed management. Chemotaxis Repellants and Attractants. Plant-root exudates are known to stimulate hatch of, and act as attractants for, certain nematode species, and certain inorganic ions may be attractive or repellent to particular nematode species. For example, cucumber roots have been shown to possess both attractive and repellent fractions for root-knot nematode juveniles. Nematode semiochemistry can play a dominant role in the development of new materials and methods for plant protection. It offers the possibility of obtaining environmentally safe attractants, repellants, or nematicides that are based upon the natural responses of infective stages to plant roots. Despite this enormous potential Dusenbery, , there is very little basic knowledge at a molecular or physiological level. In , Steiner proposed that plant-parasitic nematodes located their hosts by chemoreception. It is now well established that nematodes accumulate about the roots of host plants Lownsbery and Viglierchio, , ; Azmi and Jairajpuri, ; Prot, ; Prot and Van Gundy , Moreover, a range of plant parasites, including Heterodera schachtii Viglierchio, , M. Furthermore, an attractant for the leaf-gall nematode, Ditylenchus Orrina phyllobia , has been extracted from leaves of Solanum elaeagnifolium Robinson and Saldana, However, none of the substances responsible for any of these interactions has been isolated or identified. While knowledge of the character of root emissions has increased Schwab and Leonard, ; Thompson, , no specific set or subset of compounds has been delineated that elicits chemotaxis of nematode parasites. A potent attractant for the pinewood nematode, Bursaphelenchus xylophilus , is b-myrcene Ishikawa et al. An apparently general attraction of nematodes to carbon dioxide Klingler, ; Pline and Dusenbery, and oxygen Dusenbery, has been noted. The response of male Heterodera glycines to attractants has been examined Huettel and Jaffe, A substantial body of knowledge exists on the response to chemical stimuli of the free-living nematode, C. Host or prey lectin-nematode carbohydrate interaction has been proposed as a general mechanism for recognition of host or prey Dusenbery, ; Zuckerman and Jansson, Many exciting opportunities for research on repellants and attractants of plant-parasitic nematodes are suggested by this literature. Recent development of a quantitative bioassay for chemotaxis Castro et al. Within the last few years, several methods have been employed to assess the attractiveness of materials to nematodes. Simply counting the nematodes in zones of a Petri plate at various distances from a root fragment has been employed Bilgrami et al. Other approaches include photographing the tracks of the animals on an agar Petri plate in relation to the position of an attractant Riddle and Bird, ; Ward, or video monitoring of all nematode movements through time Pline and Dusenbery, ; Dusenbery, A possible utilization of attractants in nematode management is to combine the attractant with a nematicide in a pellet. This would render the nematicide more effective because the concentration of toxin would have to reach effective levels only in the vicinity of the pellet rather than in the entire soil volume. The pellets would be target-specific because stimulus chemicals appear to have greater specificity in their action than toxins. Consequently, adverse environmental impacts of the nematicide would be reduced. This approach could well be combined with controlled release technology, which may be desirable for future nematicides Feldmesser et al. Cost would depend on the price of the materials, the cost of application, the number of pellets required, the extent to which they must be incorporated into the soil, and their period of effectiveness Dusenbery, Root exudates have long been known to induce hatching of certain nematodes Balam et al. The chemistry of one hatching stimulus, glycinoecleptin, has been characterized Fuzukawa et al. A variety of simple chemicals can also stimulate hatch of eggs of certain nematodes Clarke and Shepherd, ; Jantzen, ; Okada, ; Greet, ; Clarke and Hennesey, Molting of certain nematode juvenile stages can be induced by carnation root diffusates Rhoades and Linford, and other substances Shepherd and Clarke, All of these responses to stimulants are potentially important in nematode control. One approach to controlling nematode parasitism may be to alter the plant. Selective breeding or genetic engineering might be used to make a crop plant less attractive to nematodes. The plant could be altered to reduce its release of attractants, increase release of repellants, or modify internal stimuli. Very little is known of the mode of action of stimuli released from roots. So far, CO2 is the only attractant stimulus produced by roots that has been clearly identified. Because it is a product of energy metabolism, reducing its production would require altering basic plant physiology which would probably be impossible without reduction of yield. Recent studies by Diez and Dusenbery have demonstrated that plant roots release repellants that can be manipulated chemically. If these chemicals can be identified, they may provide a basis for breeding or engineering plants that produce increased amounts of repellant Dusenbery, Modified crop plants would provide an inexpensive management strategy and should have minimal environmental impact. However, the research and development necessary through selection and breeding, or genetic engineering, will be time-consuming and costly. Apart from plant roots, certain nematophagous fungi are known to attract nematodes Zuckerman and Jansson, ; Balan et al. Infection by these fungi occurs specifically at the chemosensory organ Jansson and Norbring-Hertz, No chemical structures have been identified, but a lectin-carbohydrate interaction is suspected Zuckerman and Jansson, The discovery that certain bacteria attract second-stage M. Bacteria on the root surface are ideally located to intercept root-feeding nematodes. Seed might be coated with inoculum of a bacterial strain that would colonize the root surface and produce nematode repellants. Alternatively, bacteria that produce an attractant could be formulated into a nematicide pellet, thus increasing its effectiveness. The automated culturing and screening procedures for bacterial metabolites that are now implemented in state-of-the-art biopesticide laboratories provide an excellent vehicle for identification of effective organisms in naturally-occurring populations. Given the recent and potential advances in genetic engineering, it might even be possible to develop bacteria that produced both a nematicide and a nematode attractant. Methods for inoculating bacteria into the rhizosphere have been described by Lynch The release of bacterial strains into the environment, especially those genetically engineered, will be subject to appropriate, stringent regulation Dusenbery, There are various ways in which sensory responses might be exploited to control nematodes. The application of a chemical that inhibits nematode sensory responses would have an advantage over conventional nematicides because the chemical need not be inherently toxic to animal cells. Zuckerman and Jansson have suggested the use of lectins for this purpose. However, there are few examples of chemicals with inhibitory effects, even in mammals, and little effort has been expended in screening chemicals for inhibition of nematode sensory systems Dusenbery, An approach that has been employed for insect management is to flood the environment with a chemical stimulus so that gradients useful to the pest in locating host plants or mates are eliminated. Again, this has an advantage in that the chemical need not be toxic. Major limitations are the amount of chemical that must be applied to flood a soil system and the potential for rapid microbial degradation of the material. Only very potent stimuli that are relatively inexpensive would be useful, unless they could be produced in the soil by augmentation of the metabolic activities of naturally occurring organisms. Amyl acetate has been identified as a potent stimulus for the free-living nematode Panagrellus redivivus Balan, , which responds at a concentration of 1 ppb. If we assume that a concentration fold higher is needed in the soil solution to effectively confuse the nematode, and apply enough to provide the required concentration in soil containing the equivalent of 10 cm of water, g is all that would be necessary to treat 1 hectare. This approach might be cost effective for management of plant-parasitic nematodes if efficacious stimuli of similar potency and cost could be identified Dusenbery, An alternative approach may be to plant the crop into a "living mulch"-essentially an intercrop or cover crop of a different plant species. Stimuli released by such plants would flood the system and disrupt chemical gradients released by host plants. Flooding pots of soil with root-diffusates of several plants reduced infection of tomato roots by R. Research Needs - Chemical Ecology Research is needed on the effect of natural chemicals on the nervous and reproductive systems of nematodes, understanding mechanisms of biological control and rhizosphere biology, and on the development of technology for applied biological control. Many of these research needs highlight the linkages to more basic areas of nematode biology. The developmental biology of C. The complete "wiring diagram" of the nervous system of this nematode can be drawn, as can the sequence of events in its development. Study of the mutants has allowed understanding of the control of nervous and musculature system development, and provides a basis of understanding for nematode response to environmental stimuli. These advances in understanding of the fundamental biology of a small, yet complex, multicellular organism provide exciting opportunities for transfer of knowledge to the management of plant-parasitic nematodes. Our understanding of the nervous system and sensilla of plant-parasitic nematodes can be summarized rather briefly. A "nerve ring," and associated ganglia, surround the isthmus region of the esophagus ; neurons run longitudinally through the dorsal and ventral hypodermal chords; and various sensilla have associated neurons. The sensilla of plant-parasitic nematodes include pouch-like amphid s opening on both sides of the anterior end of the nematode; phasmids , whose fine-structure has been determined only recently Carta and Baldwin , in the posterior lateral field s; deirids in the anterior lateral field; and innervated setae , sensory pegs, and papillae. The first three of these sensilla are considered chemoreceptors, are generally recessed, and often contain a mucoid material. The amphids are usually the most elaborately developed of the structures, especially in marine nematodes. The setae, pegs, and papillae are probably tactile receptors. In most plant-parasitic nematodes, these tactile receptors are restricted to the head region or associated with the copulatory organs. There is some speculation, but a minimum of experimental evidence, on the functioning of the sensilla. Understanding their role and function in host-finding and response to attractant and repellent stimuli is a necessary component of real application of chemical ecology to nematode management. Some of the research priorities in the area of allelopathy include identification of plant species that are capable of decreasing nematode numbers and the specificity of such capabilities ; determination of how these plants reduce nematode numbers, i. Additional research is also needed to develop annual and perennial cropping systems for particular crop-nematode combinations that effectively utilize the potential of nematode-suppressive cover crops to reduce nematode numbers below the economic threshold. The most promising area for future research appears to be the identification of chemical stimuli released by plant roots. In spite of little previous progress, the enormously increased capabilities of analytical instrumentation in recent years greatly improves the chances of success. An array of both attractants and repellants surely awaits discovery Dusenbery,

Chapter 2 : Chemical Ecology - Ecology - Oxford Bibliographies

Journal of Chemical Ecology is devoted to promoting an ecological understanding of the origin, function, and significance of natural chemicals that mediate interactions within and between organisms. Such relationships, often adaptively important, comprise the oldest of communication systems in.

Page v Share Cite Suggested Citation: The Chemistry of Biotic Interaction. The National Academies Press. We live by our eyes and ears and tend generally to be oblivious to the chemical happenings in our surrounds. Such happenings are ubiquitous. All organisms engender chemical signals, and all, in their respective ways, respond to the chemical emissions of others. The result is a vast communicative interplay, fundamental to the fabric of life. Organisms use chemicals to lure their mates, associate with symbionts, deter enemies, and fend off pathogens. Chemical ecology is the discipline that is opening our "eyes" to these interactions. It is a multifaceted discipline, intent on deciphering both the chemical structure and the information content of the mediating molecules. And it is a discipline in which discovery is still very much in order, for the interactions themselves remain in large measure to be uncovered. Chemical ecology has made major progress in recent decades. This reflects, in part, the extraordinary technical innovation that has taken place in analytical chemistry. Highly improved procedures are now available for separating complex mixtures into their individual components, as well as for quantitating and chemically characterizing designated compounds. There has also been a vast increase in the sensitivity of the techniques. Where gram quantities were once needed for elucidation of chemical structure, milligram or even microgram quantities may now suffice. These refinements in sensitivity are of particular importance, given that organisms often produce their signal molecules in vanishingly small amounts. Progress in chemical ecology has also been fostered by advances in biology itself. Chemical interactions in nature are often social, in the sense Page vi Share Cite Suggested Citation: Conceptual advances in behavioral biology, particularly sociobiology, have helped put new slants on inquiries into such social phenomena as mate attraction, sexual selection, parental investment, caste determination, and colony organization, all frequently mediated by chemicals. The questions themselves, answered at one level of organization, often lead to inquiries at another level. Studies of pheromones, for instance, first with insects and then with selected mammals, were doubtless influential in prompting the highly promising current inquiries into pheromonal communication in humans. Other biological disciplines are also proving relevant. Virtually every chemically mediated interspecific interaction, whether between predator and prey, herbivore and plant, or parasite and host, lends itself to interpretation in the broadest evolutionary, ecological, population-biological, and molecular-biological terms. Molecular biology may, in fact, increasingly shape the questions that are asked in chemical ecology. How do given signal molecules arise in the course of evolution? How are they synthesized, and how is the rate and timing of their production controlled? How are they recognized at the level of the receptor? How do noxious chemical signals, designed to repel or poison, affect their intended targets? How is it that receiver organisms are sometimes able to circumvent, counteract, or even secondarily employ, such offensive chemicals? Molecules that transmit information between organisms are a fundamental part of the regulatory chemicals of nature. The rules that apply to intraorganismal chemical regulation apply in large measure to them as well. Molecules that have signal value in nature sometimes prove to be of use to humans. One need only cite the example of medicinals to underscore the point. Major recent additions to our therapeutic arsenal include ivermectin, cyclosporin, FK, and taxol, compounds that can all be expected to have evolved as signaling agents. Many and varied benefits can be expected to be derived from an ongoing search for natural products. Chemical ecologists should become active participants in this search. They have the expertise, gained through laboratory and field experimentation and observation, to rate species by "chemical promise" and therefore to aid in the important task of selecting species for chemical screening. Chemical ecologists are also in a position to provide some assessment of the hidden value of nature. The search for natural products has essentially only begun. Most species, especially microbial forms and invertebrates, remain to be discovered, let alone to be screened for chemicals. What remains unknown is of immense potential value, and deserving of protection, lest we be forever impoverished by its loss. To help in the preservation effort, chemical ecologists will need to speak out as conservationists. Page vii Share Cite Suggested Citation: Almost participants attended the proceedings. The papers do not provide an overview of the discipline but rather give a glimpse into selected research areas that are contributing to advancement of the field. We are immensely grateful to our invited speakers, both for the quality of their communications and for the personal enthusiasm they brought to the meeting. Discussions were convivial and much enlivened by the youthfulness of most of the audience. Four participants, Ian T. Smith III deserve special thanks, for presiding over the sessions and for leading the discussions. We are also grateful to Jack Halpern, Vice President of the Academy, for asking us to organize the colloquium, and to Bruce Alberts, President of the Academy, for providing introductory remarks at the meeting. For help in preparation of the colloquium we are indebted to Kenneth R. Financial resources for the colloquium were provided by the Academy and supplemented by contributions from a number of industries American Cyanamid Company, E.

Chapter 3 : International Society of Chemical Ecology

Chemical Ecology contains a series of lectures presented in the fall of at State University of New York College of Forestry at Syracuse University. This book is composed of 11 chapters that deal with the salient facts and theories that are encompassed by chemical ecology and the possible application of fundamental research in this area to.

Search Journal of Chemical Ecology v. The uropygial secretions of some bird species contain volatile and semivolatile compounds that are hypothesized to serve as chemical signals. The abundance of secretion components varies with age and season, although these effects have not been investigated in many species. We used solid-phase microextraction headspace sampling and solvent extraction coupled with gas chromatographyâ€"mass spectrometry to detect and identify volatile and semivolatile chemical compounds in uropygial secretions of gray catbirds Dumetella carolinensis. We identified linear and branched saturated carboxylic acids from acetic C2 through hexacosanoic C26 ; linear alcohols from decanol C10 through docosanol C22 ; one aromatic aldehyde; one monounsaturated carboxylic acid; two methyl ketones; and a C28 ester. We tested for the effect of age on signal strength and found that juvenile birds produced greater amounts of volatile C4 through C7 acids and semivolatile C20 through C26 acids, although the variation among individuals was large. Adult birds displayed small concentrations and minimal individual variation among volatile compounds, but produced significantly higher levels of long-chain linear alcohols than juvenile birds. We observed no effect of sex on semivolatile compounds, but we found a significant effect of sex on levels of carboxylic acids C4 through C7 for juvenile birds only. Hardege; Thomas Breithaupt Parasite loads of animals vary among individuals, but the underlying mechanisms have not been fully identified. Here, we investigated whether health status of hedgehogs Erinaceus europaeus is correlated with tick burden, and whether chemical cues linked to the health status of the host mediate attraction of the tick Ixodes hexagonus. Behavioral choice tests demonstrated that ticks display a preference for the fecal odor from sick hedgehogs compared with healthy ones. Chemical analysis of fecal odors using gas chromatography - mass spectrometry showed differences in the odor profile between sick and healthy hedgehogs. Sick animals tended to exhibit raised levels of the volatile aromatic heterocyclic compound indole in their feces. Ticks were attracted to indole when given the choice between indole and a solvent control. However, fecal matter from healthy hosts, with the addition of indole, was not attractive to ticks, suggesting that indole interacts with other, undetected compounds in mediating attraction. This study implies that it is the attraction to fecal odor that causes higher tick burdens in sick hedgehogs. Ticks might benefit from this preference by avoiding possible repulsion mechanisms of healthy hosts. Carroll; Matthew Kramer; Robert H. Some birds and mammals roll on or wipe themselves with the fruits or leaves of Citrus spp. These anointing behaviors, as with anointing in general, are thought to function in the topical acquisition of chemicals that deter consumers, including hematophagous arthropods. We measured avoidance and other responses by nymphal lone star ticks Amblyomma americanum and adult female yellow fever mosquitoes Aedes aegypti to lemon peel exudate and to 24 volatile monoterpenes racemates and isomers , including hydrocarbons, alcohols, aldehydes, acetates, ketones, and oxides, present in citrus fruits and leaves in order to examine their potential as arthropod deterrents. Ticks confined in chemically treated paper packets subsequently were impaired in climbing and other behaviors following exposure to the peel exudate and, of the compounds tested, most impaired to carveol. Mosquitoes confined in chambers with chemically treated feeding membranes landed and fed less, and flew more, when exposed to the peel exudate than to controls, and when exposed to aldehydes, oxides, or alcohols versus most hydrocarbons or controls. However, attraction by mosquitoes in an olfactometer was not inhibited by either lemon peel exudate or most of the compounds we tested. Our results support the notion that anointing by vertebrates with citrus-derived chemicals deters ticks. We suggest that some topically applied compounds are converted into more potent arthropod deterrents when oxidized on the integument of anointed animals. Hexahydrofarnesylacetone 6,10,trimethylpentadecanone, 1 is a widespread ketone occurring in plants and insects. Several species use this compound or the respective alcohol as part of their pheromone bouquet. Here, we showed by using deuterium labeled phytol 3 and GC-MS experiments that the Large Cabbage White butterfly Pieris brassicae can take up phytol in the larval stage and transforms it into 1 by oxidative degradation. Huigens; Erik de Swart; Roland Mumm Males of a variety of insects transfer an anti-aphrodisiac pheromone to females during mating that renders them less attractive to conspecific males. In cabbage white butterflies, the transfer of an anti-aphrodisiac can result in the unwanted attraction of tiny egg parasitoid wasps of the genus Trichogramma that hitch-hike with mated female butterflies to a host plant where they parasitize the freshly laid butterfly eggs. This depletion of BC is ecologically important because it results in a reduced risk of attracting the hitch-hiking egg parasitoid Trichogramma brassicae to mated female butterflies over time since mating. Our results indicate for the first time that a reduction in anti-aphrodisiac titre in mated females due to frequent adoption of the mate-refusal posture is beneficial to both mated females and males particularly when parasitoid pressure is high. Plants attacked by herbivorous insects emit volatile organic compounds that are used by natural enemies to locate their host or prey. The composition of the blend is often complex and specific. It may vary qualitatively and quantitatively according to plant and herbivore species, thus providing specific information for carnivorous arthropods. Most studies have focused on simple interactions that involve one species per trophic level, and typically have investigated the aboveground parts of plants. These investigations need to be extended to more complex networks that involve multiple herbivory above- and belowground. A previous study examined whether the presence of the leaf herbivore Pieris brassicae on turnip plants Brassica rapa subsp. It showed that the parasitoid was not attracted by volatiles emitted by plants under simultaneous attack. This multivariate model focuses on the differences between odor blends, and highlights the relative importance of each compound in an HIPV blend. Dual infestation resulted in several HIPVs that were present in both isolated infestation types. However, HIPVs collected from simultaneously infested plants were not the simple combination of volatiles from isolated forms of above- and belowground herbivory. Only a few specific compounds characterized the odor blend of each type of damaged plant. Indeed, some compounds were specifically induced by root herbivory 4-methyltridecane and salicylaldehyde or shoot herbivory methylsalicylate , whereas hexylacetate, a green leaf volatile, was specifically induced after dual herbivory. The mechanisms involved in the specific modification of the odor blends emitted by dual infested turnip plants are discussed in the light of interferences between biosynthetic pathways linked to plant responses to shoot or root herbivory. When challenged by herbivorous insects, plants produce a suite of antinutritive proteins that disrupt digestion and absorption of essential nutrients by the insects. We hypothesized that plants would induce distinct defense responses corresponding to the distinct midgut conditions of different herbivores. We investigated whether or not tomato responds specifically to two specialist herbivores: Sphingidae , and we evaluated whether the induced defenses triggered by either species affect CPB growth. In addition, trypsin protease inhibitor activity and polyphenol oxidase activity were higher in plants damaged by THW than in plants damaged by CPB. Application of oral secretions from THW to wounded tomato plants increased transcripts compared to controls, but oral secretions from CPB decreased defense transcripts. CPB growth was compromised on plants damaged by either species, suggesting a low specificity of effect. Together, these data suggest distinct quantitative responses of tomato to two different specialist herbivores. Herbivore oral secretions might be responsible for these species-specific responses. Studies were conducted to develop an attractant for the cranberry weevil, Anthonomus musculus, a pest of blueberry and cranberry flower buds and flowers in the northeastern United States. In previous studies, we showed that cinnamyl alcohol, the most abundant blueberry floral volatile, and the green leaf volatiles Z hexenyl acetate and hexyl acetate, emitted from both flowers and flower buds, elicit strong antennal responses from A. Here, we found that cinnamyl alcohol did not increase capture of A. To identify the A. Three male-specific compounds were identified: A fourth component, E -3,7-dimethyl-2,6-octadienol geraniol , was emitted in similar quantities by males and females. The emission rates of these volatiles were about 2. Field experiments in highbush blueberry New Jersey and cranberry Massachusetts examined the attraction of A. In both states and crops, traps baited with the A. Addition of the green leaf volatiles did not affect A. Although the role of plant volatiles in host-plant location by A. The sex pheromone of Synanthedon bicingulata Staudinger , a major pest of Prunus species in many regions of northeast Asia, was identified. Two major components from the pheromone gland extracts of female moths are E,Z -3,octadecadienyl acetate E3,Z OAc , and the average ratio of these components is about 4: In addition to the major components, four minor components, Z octadecenyl acetate Z OH also were identified from pheromone gland extracts. Field tests showed that E3,Z OAc are essential for attraction of male S. Addition of the minor glandular components Z OH did not affect captures of males to the primary binary blend. Thus, the blend of E3,Z OAc at the natural ratio can be used for monitoring populations of this species. Dalusky; Kenji Mori; Cavell Brownie The male-produced bicyclic acetal endo-brevicomin is a component of the pheromone blend that mediates colonization of host pines by the bark beetle Dendroctonus frontalis Zimmermann. Efforts to identify its behavioral function have been complicated by contrasting reports that it either enhances or reduces attraction of flying beetles. In trapping trials within active D. Furthermore, the activity of racemic endo-brevicomin baits depended on trap proximity to D. The contrasting responses may reflect differences in host-seeking strategies by either aggregated or dispersing D. We suspect that much of the published variability in D. The pine caterpillar moth, Dendrolimus kikuchii Matsumura Lepidoptera: Lasiocampidae , is a pest of economic importance on pine in southwest China. Three active compounds were detected during analyses of solvent extracts and effluvia sampled by solid phase microextraction SPME from virgin female D. The compounds were identified as 5Z,7E -5,7-dodecadienyl acetate Z5,E OH , and 5Z dodecenyl acetate Z Microchemical reactions of gland extracts provided further information confirming the identifications of the three components. Solvent extractions and SPME samples of pheromone effluvia from virgin calling females provided Field behavioral assays showed that Z5,E OH were essential for attraction of male D. However, the most attractive blend contained these three components in a Our results demonstrated that the blend of Z5,E OAc comprise the sex pheromone of D. The optimized three-component lure blend is recommended for monitoring D.

Chapter 4 : Chemical Ecology

Journal of Chemical Ecology is devoted to promoting an ecological understanding of the origin, function, and significance of natural chemicals that mediate interactions within and between organisms.

References Abstract Chemical ecology is the study of the structure, origin and function of naturally occurring chemicals that mediate intraspecific or interspecific interactions. These chemicals are known as semiochemicals. Depending on the function of a semiochemical, this group of chemicals can be further divided into three classes: At the heart of the discipline are modern analytical instrumentation, careful observational biology and good bioassay design. Research during the past 50 years has identified many different semiochemicals. Several of these chemicals are currently in use as pest control agents. Although the majority of the early research focused on lepidopteran sex pheromones, in recent years, a shift is seen into semiochemicals from other insects and noninsects such as mammals, marine animals or even microorganisms. The field of chemical ecology has developed into a mature science with diverse practical applications, of which currently pest control is the most important. Key Concepts Chemical ecology studies the structure, origin and function of naturally occurring chemicals that mediate intraspecific or interspecific interactions. Bioassays are crucial in successfully identifying active semiochemicals. Semiochemicals are divided into different categories, depending on their function in an organism. Chemical ecology has developed into a mature global science during the past 50 years. Chemical ecology has benefited greatly from the advances in analytical instrumentation, such as mass spectrometry, gas chromatography and liquid chromatography. Chemical ecology has a much wider application than only its use in pest control. Categories of semiochemicals, with examples of their biological function Howse,. The diversity of the semiochemical geranial. Sex pheromone component of the oriental fruit moth. An example of a tritrophic interaction: Schwartz, Colorado State University, Bugwood. Licensed under a Creative Commons Attribution 3. Diagram illustrating the dynamic plantâ€”animal interactions Harborne,. Flow chart of procedure for isolation and identification of pheromones Stevens,. References Breer H Molecular mechanisms of pheromone reception in insect antennae. Evans HE Insect Biology, pp. Ha T and Smith D Odorant and pheromone receptors in insects. Frontiers in Cellular Neuroscience 3: Annual Review of Entomology Howse PE Pheromones and behaviour. Stevens IDR Chemical aspects of pheromones. Biology, Biochemistry and Chemical Ecology. National Academies of Science. The University of Chicago Press. Their Interaction with Secondary Plant Metabolites.

Chapter 5 : Chemical Ecology Unit

Chemical communication is truly the unspoken language of nature. The ability of organisms to transmit and perceive information through chemicals is a remarkable aspect of our natural world.

Stenhouse Without a protective shell, sea slugs have had develop other defences against predation. These include cryptic colouration or camouflage and behavioural modifications such as only being active at night. Another major development has been the use of chemicals to make them posionous or at least extremely distasteful to potential predators. Opisthobranchs have become a target for research by marine products chemists and gradually we are discovering just the widespread and complex ways chemicals are used by sea slugs. Many store these chemicals in special glands in their skin. What is starting to fascinate chemists and physiologists is the many different ways the molecules are produced. In some cases the chemical molecules [often called metabolites] are removed from their food and stored unchanged by the opisthobranch. In other cases the molecules from the food are modified by the opisthobranch, and in some cases the opisthobranch makes new molecules itself. Usually, each species of opisthobranch has very specialised food requirements and often its defensive molecules are uniquely different from closely related species. See below for relevant messages. See Defensive Glands Page for further references and messages. The above photo illustrates a good example of the role chemicals play in the life of these animals. The two nudibranchs are the chromodorid Glossodoris pallida on a large colony of a grey-black sponge which is almost certainly their food, the dictyoceratid sponge Cacospongia sp. They also showed that these chemicals do indeed deter fish. In particular they found sponge-derived terpenoid compounds concentrated around the mantle border and in the mucous secretions of the mantle. They found that at their natural concentrations these chemicals deterred some crabs and reef fishes from feeding. They also found that animals which had had their mantle borders removed were much more likely to be eaten than those in which the mantle was intact. This is a very significant advance in our understanding of the biology of these fascinating animals. Natural products of opisthobranch molluscs: Oceanography and Marine Biology: Marine Ecology Progress Series, Chemistry and Ecology in Sacoglossans and Dorids. Current Organic Chemistry, 3 4: Authorship details Rudman, W.

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Chapter 6 : Max Planck Institute for Chemical Ecology - Wikipedia

OriginalPaper. Synthesis of the two components of the sex pheromone system of the potato tuberworm moth,Phthorimaea operculella (Zeller) (Lepidoptera: Gelechiidae) and field experience with them.

Search Journal of Chemical Ecology v. The allelopathic potential of the Eurasian invasive plant Alliaria petiolata has been well documented, with the bulk of the effects believed to be mediated by arbuscular mycorrhizal fungi AMF. We exposed the herbaceous annual Impatiens pallida, which is native to North America, to fractionated A. Surprisingly, we found strong direct effects on I. We also observed strong synergistic effects with a complete A. In fact, the flavonoid enriched fraction tended to stimulate germination and presymbiosis root growth. In contrast to these strong direct effects, I. We also found no inhibition of AMF colonization of roots or soils by A. We show that AMF can actually ameliorate allelopathic effects of an invasive plant, and suggest that previously observed allelopathic effects of A. Herbivore-induced volatile emissions benefit plant hosts by recruiting natural enemies of herbivorous insects. Such tritrophic interactions have been examined thoroughly in the above-ground terrestrial environment. Recently, similar signals have also been described in the subterranean environment, which may be of equal importance for indirect plant defense. The larvae of the root weevil, Diaprepes abbreviates, are a serious pest of citrus. Infestations can be controlled by the use of entomopathogenic nematodes, yet the interactions between the plant, insect and nematode are poorly understood and remain unpredictable. Infested plants were more attractive to nematodes than larvae alone. Roots damaged by weevil larvae attracted more nematodes than mechanically damaged roots and sand controls. By dynamic in situ collection and GC-MS analysis of volatiles from soil, we determined that four major terpene compounds were produced by infested plant roots that were not found in samples from non-infested roots or soil that contained only larvae. Solvent extracts of weevil-infested roots attracted more nematodes than extracts of non-infested roots in a two choice sand-column bioassay. These findings suggest that Swingle citrus roots release induced volatiles as an indirect defense in response to herbivore feeding, and that some of these induced volatiles function as attractants for entomopathogenic nematodes. We studied the effect of epidermal leaf mining on the leaf chemistry of quaking aspen, Populus tremuloides, during an outbreak of the aspen leaf miner, Phyllocnistis populiella, in the boreal forest of interior Alaska. Phyllocnistis populiella feeds on the epidermal cells of P. Eleven days after the onset of leaf mining, concentrations of the phenolic glycosides tremulacin and salicortin were significantly higher in aspen leaves that had received natural levels of leaf mining than in leaves sprayed with insecticide to reduce mining damage. In a second experiment, we examined the time course of induction in more detail. The levels of foliar phenolic glycosides in naturally mined ramets increased relative to the levels in insecticide-treated ramets on the ninth day following the onset of leaf mining. Leaves with extrafloral nectaries EFNs had significantly higher constitutive and induced levels of phenolic glycosides than leaves lacking EFNs, but there was no difference in the ability of leaves with and without EFNs to induce phenolic glycosides in response to mining. Previous work showed that the extent of leaf mining damage was negatively related to the total foliar phenolic glycoside concentration, suggesting that phenolic glycosides deter or reduce mining damage. The results presented here demonstrate that induction of phenolic glycosides can be triggered by relatively small amounts of mining damage confined to the epidermal tissue, and that these changes in leaf chemistry occur while a subset of leaf miners are still feeding within the leaf. We examined the effects of water and nutrient availability on the expression of the defense pyrrolizidine alkaloids PAs in Senecio jacobaea and S. Senecio jacobaea, and S. We tested if PA concentration and diversity are plastic over a range of water and nutrient treatments, and also whether such plasticity is dependent on plant species. We also tested the hypothesis that hybridization may contribute to PA diversity within plants, by comparing PA expression in parental species to that in artificially generated F1 hybrids, and also in later generation natural hybrids between S. We showed that total PA concentration in roots and shoots is not dependent on species, but that species determines the pattern of PA diversification. Pyrrolizidine alkaloid diversity and concentration are both dependent on environmental factors. Hybrids produce a putatively novel PA, and this PA is conserved in natural hybrids, that are backcrossed to S. Natural hybrids that are backcrossed several times to S. These results collectively suggest that PA diversity is under the influence of natural selection. The tea weevil, Myllocerinus aurolineatus Voss Coleoptera: Curculionidae , is a leaf-feeding pest of Camellia sinensis O. Although herbivore-induced host plant volatiles have been shown to attract conspecific individuals of some beetle pests, especially members of the Chrysomelidae family, little is known about the volatiles emitted from tea plants infested by M. The results of behavioral bioassays revealed that volatile compounds emitted from tea plants infested by M. The findings provide new insights into the interactions between tea plants and their herbivores, and may help scientists develop new strategies for controlling the herbivore. Varela; Clara Nogueiras; Jose M. A study was carried out on the allelopathic potential of four forest species, Tectona grandis, Aleurites fordii, Gliricidia sepium, and Maytenus buxifolia. The most active species, T. A new compound, abeograndinoic acid, was isolated, and elucidation of its structure showed that this compound has an unusual carbon skeleton. A further 21 known terpenoidsâ€"including 4 sesquiterpenoids, 8 diterpenes and 9 triterpenesâ€"also were isolated. A biosynthetic scheme for the presence of the new compound is proposed. Bioactivity profiles that used etiolated wheat coleoptiles and phytotoxicity bioassays on the isolated compounds were conducted. The compounds that presented the highest phytotoxic activity are the diterpenes 9 2-oxokovalenic acid and 12 hydroxyferruginol. The phytotoxic effects of the lichen secondary metaboliteâ€"usnic acid on cultures of free living algaâ€"Scenedesmus quadricauda UTEX 76 and aposymbiotically grown lichen photobiont Trebouxia erici UTEX were assessed. We found a relatively strong inhibition effect of usnic acid on the growth of alga Scenedesmus, accompanied by an increase of cell size, an alteration of assimilation pigment composition, followed by strong degradation of chlorophyll a, a decrease of chlorophyll a fluorescence, and an increase of reactive oxygen species in the cells. The content of soluble proteins remained a stable parameter. Phytotoxicity of usnic acid on cultures of Trebouxia photobiont was significantly lower. Usnic acid in lichens may act as an allochemical that controls the division of photobiont cells, thereby regulating the balance between the photobiont and mycobiont forming thallus. Higher tolerance to usnic acid in Trebouxia cultures may be an adaptation resulting from the long term co-evolution of these algae with fungi that produce secondary metabolites. Mimicry is used widely by arthropods to survive in a hostile environment. Often mimicry is associated with the production of chemical compounds such as pigments. In crab spiders, the change of color is based on a complex physiological process that still is not understood. The aim of this study was to identify and quantify the ommochrome pigments and precursors responsible for the color change in the mimetic crab spider Misumena vatia Thomisidae. A modified high performance reverse phase ion-pair chromatography technique enabled us to separate and quantify the ommochrome pigments, their precursors, and related metabolites in individual spiders. Compounds such as tryptophan, kynurenine, and kynurenic acid occurred only or mainly in white crab spiders. In contrast, compounds such as 3-hydroxy-kynurenine, xanthommatin, and ommatin D occurred only or mainly in yellow crab spiders. Factor analysis ranked the different color forms in accordance with their metabolites. The biochemical results enabled us to associate the different phases of formation of pigment granules with specific metabolites. Yellow crab spiders contain many unknown ommochrome-like compounds not present in white crab spiders. We also found large quantities of decarboxylated xanthommatin, whose role as precursor of new pathways in ommochrome synthesis needs to be assessed. The catabolism of ommochromes, a process occurring when spiders revert from yellow to white, warrants further study. Crypsis; 3-Hydroxy-kynurenine; Xanthommatin; High Performance reverse phase ion-pair chromatography technique Regulation of Reproduction in the Primitively Eusocial Wasp Ropalidia marginata: Deshpande; Kannepalli Chandrasekhar; Dattatraya G. Naik; Abraham Hefetz; Raghavendra Gadagkar Queens and workers are not morphologically differentiated in the primitively eusocial wasp, Ropalidia marginata. Upon removal of the queen, one of the workers becomes extremely aggressive, but immediately drops her aggression if the queen is returned. If the queen is not returned, this hyper-aggressive individual, the potential queen PQ , will develop her ovaries, lose her hyper-aggression, and become the next colony queen. Because of the non-aggressive nature of the queen, and because the PQ loses her aggression by the time she starts laying eggs, we hypothesized that regulation of worker reproduction in R. We also correctly distinguished queens and workers of R. Metz; Tanya Pankiw; Shane E. The 10 fatty acid ester components of brood pheromone were extracted from larvae of different populations of USA and South African honey bees and subjected to gas chromatography-mass spectrometry quantitative analysis. Honeybee releaser and primer pheromone responses to USA,Africanized andâ€"European pheromone blends were tested. Texas-Africanized and Georgia-European colonies responded with a significantly greater ratio of returning pollen foragers when treated with a blend from the same population than from a different population. There was a significant interaction of pheromone blend by adult population source among Georgia-European bees for modulation of sucrose response threshold, a primer response. Brood pheromone blend variation interacted with population for pollen foraging response of colonies, suggesting a self recognition cue for this pheromone releaser behavior. An interaction of pheromone blend and population for priming sucrose response thresholds among workers within the first week of adult life suggested a more complex interplay of genotype, ontogeny, and pheromone blend. Njagi; Ian Gordon; Baldwyn Torto Cuticular hydrocarbons CHCs are used for chemical communication among nestmates in many ant species, and they may play a role in the discrimination of nestmates and non-nestmates. Using the mandible opening response MOR bioassay, we tested the response of the African termite raiding ant, Pachycondyla analis, to CHC extracts of nestmates and non-nestmates. The ants were able to distinguish control chemical cues, from nestmate CHCs, and from non-nestmate CHCs, and, based on a CHC recognition threshold, aggression was demonstrated toward non-nestmates. Gas chromatography GC and GC-mass spectrometric analyses showed that CHC components of different ant colonies had chain lengths ranging from C8 to C31, comprising mainly n-alkanes, alkenes, and methyl branched alkanes, with the n-alkanes occurring in the same proportions among all colonies. The ants were grouped successfully according to their colonies of origin by using discriminant analysis of CHCs. We demonstrate that nestmate recognition occurs in P. Lorenzo; Gabriel Manrique Several triatomine bug species utilize chemical cues for sexual communication. We tested whether female or male Rhodnius prolixus, a vector of Chagas disease, produce volatile chemicals that elicit flight responses from conspecifics, and then isolated the source of the chemical. Males confronted with an airstream containing female odors showed a significantly greater take-off frequency compared to a blank airstream or an airstream with male odors. In contrast, females exhibited similar take-off frequencies to male or female odor as to a clean airstream. Occlusion of female metasternal glands with paraffin wax resulted in a significant decrease in male take-off frequency compared to that of intact females. Additionally, excised female metasternal glands elicited a similar take-off frequency from males as did intact females, both significantly greater than the take-off frequency to clean air. These results show that R.

Chapter 7 : Chemical Ecology Rev 5

This volume is based on the National Academy of Sciences' colloquium entitled "Chemical Ecology: The Chemistry of Biotic Interaction." The articles appearing in these pages were contributed by speakers at the colloquium. Any opinions, findings, conclusions, or recommendations expressed in this.

We live by our eyes and ears and tend generally to be oblivious to the chemical happenings in our surrounds. Such happenings are ubiquitous. All organisms engender chemical signals, and all, in their respective ways, respond to the chemical emissions of others. Chemical ecology is the study of ecological interactions between organisms mediated by chemicals produced by those organisms. Chemical interactions between organisms can be analyzed across all organizational levels, reaching from cell-cell interaction and intraspecific and multitrophic-level interactions to whole community interactions and environmental ecological processes. Because of their ubiquity, chemical signals that carry information semiochemicals can be categorized by the types of ecological interactions they mediate, such as intraspecific social communication, antagonistic interactions, and mutualism. Accordingly, this article is organized into three core areas, one formed by the chemicals mediating interactions between members of the same species pheromones , and the others by interspecific interactions involving allomones where the sender benefits , and synomones where both sender and receivers benefit. A fourth group of signals, kairomones where the receiver benefits , can comprise all other signal categories when they are perceived and utilized by a third organism that itself gains a benefit from eavesdropping on communication between others. The very rapid growth of the chemical ecology literature over recent decades has been, in part, driven by the growing appreciation of the high economic value of understanding chemical communication, reaching from applications in pest management over the control of disease vectors in agriculture to the use of chemical signals in medicine. Moreover, the field has dramatically profited from innovations in analytical chemistry, making the separation of complex compound mixtures as well as the identification of compound structures efficient and accessible to a broader community of researchers. Recent advances in molecular ecology have aided an even more rapid mechanistic and functional analysis of semiochemicals, leading to a modern consolidation of different research fields. This collection of significant publications focuses on the functional and evolutionary analysis of chemical signals important in mediating ecological interactions. Moreover, attention has been given to publications that provide conceptual frameworks and are among the most highly cited in the respective subdisciplines. They can thus provide a good introduction for the interested reader and allow efficient forward and backward searching for more detailed information. General Overviews The field of chemical ecology as such is relatively young, but it has experienced a very rapid growth in the past few decades, primarily fueled by more readily available chemical analytical and molecular methods. This, on one hand, explains the limited number of concise textbooks in this field, but on the other hand, it also explains the increasing impact and explanatory power chemical ecology has in almost all fields of ecology, evolutionary biology, and biochemistry. The coevolutionary aspects of chemical communication has always been a major concern of the field, and it is nicely summarized in Spencer Harborne was one of the first textbooks to reach a broader audience of students. The textbooks and collections of articles cited in this section either provide a general overview or focus on the chemical ecology of particular groups of organisms, while also allowing the extraction of the principal and generally applicable concepts. The book covers algal chemical ecology of both freshwater and marine habitats. Breithaupt, Thomas, and Martin Thiel. Chemical communication in crustaceans. Advances in insect chemical ecology. Eisner, Thomas, and Jerrold Meinwald, eds. The chemistry of biotic interaction. A collection of articles providing a broad overview of the major research areas in chemical ecology. Introduction to ecological biochemistry. A textbook that describes many aspects of biochemical interactions between plants and insects in a didactically immaculate way. Chemical ecology of vertebrates. The first comprehensive textbook that entirely focuses on vertebrate chemical ecology. It covers all four areas of chemical interaction, through pheromones, synomones, kairomones and allomones. A collection of articles that provides a comprehensive view on how natural selection may shape insect chemical interactions with their biotic environment. This book was the first concise introduction into the new field of chemical ecology and was based on a lecture series taught at Syracuse University. It provides basic terminology and a theoretical framework for the then newly formed field. Chemical mediation of coevolution.

Chapter 8 : The Sea Slug Forum - Chemical ecology

Welcome! The International Society of Chemical Ecology (ISCE) is organized exclusively for scientific purposes, and specifically to promote the understanding of interactions between organisms and their environment that are mediated by naturally occurring chemicals.

Chapter 9 : Journal of Chemical Ecology

Chemical ecology is the study of the structure, origin and function of naturally occurring chemicals that mediate intraspecific or interspecific interactions. These chemicals are known as semiochemicals.