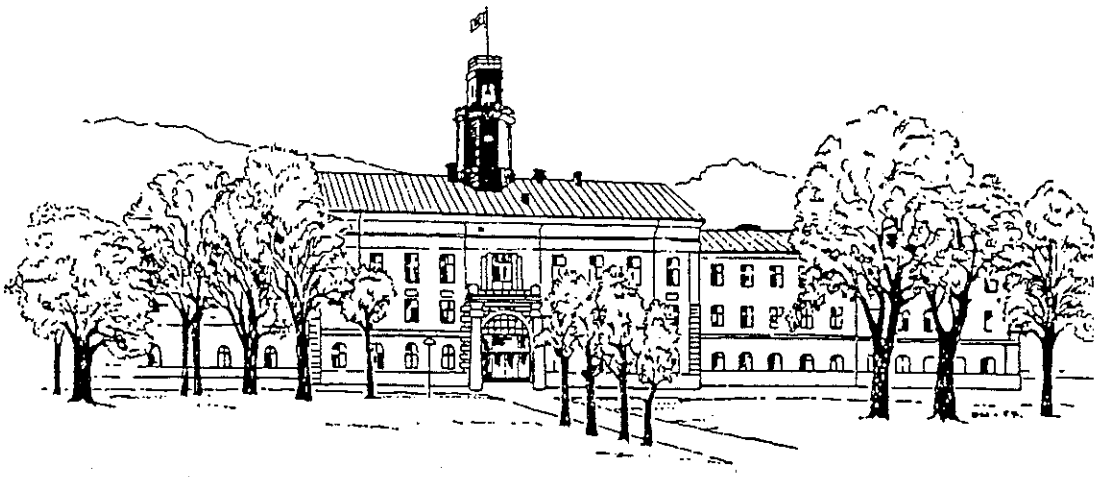
ISCE

International Society of Chemical Ecology

6th Annual Meeting, 7 - 11 August 1989



at the Nordic School of Public Health

University of Göteborg

Göteborg, Sweden

6th Annual Meeting

International Society

of Chemical Ecology

Göteborg, Sweden

August 7 - 11, 1989

* Programme Schedule
* Detailed Programme
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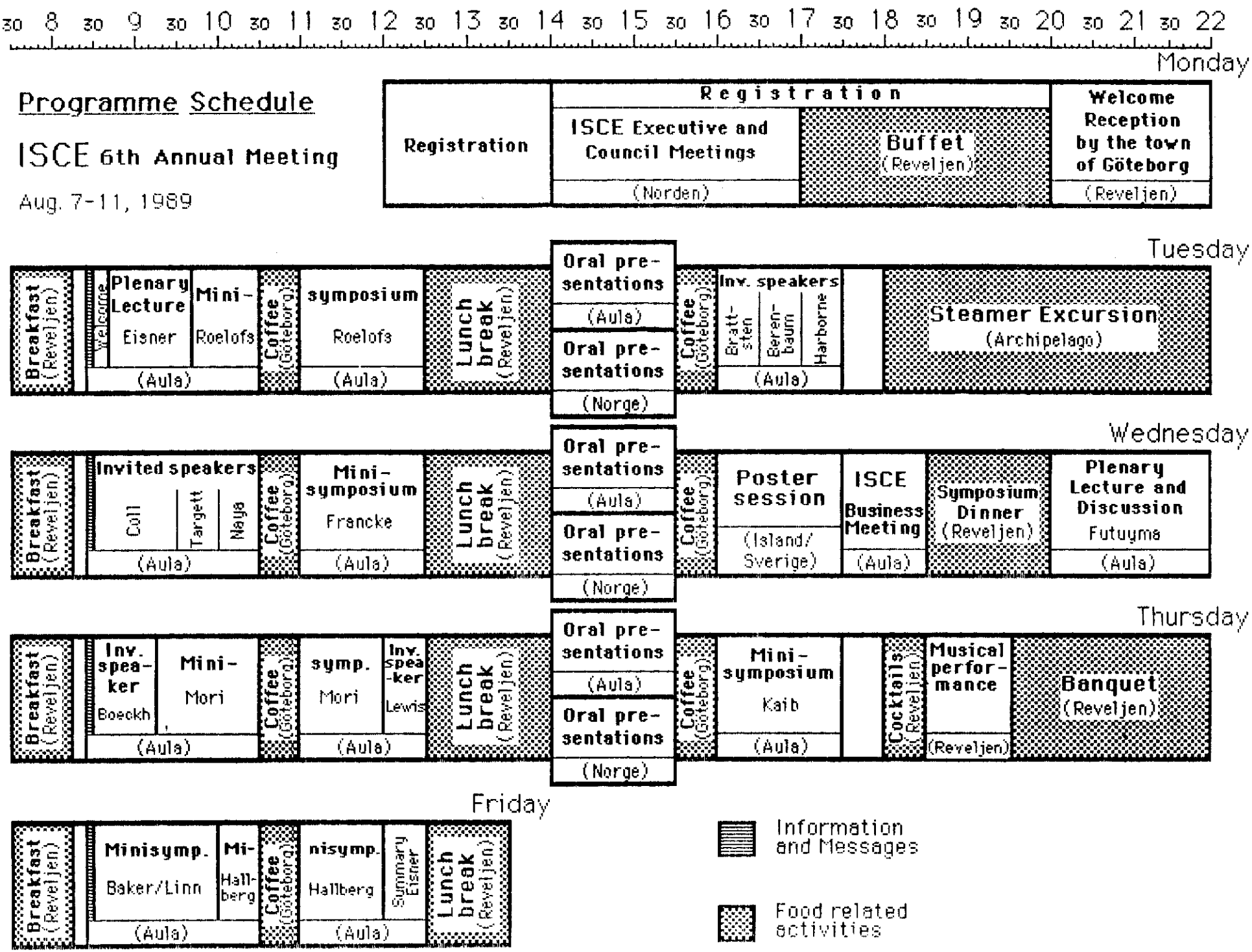
* Abstracts
* Acknowledgements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Monday
Programme Schedule
ISCE 6th Annual Meeting
Aug. 7-11, 1989
Registration
Registration
ISCE Executive and Council Meetings
(Norden)
Buffet
(Reveljen)
Welcome Reception by the town of Göteborg
(Reveljen)
Tuesday
Breakfast (Reveljen)
Welcome
Plenary Lecture
Eisner
Mini-
Roelofs
(Aula)
Coffee (Göteborg)
symposium
Roelofs
(Aula)
Lunch break (Reveljen)
Oral pre-sentations
(Aula)
Oral pre-sentations
(Norge)
Coffee (Göteborg)
Inv. speakers
Bratt-sten
Beren-baum
Harborne
(Aula)
Steamer Excursion
(Archipelago)
Wednesday
Breakfast (Reveljen)
Invited speakers
Coll
Targett
Naya
(Aula)
Coffee (Göteborg)
Mini-symposium
Francke
(Aula)
Lunch break (Reveljen)
Oral pre-sentations
(Aula)
Oral pre-sentations
(Norge)
Coffee (Göteborg)
Poster session
(Island/ Sverige)
ISCE Business Meeting
(Aula)
Symposium Dinner
(Reveljen)
Plenary Lecture and Discussion
Futuyma
(Aula)
Thursday
Breakfast (Reveljen)
Inv. spea-ker
Boeckh
Mini-
Mori
(Aula)
Coffee (Göteborg)
symp.
Mori
Inv. spea-ker
Lewis
(Aula)
Lunch break (Reveljen)
Oral pre-sentations
(Aula)
Oral pre-sentations
(Norge)
Coffee (Göteborg)
Mini-symposium
Kaib
(Aula)
Cocktails (Reveljen)
Musical perfor-mance
(Reveljen)
Banquet
(Reveljen)
Friday
Breakfast (Reveljen)
Minisymp.
Baker/Linn
Mi-
Hall-berg
(Aula)
Coffee (Göteborg)
nisymp.
Hallberg
Summary Eisner
(Aula)
Lunch break (Reveljen)
Information and Messages
Food related activities

PROGRAMME

Monday, August 7

12.00-20.00		Registration (Entrance hall)
14.00-17.00		ISCE Executive and Council Meetings (Norden)
17.00-19.00		Buffet Dinner (Reveljen)
20.00-22.00		Welcome Reception by the town of Göteborg (Reveljen)
20.30	***Jörgen Linder*** Lord Mayor of Göteborg	Welcome Address

Tuesday, August 8

07.30-08.15		Breakfast (Reveljen)
08.25-08.30		Today's information (Aula)
08.30-08.45	***Ingvar Lindgren*** Dean of the Faculty of Natural Sciences, University of Göteborg ***Lennart Köhler*** Dean of the Nordic School of Public Health	Opening addresses (Aula)
08.45-09.45	***Thomas Eisner*** Cornell University, USA	Plenary lecture (Aula) The insect as druggist - the utilization of plant secondary metabolites by insect

09.45-10.40	***Wendell Roelofs*** Cornell University, USA	Minisymposium (Aula) ***Evolution of mate recognition systems***
09.45-10.15	***David Lambert*** Univ of Auckland, New Zealand	Chemical signals and the recognition concept
10.15-10.40	***Wendell Roelofs*** Cornell University, USA	The volcanic hypothesis for evolution of moth sex pheromones
10.40-11.10		Coffee (Göteborg/Aula pre-room)
11.10-12.30	***Wendell Roelofs*** Cornell University, USA	Minisymposium cont. (Aula)
11.10-11.35	***Christer Löfstedt*** Univ of Lund, Sweden	Evolution of specificity in moth pheromone communication systems and its genetic control
11.35-12.00	***P. Larry Phelan*** Ohio State Univ, USA	The evolution of male courtship pheromones in the Lepidoptera
12.00-12.30	***Laurie Tompkins*** Temple University, USA	Analysis of sex pheromones in Drosophila melanogaster, a genetically tractable organism
12.30-14.00		Lunch (Reveljen)
14.00-15.30		Contributed papers - oral presentations Sections A (Aula) and B (Norge)
		Section A
14.00-14.18	***Jocelyn G. Millar*** Univ of California, Riverside, USA	Unsaturated epoxides as sex pheromones and sex attractants for Geometrid moths: Interactions of enantiomers and regioisomers
14.18-14.36	***Guy Poppy*** Oxford Univ, UK	Hair-pencils revisted: they are sex pheromones after all
14.36-14.54	***Jeremy N. McNeil*** Université Laval, Canada	Effects of temperature on male receptivity to the female sex pheromone: studies on the true armyworm and the European cornborer

14.54-15.12	***Arnon Shani*** Ben-Gurion Univ, Israel	Calling behaviour of single almond moth (Ephestia Cautella) females in a glass cage and pheromone blend trapped on cage walls and extended capillaries
15.12-15.30	***Ezra Dunkelblum*** Volcani Center, Israel	Effect of PBAN in Chrysodeixis chalcites (Lepidoptera: Noctuidae)
		Section B
14.00-14.18	***Wilhelm Boland*** Universität Karlsruhe, West Germany	Biosynthesis of 1-alkenes in higher plants and insects
14.18-14.36	***Clive G. Jones*** Inst of Ecosystem Studies, Millbrook, USA	Plant chemistry, stress- and damage-induced shifts in cotton-wood resistance to insects and diseases
14.36-14.54	***Douglas Whitman*** Illinois State Univ, USA	Tritrophic chemical communication: parasitic wasps respond to chemical "SOS" from plants
14.54-15.12	***C.A. McDaniel*** USDA, Gulfport, USA	Major antitermitic components of western red cedar
15.12-15.30	***Hermann M. Niemeyer*** Univsersidad de Chile, Chile	Chemical basis of wheat defense against pests and diseases
15.30-16.00		Coffee (Göteborg/Aula pre-room)
16.00-17.30		Invited lecturers (Aula)
16.00-16.30	***Lena Brattsten*** Rutgers Univ, USA	Metabolism of plant allelochemicals in insects: the benefits of diversity
16.30-17.00	***May Berenbaum*** Univ of Illinois, USA	Chemical ecology of Papillionidae: a Swallowtail tale
17.00-17.30	***Jeffrey Harborne*** Reading University, UK	Interactions of insects with plant flavonoids
18.00-22.00		Excursion by Steamer "Bohuslän" to the archipelago of Göteborg

Wednesday, August 9

07.30-08.15		Breakfast (Reveljen)
08.25-08.30		Today's information (Aula)
08.30-10.30		Invited lecturers (Aula)
08.30-09.30	***John C. Coll*** James Cook Univ of North Queensland, Australia	Chemically mediated interactions between marine organisms. II.
09.30-10.00	***Nancy Targett*** Univ of Delaware, USA	Allelochemical cues in the marine environment
10.00-10.30	***Yoko Naya*** Suntory Inst for Bioorganic Research, Japan	Chemicals involved in symbiotic relationships: sea anemone-fish and insects-microorganisms
10.30-11.00		Coffee (Göteborg/Aula pre-room)
11.00-12.30	***Wittko Francke*** Universität Hamburg, West Germany	Minisymposium (Aula) ***Evolution of chemical communication systems in forest insects***
12.30-12.55	***David L. Wood*** Univ of California, Berkeley, USA	Evolution of host and conspecific discrimination among sibling Ips Spp
12.55-13.15	***Stephen A. Teale*** State University College, Syracuse, USA	Correlation of qualitative variation in pheromone synthesis and response specificity in Ips pini (Coleoptera: Scolytidae)
13.15-13.30	***Fredrik Schlyter*** Univ of Lund, Sweden	Evolution of aggregation pheromones and mass-attack mechanisms
13.30-13.45	***Wittko Francke*** Universität Hamburg, West Germany	From monoterpene hydrocarbons to acetogenins: Evolutionary principles in the chemistry of bark beetle communication?
13.45-14.00	***Olle Anderbrant*** Univ of Lund, Sweden	Pheromone communication in diprionid sawflies
12.30-14.00		Lunch (Reveljen)

14.00-15.30		Contributed papers - oral presentations Sections A (Aula) and B (Norge)
		Section A
14.00-14.18	***Glenn D. Prestwich*** State Univ of NY, Stony Brook, USA	How pheromones work: Bio-organic chemistry of binding and catabolic proteins in moths
14.18-14.36	***John A. Byers*** Univ of Lund, Sweden	Field methods in chemical ecology
14.36-14.54	***Steven Seybold*** Univ of California, Berkeley, USA	The enantiomeric composition of ipsenol and ipsdienol from selected species in subgeneric groups of Ips
14.54-15.12	***Göran Birgersson*** Univ of Georgia, USA Univ of Göteborg, Sweden	Is myrcene really the natural precursor for ipsdienol and ipsenol?
		Section B
14.00-14.18	***Remy Brossut*** Lab de Zoologie, Dijon, France	The different patterns of emission of sexual pheromones in cockroaches
14.18-14.36	***Robert K. van der Meer*** USDA, Gainesville, USA	Parasite and host fire ant interactions: the chemical ecology of parasite integration
14.36-14.54	***Claude Everaerts*** Lab de Zoologie, Dijon, France	Chiral alarm pheromone and caste-specific reaction in Nasutitermes princeps
14.54-15.18	***Angel Guerrero*** Dept of Biological Organic Chemistry, Barcelona, Spain	Inhibitory pheromonal activity promoted by some analogs of the sex pheromone of the pine processionary moth Thaumetopoea pityocampa

15.18-15.30	***Steven Cork*** CSIRO, Canberra, Australia	Adaptations of arboreal Australian marsupials for dealing with plant cell-wall polysaccharides, lignin and tannins
15.30-16.00		Coffee (Göteborg/Aula pre-room)
16.00-17.30		Poster session (Island and Sverige)
17.30-18.30		ISCE Business Meeting (Aula)
18.30-20.00		Dinner (Reveljen)
20.00-22.00		Plenary lecture followed by discussion
	Douglas Futuyma State Univ of New York, Stony Brook, USA	Ecological chemistry in evolutionary focus: what are the questions?

Thursday, August 10

07.30-08.15		Breakfast (Reveljen)
08.25-08.30		Today's information (Aula)
08.30-09.15	***Jürgen Boeckh*** Regensburg Univ, West Germany	Invited lecturer (Aula) Receptoral and neuronal mechanisms of encoding and identification of natural odors
09.15-10.30	***Kenji Mori*** Univ of Tokyo, Japan	Minisymposium (Aula) ***Identification and synthesis of new semiochemicals***
09.15-09.40	***Heinrich Arn*** Swiss Federal Research Station, Wädenswil, Switzerland	Identification of (3Z,6Z)-1,3,6-9,10-epoxyheneicosatriene and (3Z,6Z)-1,3,6-9,10-epoxyeicosatriene in the sex pheromone of Hyphantria cunea
09.40-10.05	***Tatsuji Chuman*** Japan Tobacco Inc, Yokohama, Japan	New pheromone mimics: shape analysis and activity of periplanones and their mimics
10.05-10.30	***H. Hauptmann*** Regensburg Univ, West Germany	Periplanone D_1 and D_2 - two novel bioactive constituents from Periplaneta americana

10.30-11.00		Coffee (Göteborg/Aula pre-room)
11.00-12.00	***Kenji Mori*** Univ of Tokyo, Japan	Minisymposium cont. (Aula)
11.00-11.20	***Kenji Mori*** Univ of Tokyo, Japan	Recent results in the synthesis of semiochemicals
11.20-11.40	***Allan C. Oehlschlager*** Simon Fraser Univ, Burnaby, Canada	Increasing the efficiency of pheromone synthesis
11.40-12.00	***John A. Pickett*** Rothamsted Experimental Station, Harpenden, UK	Aphid sex attractants and coleopteran host attractants
12.00-12.30		Invited lecturer (Aula)
	W.J. Lewis USDA, Tifton, GA, USA	Roles and functional mechanisms of semiochemicals in the tritrophic interaction of plants, phytophages and parasitoids
12.30-14.00		Lunch (Reveljen)
14.00-15.30		Contributed papers - oral presentations Sections A (Aula) and B (Norge)
		Section A
14.00-14.18	***Jean-Luc Boevé*** Universität Bern, Switzerland	Which factors influence the composition of a secretion in the ventral glands of nematine larvae (Hymenoptera, Tenthredinidae)?
14.18-14.36	***E. David Morgan*** Univ of Keele, UK	The trail pheromone of the ant Tetramorium impurum and the specificity of its structure deduced from studies with related compounds
14.36-14.54	***Jeffrey R. Aldrich*** USDA, Beltsville, MD, USA	Pheromone blends of green stink bugs and possible parasitoid selection
14.54-15.18	***James L. Nation*** Univ of Florida, USA	Biology of pheromone release by Caribbean fruit flies
15.18-15.30	***Hans Alborn*** USDA, Gainesville, USA Univ of Göteborg, Sweden	Semiochemically mediated host recognition and learning in a parasitic wasp, Microplitis croceipes

Section B

14.00-14.18	***Edwin Bourget*** Université Laval, Quebec, Canada	Spatial scales and shift of cue of barnacle larvae at settlement
14.18-14.36	***Mona C. De Vries*** Duke University Marine Laboratory, USA	Rhizocephalan parasitized crabs respond to analogues of crab larval release pheromones
14.36-14.54	***Mitchell J. Smith*** Columbia Univ, New York, USA	Chemical respiration and metal ion metabolism: recurrent ecologic features uniting primitive eukaryotes and prokaryotes?
14.54-15.12	***B.S. Kil*** Wonkwang Univ, Republic of Korea	Phytotoxic effects on selected species by naturally occurring chemical substances from several plants in Korea
15.12-15.30	***Ana Luisa Anaya -*** Universidad Nacional Autonoma de Mexico, Mexico	Allelopathic potential of Ipomoea tricolor L (Convolvulaceae)
15.30-16.00		Coffee (Göteborg/Aula pre-room)
16.00-17.30	***Manfred Kaib*** Univ of Bayreuth, West Germany	Minisymposium ***Multifunctionality of chemical signals***
16.00-16.10	***Manfred Kaib*** Univ of Bayreuth, West Germany	Multifunctional chemical signals: an introduction to the symposium
16.10-16.40	***J. Billen*** Zoological Inst, Leuven, Belgium	The social insect: a glandular success-formula
16.40-17.05	***Murray S. Blum*** Univ of Georgia, Athens, USA	Pheromonally mediated behaviour in ants: evolutionary significance
17.05-17.30	***Hanna Mustaparta*** Univ of Trondheim, Norway	Pheromones and interspecific chemical signals: function, receptor specificities and CNS processing

18.00		Cocktails (Reveljen)
18.30		Musical performance (Reveljen)
19.30-22.00		Banquet (Reveljen)
	Jerrold Meinwald ***Wittko Francke***	Presidential addresses
	Sigvard Höggren	The philosophy of a major company: Volvo's environmental policy
	Gunnar Bergström	A personal philosophy of chemical ecology

Friday, August 11

07.30-08.15		Breakfast (Reveljen)
08.25-08.30		Today's information (Aula)
08.30-10.00	***Thomas C. Baker and Charles Linn*** Univ of California, USA	Minisymposium ***Behaviour mechanisms in chemical communication***
08.30-08.55	***Thomas C. Baker*** Univ of California, Riverside, USA	Pheromone-mediated flight in moths
08.55-09.15	***Kjell Döving*** Univ of Oslo, Norway	Odour-mediated behaviour in salmon
09.15-09.35	***Charles Linn*** New York State Agricultural Experiment Station, USA	Multicomponent blends, signal specificity and the long range attraction of male moths
09.35-10.00	***Maurice Sabelis*** Univ of Amsterdam, The Netherlands	Behavioural responses of predatory mites to kairomones
10.00-12.00	***Eric Hallberg*** Univ of Lund, Sweden	Minisymposium (Aula) ***Olfactory receptor morphology***

10.00-10.30	***Eric Hallberg*** Univ of Lund, Sweden	Olfactory sensilla in Crustacea
10.30-11.00		Coffee (Göteborg/Aula pre-room)
11.00-12.00		Minisymposium cont. (Aula)
11.00-11.30	***Bert Ph.M. Menco*** Northwestern Univ, Evanston, USA	Ultrastructural and cytochemical explorations of the rat's olfactory epithelium with freeze - etching and freeze - substitution
11.30-12.00	***Rudolf A. Steinbrecht*** MPIV, Seewiesen, West Germany	Insect chemoreceptive sensilla
12.00-12.30	***Thomas Eisner*** Cornell Univ, USA	Summary of the meeting
12.30		Lunch (Reveljen)

(In parenthes: respective localities)

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August 31, 1989

Abstracts

Alborn, H., Tumlinson, J. H., and Lewis, W. J. Semiochemically Mediated Host Recognition and Learning in a Parasitic Wasp, *Microplitis croceipes*. USDA-ARS P.O. Box 14565, Gainesville, FL 32604 and P.O. Box 748, Tifton, GA

Females of parasitic wasps increase their responses to host related cues after an experience with hosts or host products. *M. croceipes* attacks only *Heliothis* spp. larvae, which are polyphagous and severe pests on several important crops. After contact with host feces female wasps will fly to volatiles emitted by the feces and characteristic of the plant on which the host is feeding. Host recognition and learning behavior is mediated by a combination of several components in the feces. 13-methylhentriacontane, along with more volatile components, stimulates the females to antennate the feces. Upon antennation they detect non-volatile, polar components that act as host recognition kairomones. There are at least two of the latter, one of which is a high molecular weight compound and appears to be the most active in laboratory assays. The other seems to increase the activity of the mixture. The female wasps associate the odor of volatiles in the feces with the presence of these non-volatile host recognition cues and subsequently search for that odor during their foraging. These chemical cues, when they are identified and synthesized, should be very useful in manipulating female parasitoids and increasing their effectiveness in biocontrol programs.

Aldrich, Jeffrey R. Pheromone blends of green stink bugs and possible parasitoid selection. Insect Hormone Laboratory, USDA-ARS, Agricultural Research Center-East, Beltsville, MD 20705, USA.

The ratio of *trans*- and *cis*-(Z)-α-bisabolene epoxides in the pheromone blend of the southern green stink bug, *Nezara viridula*, varies among isolated populations of this cosmopolitan pest. Japanese and European populations of *N. viridula* release equivalent amounts of the two epoxide isomers, whereas in populations of the bug from the western hemisphere the *trans*-isomer predominates. Male green stink bugs from the genus *Acrosternum* that are native to North America release pheromone blends containing the same major sesquiterpenes as in the *Nezara* pheromone, but have relatively more of the *cis*-epoxide isomer. It is proposed 1) that the chemical similarity of *Acrosternum* and *Nezara* pheromones facilitated the adoption of *N. viridula* as a host in the New World by parasitic tachinid flies and 2) that tachinid parasitization of immigrant populations of *N. viridula* led to the contemporary pheromone strains of this bug in the Americas containing predominantly the *trans*-epoxide isomer.

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MATA Rachel. Facultad de Química.
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"ALLELOPATHIC POTENTIAL OF Ipomoea tricolor L. (Convolvulaceae)".

Different species of Ipomoea and beans (particularly Stizolobium pruriens) are used in tropical zones of Mexico to control weeds. All of these species are highly competitive and also possess an allelopathic potential. Ipomoea tricolor L. is used in some dry tropical zones of Morelos, Mexico, in sugar cane fields, as a cover non crop plant, both to fertilize the soil with its organic matter, and to control the growth of weeds. In the present study we found a strong inhibitory effect of fresh and dry plant, and some organic and aqueous extracts on the radicle growth of Amaranthus and Echinochloa Column chromatography of an ethyl acetate extract produced four fractions, one of them was a white-yellow crystalline solid melting at 109-111°C with a probable glycoside highly hydrocarbonated structure At 100 ppm this solid caused a mean of 80% inhibition of the radicle growth of the above mentioned test species.

Anderbrant, Olle. Pheromone communication in diprionid sawflies. Department of Ecology, Animal Ecology, Lund University, Ecology Building, S-223 62 Lund, Sweden.

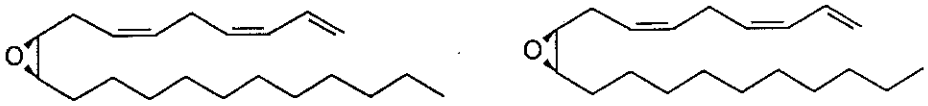
The hymenopteran family Diprionidae consists of about 85 species, which have differentiated in the coniferous forests of the northern hemisphere. One center of speciation seems to have been in North America and another in Europe/Asia. The females attract males by a pheromone, which in all investigated species from both proposed lines of speciation, consists of acetates or propionates of 3,7-dimethylpenadecan-2-ol (diprionol). Based on the very limited number of species investigated it seems like propionates are used by species in the Old World genus Diprion and acetates are used by the Old World genus Gilpinia and the New World genus Neodiprion. Premating reproductive isolation between sympatric species may be maintained by the usage of different combinations of the stereoisomers of diprionol acetate or propionate. In Neodiprion, all investigated species are attracted to (2S,3S,7S)-diprionol acetate. Since several of these species are sympatric, other isomers or substances are most likely involved in their communication system. Recently improved methods of chiral synthesis and analysis should help us understand the evolution of apparently subtle species differences between the pheromone communication systems in diprionid sawflies.

Tóth, M., Buser, H.R., Peña, A., Arn, H.*, Mori, K., Takeuchi, T., Nikolaeva, L.N., Kovalev, B.G.

Identification of (3*Z*,6*Z*)-1,3,6-9,10-epoxyheneicosatriene and (3*Z*,6*Z*)-1,3,6-9,10-epoxyeicosatriene in the sex pheromone of *Hyphantria cunea*[1].

Swiss Federal Research Station, Wädenswil, Switzerland, Research Institute of Plant Protection, Budapest, Hungary, University of Tokyo, Tokyo, Japan, All-Union Research Institute for Biological Control Methods, Kishinev, USSR.

(3*Z*,6*Z*)-3,6-9,10-Epoxyheneicosadiene, linoleic and linolenic aldehyde were previously identified as sex pheromone components of the fall webworm, *Hyphantria cunea*[2,3]. However, no information of field activity of the 3-component blend has been reported. GC-EAD analysis of female sex gland extracts now confirmed the presence of these components and, in addition, a highly active compound more polar and present at a 10 times lower amount than the dienic epoxide. Mass spectra suggested the trienic C_{21} epoxide shown below. A trace of another biologically active compound was tentatively identified as the C_{20} homolog. The two enantiomer pairs were stereoselectively synthesized; in each case the 9*S*,10*R* enantiomer was at least 10 times more EAG active than the other. A mixture of the two aldehydes and the three 9*S*,10*R* epoxides was attractive to *H. cunea* males in the field.



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Jacques AUGER, Chantal LECOMTE and Eric THIBOUT

LEEK-MOTH AND DIAMOND-BACK-MOTH FRASS VOLATILES THAT STIMULATE PARASITOID, DIADROMUS PULCHELLUS. POSSIBLE NEW THIO-COMPOUNDS PATHWAYS

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Acrolepiopsis assectella and Plutella xylostella frass volatiles were trapped and examined by GC. In both moths we found the same three disulfides, dimethyl- dipropyl- and methyl propyl- . Disulfides elicited the same behavioral response by the parasitoid, Diadromus pulchellus, as frass.

Feeding leek moths on an artificial diet has shown the vegetal origin of the disulfides. The addition of either propyl or methyl disulfide or their precursors to the diet leads to appearance of the three disulfides in the frass. This implies the transformation of the S-propyl moiety to S-methyl and vice versa by an as yet unknown mechanism.

Baker, Thomas C., Vickers, Neil K.

PHEROMONE-MEDIATED FLIGHT IN MOTHS

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In order to control its direction and speed of displacement in wind in the horizontal plane, a male moth responding to sex pheromone or a female moth responding to host odor must change its course angle (the direction towards which it is thrusting, relative to the wind line) and change its airspeed (its speed through the air mass next to its body). The two main mechanisms known to be used for the location of such odor sources by flying moths, optomotor anemotaxis (steering with respect to the wind) and self-steered counterturning, both rely on these two behavioral reactions. The direction of thrust (steering) can be changed by either yawing or rolling the body, the latter having been neglected over the years. The amount of thrust can be changed either by a change in total wing force (e.g., wing beat frequency) or by a change in the angle of the body relative to the ground (pitch angle). The changes in the strength and direction of the wing force in the horizontal plane are inextricably linked to changes in lift (hence altitude) that are also under visual feedback control. Altitude is also controlled by pheromone-stimulated moths, and thus places restrictions on the flight in the horizontal plane. Much more needs to be learned about height control in pheromone-stimulated moths. There is much support for the existence of counterturning programs in free-flying males of several species flying within odor plumes, among which is the temporal regularity of the lateral deviations, the continuation of the zigzags even in zero wind, and even the initiation of counterturns in pheromone in zero wind. Optomotor anemotaxis polarizes the otherwise meandering zigzags into an orderly upwind resultant, taking the moth upwind in the plume to the source.

Göran Birgersson, IS MYRCENE REALLY THE NATURAL PRECURSOR FOR IPSDIENOL AND IPSENOL? Department of Entomology, University of Georgia, Athens, GA 30602, U.S.A.

Most, if not all, species of the bark beetle genus Ips are known to produce ipsdienol and/or ipsenol, which are used in their semiochemical systems. In addition to these compounds, (-)cis-verbenol is used by many Ips species in their aggregation pheromones. All these compounds are monoterpene alcohols, structurally related to monoterpene hydrocarbons in the resin of their host trees.

Beetles exposed to (-)-α-pinene will produce (-)cis-verbenol, However, males of some Ips species, such as I. typographus and I. schmutzenhoferi, do not produce ipsdienol or ipsenol when exposed to myrcene, while other species, such as I. duplicatus and I. paraconfusus, will synthesize these compounds.

Furthermore, if males of I. schmutzenhoferi are allowed to attack bolts of Norway spruce (Picea abies), which is rich in α-pinene but poor in myrcene, the beetles produce large amounts of ipsenol (and ipsdienol) as well as myrcenol, but only trace amounts of cis-verbenol.

Males of I. typographus were only found to produce ipsdienol and ipsenol if they were mated and their galleries were surrounded by unstained phloem, with no correlation to the concentration of myrcene. Unmated males, and mated ones surrounded by brown stained phloem, did not produce ipsdienol nor ipsenol.

When I. paraconfusus males were allowed to attack bolts from several species of pine trees with very different amounts of monoterpene hydrocarbons, especially myrcene, there were no quantitative differences in their production of ipsenol and ipsdienol. There was no apparent relationship to myrcene content in the phloem, which varied from very high, in Jeffery pine, to absent, in Digger pine.

Conclusion: Males of Ips beetles are able to produce their pheromone components ipsdienol and/or ipsenol independent of the presence of the monoterpene hydrocarbon myrcene in their host trees. This production is probably de novo and hormonally regulated. In addition, some of the species are able to hydroxylate myrcene to ipsdienol, upon exposure.

Blum, Murray S. Pheromonally Mediated Behavior in Ants: Evolutionary Significance. Laboratory of Chemical Ecology, Department of Entomology, University of Georgia, Athens, Georgia 30602, USA.

The behaviors of ants are largely integrated by chemical signals to which these invertebrates have evolved a programmed responsiveness in a variety of societal contexts. Ants have expanded their social horizons utilizing a treasure-trove of pheromones to regulate a diversity of colonial interactions. Pheromones can be regarded as the critical nexuses that insure that the collective resources of a colony can be rapidly exploited in response to specific stimuli, especially in the milieu of the nest. Ant societies can now be described in chemisocial terms because it has been possible to decode the information encoded in their eclectic chemical signals. The evolution of a viable ensociality is correlated with the pheromonal largess which characterizes the products of the multifarious exocrine glands with which ants are endowed.

Boevé, Jean-Luc. Which factors influence the composition of a secretion in the ventral glands of nematine larvae (Hymenoptera, Tenthredinidae)? Lehrstuhl für Tierökologie II - Universität Bayreuth - Postfach 101251; NWI - D-8580 Bayreuth - WEST GERMANY.

Nematine larvae present a row of ventral glands on the abdomen. The secretion of these glands has a defensive function towards predators, especially small invertebrates. Single glands of Nematus pavidus have been studied by GLC. No significant intra-individual variations are noted in the chemical composition of the secretion. In contrast, variations are observed from the first larval instar until the prepupa (which also presents ventral glands). Some first results will be given on chemical aspects of the secretory mechanism. The glandular secretion has been studied by GC-MS in about 50 nematine species (about 30 species for a first time) belonging to 19 genera. The distribution of the chemicals within the subfamily is influenced by taxonomic factors; e.g. components with a relatively short retention time are absent in the most primitive genera. The importance of other factors (activity of the components, gland size, biology and behaviour of the larva) will be discussed.

CHEMICAL AND PHARMACOLOGICAL STUDIES OF THE THAI MEDICINAL PLANT *Ipomoea pes-caprae* (CONVOLVULACEAE).

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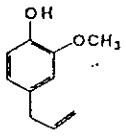
Ipomoea pes-caprae (L. R. Br.) is a plant in Thailand (thai name "phakbung tha-le"), which is used as an antidote for jelly fish stings and as an antipruritic agent. An extract (IPA) was obtained from petroleum ether extraction of a water distillate of dried leaves of the plant. This extract showed antagonistic activities.[1,2] Fractionation was monitored by using different bioassays. This technique lead to the isolation of eugenol (1) from a complex fraction, which inhibited prostaglandin synthesis. Further, two diastereomerically related compounds (2) were isolated from a fraction inhibiting ethylphenylpropiolate-induced inflammation on rat ear.

Identification of the diastereomers of 2 was performed using MS and advanced NMR techniques. The absolute configuration and relative stereochemistry have not yet been fully established. Isomers of 2 have earlier been isolated from grapes, *Vitis vinifera*,[3] and the Japanese plant *Actinidia polygama*.[4] They have been reported to show pharmacological activity.



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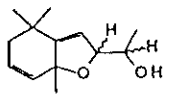

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Biosynthesis of 1-Alkenes in Higher Plants and Insects

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Uneven numbered 1-alkenes, such as 1-pentadecene or 1,8,11,14-heptadecatetraene etc. are common constituents of e.g. plant root oils or defensive secretions of insects. They are formed from the corresponding fatty acids by fragmentative decarboxylation. Incubation studies with germinating safflower (*Carthamus tinctorius*) or *Tribolium confusum* using chiral 12-phenyl[^{2}H]dodecanoic acids as artificial precusors revealed the fragmentation to be an overall *anti*-elimination of hydrogen and the carboxyl group (anti-periplanar transition state). The activation of the substrate acid is enantiospecific and occurs with removal of the 3-*pro-S* hydrogen of the precursor acid. The mechanistic alternatives are in agreement with abstraction of a 3-*pro-S* hydride and fragmentation, or a stereo- and enantiospecific insertion of oxygen into the 3-*pro-S* C-H bond of the free fatty acid followed by appropriate activation and fragmentation. 3-Hydroxy acids from the metabolic pool of lipids are not involved. The mechanism seems to be of general importance for the biosynthesis of vinylic substructures of natural products from oxygenated precursors.

Bourget, Edwin . Spatial scales and shift of cue of barnacle larvae at settlement. GIROQ, Département de biologie, Université Laval, Ste-Foy, Québec G1K 7P4, Canada

I summarize recent experiments on habitat selection by larvae of the barnacle *Semibalanus balanoides* in two regions, the nothwestern Gulf of St. Lawrence and Passamaquoddy Bay along the Atlantic coast of Canada, and examine the mechanism of habitat selection used by the larvae in these two regions. The focus is placed on scales of heterogeneity, scales in the exploration by the larvae and the larvae's perception of cues. Results show that there is a shift in cues from biological cues (algae) during the broad exploration phase, to a mixture of biological and physical cues during close exploration, to physical cues (microheterogeneity) during final inspection.

THE DIFFERENT PATTERNS OF EMISSION OF SEXUAL PHEROMONES IN COCKROACHES.

BROSSUT R.; FARINE J.P.; ABED D; SIRUGUE D.
CNRS, URA 55. Laboratoire de Zoologie, 6 Bd Gabriel 21000 Dijon, France.

In most species of Blattoidea and Blaberoidea, the female emits a sexual pheromone which attracts the male at short or long distance and initiate the courtship behavior.

The production of a volatile sex pheromone by the males has been demonstrated in several species of the subfamily Oxyhaloinae (Blaberoidea). This atypical sexual behavior has been correlated with their assumed "highly evolved" status within the Blaberoidea.

Our current research on the courtship behavior in the Blaberoidea (Periplaneta americana, Blatta orientalis, Eurycotis floridana and E. kevani) indicates the existence of several patterns of pheromonal communication.

The sexual pheromones are produced by the females in P. americana and B. orientalis, by the males in both species of Eurycotis. Females or males of each species display a characteristic calling posture associated with the emission of the pheromones which are produced by specialized glandular areas.

Byers, John A.

FIELD METHODS IN CHEMICAL ECOLOGY

A novel method, Diffusion-Dilution, for release of synthetic chemicals is presented with examples from the western pine beetle in California. The Effective Attraction Radius, EAR, is another new method which can be used to compare the attractiveness of various species pheromones and synthetic pheromone components regardless of varying flight densities and conditions. A third concept, Wind-Vane Traps, may provide new ways of studying orientation in flying insects. A fourth technique, under investigation, appears to reduce catch variation so that meaningful tests of pheromone component blends can be conducted with a minimum of effort and time.

CHUMAN, T., K. SHIMAZAKI, M. MORI and K. OKADA.

NEW PHEROMONE MIMICS: SHAPE ANALYSIS AND ACTIVITY OF PERIPLANONES AND THEIR MIMICS.

Life Science Research Laboratory, Japan Tobacco Inc. 6-2 Umegaoka, Midori-ku, Yokohama, Kanagawa 227, Japan.

Periplanones, sex pheromones of american cockroach are forcussed to study on the relationship between molecular shapes and their activity. Several candidates, designed by computational chemistry to be templeted with energy-mimimum conformation of periplanone-B, were synthesized and their pheromonal activity was estimated by behavioural bioassay and EAG recordings. Obvious relationship on activity and energy-mimimum conformations of the mimics, which refined by molecular mechanics and molecular orbital calculation, X-ray and 500MHz NMR, were indicated from the comparison study..

Cork, Steven[1], Foley, Bill[2], & Sanson, Gordon[2]. [1]CSIRO, Division of Wildlife & Ecology, Canberra, Australian Capital Territory, Australia, and [2]Zoology Department, Monash University, Clayton, Victoria, Australia. **Adaptations of Arboreal Australian Marsupials for dealing with Plant Cell-Wall Polysaccharides, Lignin, and Tannins.**

In Australian Eucalyptus forests, leaf-eating marsupials face high levels of lignin and other phenolic compounds, including tannins, which depress digestibility of cell-wall polysaccharides, increase faecal and urinary losses of nitrogen, reduce metabolizability of absorbed energy, and challenge acid-base balance. Differences in body size, rate of metabolism, gut function, and dentition between the four main folivores of temperate Australia suggest differences in ability to deal with lignin and tannins, and are consistent with the different feeding strategies of these species. Koalas (5-10 kg body weight), brushtail possums (~2 kg), greater gliders (~1 kg), and ringtail possums (~700 g) are all hindgut fermenters and have basal metabolic rates and maintenance energy requirements lower than the mammalian average. Koalas, greater gliders, and ringtail possums are highly folivorous and have the ability to selectively expel large, lignified, leaf fragments from the hindgut and retain smaller, more digestible, particles. This selective retention probably minimizes faecal losses of nitrogen associated with ingestion of tannins. Koalas have especially low metabolic energy requirements, and have teeth which efficiently shear lignified vascular bundles in the mature foliage that they utilize. Ringtail possums appear to break down tannin:cytoplasm complexes microbially in the hindgut, practice caecotrophy which enhances nitrogen retention, and have dentition which crushes the poorly lignified leaf tissue which they select from between vascular bundles. Greater gliders have dentition intermediate between shearing and crushing types and are highly selective for young foliage. The brushtail possum lacks the ability to separate digesta and, we suggest, is obliged to be more broadly herbivorous than the other three species.

COLL, John C.: "Chemically Mediated Interactions Between Marine Organisms. II" Department of Chemistry and Biochemistry, James Cook University, Townsville, Queensland. 4811 Australia.

Secondary metabolites, especially terpenes, have been implicated in interactions between marine organisms. These interactions include defensive strategies against predators, competitive strategies against neighbours in the quest for space, and communication between and within species. (Sammarco, P.W. and Coll, J.C. The Chemical Ecology of Alcyonarian Corals (Collenterata : Octocorallia). In Bioorganic Marine Chemistry Vol 2, pp 87-116, (P.J. Scheuer Ed.) Springer-Verlag Berlin 1988). This lecture will focus on recent studies involving competition for space on coral reefs, and the role of terpenes in this competition. Case studies will include the competition between encrusting octocorals and scleractinian corals, and between red algae and alcyonacean corals.

Dobson, Heidi, Inga Groth and Gunnar Bergström. **Pollen volatiles: signals in flower fragrances?** Ecological Research Station of Uppsala University, Ölands Skogsby 6280, S-386 00 Färjestaden, Sweden, and Department of Chemical Ecology, University of Gothenburg, Box 33031, S-400 33 Gothenburg, Sweden.

Pollen is a principal food reward to many flower-visiting insects, and it seems likely that recognition of pollen-rewarding flowers is enhanced by specific olfactory, as well as visual, stimuli. To evaluate the spatial patterning of olfactory stimuli within flowers, volatile profiles of different floral organs were compared in several species, with attention to pollen versus whole flowers. Volatiles were collected using headspace adsorption methods and analyzed by GC-MS. Results indicate that 1) distinctness of the major odor components of pollen versus whole flowers varies between species, 2) the volatile profile of pollen can range from weak and nondescript to clearly distinctive, and 3) in species with distinctive pollen odors, the major compounds may be mostly similar to those in whole flowers or composed of pollen-typical volatiles. Detailed comparisons between whole flowers and various floral parts were carried out in one species, Rosa rugosa, where it was found that 1) sepals, petals, empty anthers, and pollen have characteristic odors and 2) while the whole-flower fragrance is dominated by petal compounds, it does include small contributions from pollen. It is suggested that pollen volatiles may serve as close-range, pre-alighting signals to inform insects of the availability of pollen food-rewards.

Dunkelblum, Ezra and Miriam Altstein, Effect of PBAN in Chrysodeixis chalcites (Lepidoptera: Noctuidae). Instsitute of Plant Protection, Volcani Center, Bet Dagan 50250, Israel

The presence of a pheromone biosynthesis activating neurohormone in the brain (PBAN), and its effect on the sex pheromone biosynthetic pathway, were investigated in the tomato looper Chrysodeixis chalcites (Esper). The amounts of pheromone components and fatty acid precursors were compared in the presence and absence of PBAN in untreated, ligated and ligated and injected virgin females. The most abundant pheromone components, Z7-12:Ac and Z9-14:Ac, and the putative biosynthetic precursors 16:Acyl, Z11-16:Acyl, Z9-14:Acyl and Z7-12:Acyl were monitored. Comparison of their amounts in the three groups of females indicated that PBAN is involved in the regulation of the pheromone biosynthesis in C. chalcites. Lack of such a factor resulted in a depletion of the sex pheromone components as well as the their unsaturated putative biosynthetic precursors. However, no decrease was observed in the content of palmitoate suggesting that the $\Delta 11$ desaturation step is affected by the neuroendocrine factor. Injection of head ganglia extracts into ligated females resulted in a complete recovery of unsaturated precursor and pheromone components. On the other hand, PBAN was not involved in the terminal acetylation step as found by topical application of external alcohol to pheromone glands of ligated females. Both male and female head ganglia were found to contain a sex pheromone biosynthesis regulatory factor.

Francke, Wittko

Inst. für Organische Chemie, Martin-Luther-King-Platz 6, D-2000 Hamburg 13

FROM MONOTERPEN HYDROCARBONS TO ACETOGENINS:

"Evolutionary principles in the chemistry of bark beetle communication?"

The high "olfactory background noise" caused by monoterpenes in coniferous forests may "jam" (primitive?) systems of bark beetle communication which exclusively focus on the orientation towards host compounds (α-pinene or terpinolene). Selective transformation of the host's monoterpen hydrocarbons through allylic oxidation or hydration of double bonds furnishes more advanced signals which nevertheless may interfere with unspecific products of autoxidation reactions of host components. Possibly more specific chemical messengers which can not be derived from monoterpen hydrocarbons by one oxidation step are 6-methyl-5-hepten-2-one, 6-methyl-6-hepten-2-one or derivatives like sulcatol, pityol, vittatol, and frontalin. With respect to the generation of an unequivocal signal the use of acetogenins appears superior to the sensitive terpenoid principle. In fact, some bark beetle species produce mixtures of terpenoids and acetogenins (brevicomin or chalcogran) while the (highly developed?) aggregation pheromone of Pityogenes chalcographus is represented by acetogenins only.

Douglas J. Futuyma

Thirty-five years have elapsed since Dethier's paper on the evolution of feeding preferences in phytophagous insects, thirty since Fraenkel's statement of the raison d'etre of plant compounds, and twenty-five since Ehrlich and Raven's hypothesis of plant/insect coevolution. The secondary compounds of plants played a leading role in these seminal papers. I attempt in this presentation to review these authors' hypotheses and their evidence, to specify other questions that arise from their ideas, and to assess in part the extent to which these hypotheses have been supported. The chemistry of plant/insect interactions emerges as an important but not sole determinant of their evolution. The nature and reality of coevolution remains uncertain. The role of plant chemistry in the evolutionary diversification of insect feeding habits will, I argue, profit from an integration of chemical and ecological study with phylogenetic and genetic studies. I shall briefly describe a research program that exemplifies how such an integration might be approached.

González-Coloma, Azucena; Melchor García Hernández and Braulio M. Fraga
ON THE CHEMICAL ECOLOGY OF THE CANARIAN LAUREL FOREST: TOXIC NATURAL PRODUCTS FROM THE TREE PERSEA INDICA (LAURACEAE). Instituto de Productos Naturales Orgánicos del CSIC, Avda. Francisco Sánchez, 2, 38206 La Laguna, Tenerife, Canary Islands, Spain.

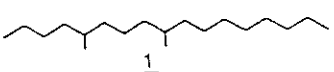
To begin our studies of the chemical ecology of the Canarian laurel forest, we have chosen the tree Persea indica for two reasons: a) it is considered to be a good palaeoendemism and b) it can readily be distinguished by its defoliated appearance due to the seasonal action of a wild forest rat (Ratus sp.) that eats the cortical tissues of the tree by biting through the stem of the terminal twigs.
We have found that an ethanolic extract of P. indica, as well as its ethyl acetate and water fractions were toxic when injected into laboratory mice. The mice also died when fed on P. indica stems. Two toxic natural products have been isolated and identified so far by DCCC chromatography and spectroscopic techniques: 1) ryanodol, a diterpene related to the insecticidal alkaloid ryanodine from Ryania speciosa, and 2) cinnzeylanol, previously isolated from Cinnamomum cassia cortex as an insecticidal substance.
We are currently studying the possible presence of more active compounds in addition to the role played by these products as defensive substances in P. indica.

Riba, M., Rosell, J.A., Eizaguirre, M., Canela, R., Guerrero, A.*

Identification of a minor component of the sex pheromone of *Leucoptera malifoliella* (Lepidoptera, Lyonetiidae).

Centre R & D (UPC-IRTA). Av. Rovira Roure, 177. 25006-Lérida. Department of Biological Organic Chemistry, C.I.D. (CSIC), Jordi Girona Salgado, 18 08034-Barcelona, Spain.

A new minor component in the female volatiles extract of the mountain-ash bentwing *Leucoptera malifoliella* (Costa) (Lepidoptera, Lyonetiidae), formerly *Leucoptera scitella* (Zeller), has been identified as 5,9-dimethyloctadecane 2. The amount detected of the minor compound 2 ranged from 4 to 8% in comparison with the major component 5,9-dimethylheptadecane 1. The identification has been based on its spectroscopic properties and chromatographic behaviour in comparison with an authentic sample. The synthesis has been carried out through a short and convenient route from 2-n-butyl-2,6-dimethylcyclohexanone with an overall yield of 26-30%. In field tests compound 2 appears to act as a synergist of the major component 1 when mixed with the latter in a 100:0.1 ratio. The flight curves of the insect in some locations of Catalònia as well as the persistence of the major component 1 in the field is also presented.



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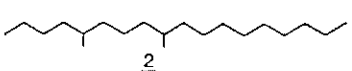


2

JOHANSSON, KJELL U.I. & HALLBERG, ERIC

Morphological characteristics of the first antenna and olfactory lobe of Macrobrachium rosenbergii (Crustacea, Decapoda).

The first antenna of the fresh-water prawn Macrobrachium rosenbergii has a common basal lobe and two filaments. The medial filament has a large number of aesthetascs that are regularly arranged along the filament. The aesthetascs have a chemosensory (olfactory) function, and are innervated by large numbers of sensory cells. Other sensilla with a presumed combined taste/tactile function occur along the filaments. The olfactory lobe constitutes the first synaptic area of the antennular sensory neurons. The lobe has a columnar arrangement with densely packed "glomeruli". A few interneurons with cell-bodies outside the lobe have serotonin-like reaction, and have been investigated with immunocytochemistry. These neurons ramify in the columns of the olfactory lobe. Interneurons that exhibit FMRF-amide-like activity invest the peripheral part of the olfactory lobe.

HALLBERG, ERIC

Olfactory sensilla in Crustacea.

An olfactory function has been assigned to the so-called aesthetascs in crustaceans. These sensilla are present on the first antenna, and are usually innervated by a large number of sensory cells. Except for apical moulting pores these sensilla lack differentiated pores. The arrangement of sheathing cells is usually complicated. Aesthetascs have mainly been studied in higher crustaceans, i.e. decapods, but are also present in other taxons.
Sexual dimorphism of antenna and sensilla is present in some species. In mysid shrimps the aesthetascs are longer in the males, and a well developed tuft of sensilla is found on the basal parts of the first antenna. These sensilla are not of the aesthetasc-type, being innervated by few sensory cells. Their function has not been investigated so far. In amphipods the males carry a special sensillar type, called calceolus on the second antenna. The presence of sexual pheromones has been indicated in some groups (copepods, amphipods, decapods), but unequivocal evidence is mostly lacking.

HARBORNE, Jeffrey B. Interactions of Insects with Plant Flavonoids. Department of Botany, University of Reading, Whiteknights, Reading, RG6 2AS, U.K.

Because flavonoids are universally distributed in plants, all phytophagous insects may encounter these pigments at some stage in their development. Larvae feeding on plants may avoid their ingestion, excrete them unchanged, metabolise them and very occasionally sequester and store them in conjugated form. Their presence in leaves may determine the feeding preferences of particular insects, or, in the case of Lepidoptera, may stimulate or deter oviposition in the gravid female. Their presence in flowers may provide a visual or ultraviolet signal for nectar collection and plant pollination.

In this review, attention will be focussed particularly on the flavonoids involved in plant-Lepidoptera interactions and on the purpose of flavonoid sequestration by some ten per cent of all butterflies.

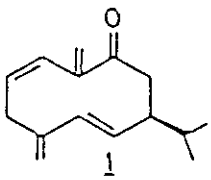
Harmatha Juraj (1), Nawrot Jan (2), Opletal Luboš (3) and Sovová Marie (3). (1) Institute of Organic Chemistry and Biochemistry, Czech.Acad.Sci. 16610 Prague, Czechoslovakia. (2) Institute of Plant Protection, 60-318 Poznaň, Poland. (3) Faculty of Pharmacy, Charles University, 50165 Hradec Králové, Czechoslovakia:

Insect feeding deterrent activity of allelochemical substances from the seeds and herbs of crownvetch, Coronilla varia L. (Fabaceae).

Five main constituents of cardenolide type (hyrcanoside, deglucohyrcanoside) and coumarin type (dafnoretin, scopoletin, umbelliferon) together with 3-nitropropionic acid and four of its glucose esters (karakin, corollin, coronillin, coronarian) were tested for feeding deterrent activity against three species of insect storage pests: Sitophilus granarius, Tribolium confusum and Trogoderma granarium. Their activities were compared with further commercially available cardenolides or coumarins and the relation between the structure and activity was followed. The strongest antifeeding activity has been observed with the 3-nitropropionic acid, and is comparable with the best antifeedants of sesquiterpene, rotenone or lignane type. Ref.: Biochem.Syst.Ecol., 12, 95 (1984) and 17, 55 (1989).

Hauptmann, H. and Biendl, M. : Periplanone D_1 and D_2 - two novel bioactive constituents from Periplaneta americana
Institut für Organische Chemie der Universität Regensburg, Universtätsstraße 31, D-8400 Regensburg, West Germany

Two novel bioactive sesquiterpenes have been isolated from the faeces of female American cockroaches and named as periplanone D_1 (1) and periplanone D_2 (2). The structures of the new periplanones have been confirmed on the basis of spectroscopic data and by comparison with synthetic material.
Bioassay results showed the periplanones D_1 and D_2 about 1000 times less active than periplanone A (3).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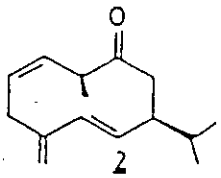
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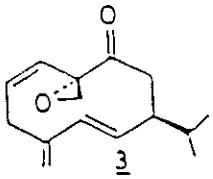
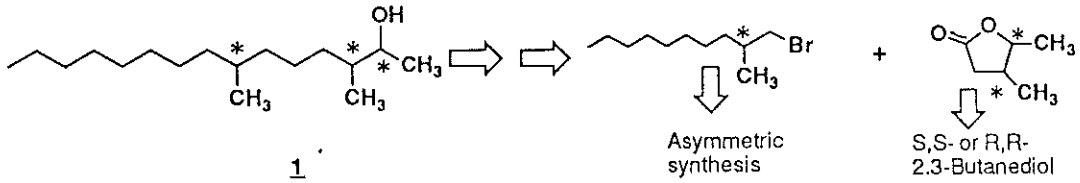

3

Synthesis and Biological Activities of all the Eight Stereoisomers of Diprionyl Acetate, Pheromone Components of the Pine Sawflies.

Hans-Erik Högberg[a], Erik Hedenström[a], Jan Löfqvist[b], Olle Anderbrant[b], Bill Hansson[b], Ann-Britt Wassgren[c] and Gunnar Bergström[c]

[a]University College of Sundsvall/Härnösand, Box 860, S-851 24 Sundsvall, Sweden.
[b]Department of Animal Ecology, University of Lund, S-223 62 Lund, Sweden.
[c]Department of Chemical Ecology, University of Göteborg, S-400 33 Göteborg.

Olfactory communication in the diprionid sawflies was first noted by Coppel et al.[1] who later identified the acetate and propionate of diprionol 1 as the major pheromone component of the diprionid sawflies and studied their activities in field tests.[2]



1

Retrosynthesis of Diprionol.

The pine sawfly *Neodiprion sertifer (Diprionidae)* is a pest on Scots pine in Sweden. For some years we have, therefore, been studying the synthesis and biological activities of potential pheromone components for this insect.[3,4] We now wish to report improved methods for the preparation of the eight possible stereoisomers of the acetates of diprionol 1 in very high isomeric purities. We also describe the analytical procedures developed for controlling the stereochemical purities of these isomers. The results of electrophysiological studies and field tests with the isomeric acetates of 1 prepared by us will also be described.

References
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2. Olaifa, J.I., Matsumura, F., Kikukawa, T. and Coppel, H.C. *J. Chem. Ecology*, 14 (1988) 1131 and ref cited therein.
3. Ahlgren, G., Bergström, G., Löfqvist, J., Jansson, A. and Norin, T. *J. Chem. Ecology*, 5, (1979) 309.
4. Byström, S., Högberg, H.-E. and Norin, T. *Tetrahedron*, 37, (1981) 2249.

Jackson, Brian D., Athula B. Attygalle†, Johan P.J. Billen* and E. David Morgan. ISOPROPYL ESTERS FROM THE DUFOUR GLANDS OF *PSEUDOMYRMEX* SPECIES (FORMICIDAE). Dept. of Chemistry, University of Keele, ST5 5BG, England. †Institute for Organic Chemistry, University of Erlangen--Nürnberg, Henkestr. 42, D-8520 Erlangen, F.R.G. *Zoological Institute, University of Leuven, Naamsestraat 59, B3000, Leuven, Belgium.

Ants of the small subfamily Pseudomyrmecinae are noted for their intimate relationship with certain plants. In return for nest sites and food, the ants protect the plant, making use of their well developed sting apparatus. We report the first detailed chemical analysis of the contents of the Dufour gland (part of the sting apparatus) of two *Pseudomyrmex* species and discuss chemotaxonomic aspects. Both species contain chiefly linear hydrocarbons and isopropyl esters, with heptadecane, pentadecane, isopropyl palmitate and isopropyl oleate being the major components. Hydrocarbons are ubiquitous in ant Dufour secretions, but isopropyl esters have only recently been encountered in insects, including the defensive secretion of the rove beetle *Coprophilus striatulus* and the male pheromone boquet of the hide beetle *Dermestes maculatus*. Also present in the *Pseudomyrmex* Dufour glands are small amounts (less than 2 ng) of 3-methylheptadecane, 2-pentadecanone, aldehydes and ethyl and 2-butyl palmitates.

JONES, CLIVE G.[1] & JAMES S. COLEMAN[2]. **Plant Chemistry, Stress- and Damage-Induced Shifts in Cottonwood Resistance to Insects and Diseases.** [1]*Institute of Ecosystem Studies, Box AB, Millbrook, NY 12545, USA.* [2]*Dept. Organismic & Evolutionary Biology, Harvard Univ., Cambridge, MA 02138, USA.*

Exposure of two cottonwood clones to a single acute dose of ambient ozone alters plant resistance to a leaf-chewing beetle and an obligate biotrophic rust fungus, but not a leaf-sucking aphid or a facultative necrotrophic leaf-spot fungus. In comparison to charcoal-filtered air controls, ozone exposure altered leaf chemistry by: 1) increasing carbon and nitrogen content; 2) shifting carbon and nitrogen allocation to polar, and perhaps more mobile forms; 3) decreasing phenol glycoside concentrations; and 4) polymerizing phenolics to cellular material. Leaf physical characteristics and overall plant growth were not affected. The relationships between changes in foliar chemistry and: 1) plant physiological and biochemical responses to ozone stress and damage; and 2) ozone-induced changes in insect and disease resistance are discussed.

Kil, B.S., and Y.S. Kim
(Dept. of Biology Education, Wonkwang Univ. and Dept. of physical Therapy, Wonkwang Health Junior College, Iri, ROK)

PHYTOTOXIC EFFECTS ON SELECTED SPECIES BY NATURALLY OCCURRING CHEMICAL SUBSTANCES FROM SEVERAL PLANTS IN KOREA.

To verify allelopathic effects of several pine and other species, donor plants, a number of laboratory experiments have performed. Aqueous extracts of leaves, stems and roots of the donor plants inhibited seed germination and seedling growth of experimental species, receptor plants. In general the higher was the concentration of the extracts, the lower was the germination rate and the growth rate. Volatile substances released from leaves of the donor plants also inhibited the seed germination and the radicle elongation of receptor plants.

Therefore, to find out the inhibitory substances emitted from the donor plants, gas chromatography was employed. As a results of the analysis 17 chemical substances were isolated from the leaves and most of them were identified as phenolic compounds.

The growth of lettuce was inhibited in the experiment using reagent identical to these chemical substances and a great inhibition was observed in the concentration of less than 5×10^{-3} M. Phenolic compounds are assumed as the substance related to the allelopathic effects.

Kaib, Manfred ***Multifunctional Chemical Signals: An Introduction to the Symposium.*** Department of Animal Physiology, University of Bayreuth, D-8580 Bayreuth, Fed. Rep. Germany

Chemical signals have a key role in insect communication and recognition. They are produced by a variety of exocrine glands - including the epicuticula - and trigger a diversity of intra- and interspecific reactions on both, an individual as well as an integrated level. The complexicity of these semiochemicals, the adaptation of glandular secretions to multiple functions, and the responsiveness of insects to the blend of signals enable insects to evolve colonial integrity up to eusocial organisations like in Isoptera and Hymenoptera.

Based on the African termite *Schedorhinotermes lamanianus* multiple functions of exocrine secretions will be demonstrated. In peripheral nest divisions *Schedorhinotermes* soldiers mediate behavioural patterns of individual termites by the interaction of chemical signals from both, the sternal gland and the frontal gland: gallery-building by workers, soldier-initiated foraging, recruitment of workers, alarm, and defense. Termite workers lack the frontal gland, but signals from their head glands lead to feeding aggregations which, however, are inhibited by their sternal gland secretion. Termite workers and soldiers respond caste-specifically distinct to chemical signals, depending on the actual social and environmental needs.

Knudsen, J. T. & L. Tollsten.

Floral odours, chemical guides for pollinating insects?

Flowers of species in the genera *Pyrola* and *Moneses* (Pyrolaceae) contain only pollen as a reward for visiting insects and are pollinated by species of *Bombus*, which vibrate (buzz) the flowers to harvest pollen. The attraction cues are both visual and olfactory. The main olfactory compounds, identified by GC-MS, in the petals of *Pyrola rotundifolia* L. and *P. media* (L.) Swartz do not occur or occur only in trace amounts in the stamens and vice versa. Main compounds found in petals: cinnamic aldehyde, cinnamic alcohol, and 3-phenylpropanol, main compounds found in stamens: 1,4 di- and 1,3,5 trimethoxybenzen. In *Moneses uniflora* (L.) A. Gray the main olfactory compounds are the same in petals and stamens, citronellol, nerol, and geraniol. The distal part of the petals in *M. uniflora* is stronger scented than the basal part. The floral morphology differs among the plant species. *Pyrola rotundifolia* have zygomorphic flowers with the stamens in a bunch above the style. *Pyrola media* and *M. uniflora* have almost actinomorphic flowers, but the stamens in *P. media* are adpressed to the ovary, whereas in *M. uniflora* they are adpressed to the petals. The bumblebees behave differently when handling these species. In *P. rotundifolia* they grasp the bunch of stamens with the mandibles and forelegs and vibrate most at one time. *Pyrola media* is probably handled like the morphologically alike species *P. minor* L., where the bees vibrate 2-3 stamens, then move to a new position. *Moneses uniflora* is handled almost like *P. minor* but differs in that the bees are positioned with the head toward the margin of the flower. The floral morphology and the behaviour of the bees suggest that the scent of the stamens in *Pyrola rotundifolia* and *P. media* and the stronger scent of the distal part of the petals and of the stamens in *M. uniflora* play a major role in guiding the bees at close range toward the pollen source in the anthers. This is essential both for the bees, which use pollen as larval food, and for the transfer of pollen to a conspecific stigma, thereby securing the reproductive success of the plant.

Lambert, David; Foster, Steven; White, Chris.

CHEMICAL SIGNALS AND THE RECOGNITION CONCEPT.

Recognition at many biological levels, is a fundamental property of living systems. With respect to sexuality, recognition operates between individuals and gametes of complementary sexes and may ultimately result in fertilization. Individuals of the same species consequently share a common Specific-mate Recognition System.[1] Owing to the existence of such systems of mate recognition, the biological world has a particular intelligible structure.[2]

We will review aspects of Specific-mate Recognition which illustrate that it operates as an interactive system, as opposed to a mere collection of independent elements. Our knowledge of sex pheromone mating systems will be discussed with respect to the biosynthesis of pheromones and the chemically-mediated aspect of mate recognition.[3] Our conclusions for current debates on sexual selection and speciation will be briefly outlined, as will the implications of this perspective for the nature of the relationship between biology and history.

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2. Henderson,NR and Lambert,DM. 1982. Nature 300:437-440.
3. Lambert, DM, Michaux,B, White, CS 1987 Syst. Zool. 36(2).196-205

Teale, S.A., G.N. Lanier, R. Tang, F.X. Webster and R.M. Silverstein

Correlation of qualitative variation in pheromone synthesis and response specificity in *Ips pini* (Coleoptera: Scolytidae)

A pheromone system involves emmitters and respondents. As the system undergoes evolutionary change, there must be a mechanism coordinating changes in both interactants or the system would become maladapted and hence nonfunctional. To evidence such a mechanism, a correlation between qualitative variation in pheromone synthesis and corresponding variation in pheromone perception and response must be demonstrated. Response preference in *Ips pini* was measured by field trapping beetles with a range of enantiomeric blends of its aggregation pheromone, ipsdienol. Both intra- and interpopulational variation in the enantiomeric composition of the male-produced aggregation pheromone, ipsdienol have been reported. Live-trapped males were taken into the laboratory and their ipsdienol was collected on porapak in an individual beetle aeration device. Ipsdienol chirality was determined by diastereomerization and separation by capillary GC. Variation in the two systems was found to be correlated (R^2=0.80, P<.001). Several known genetic and physiological mechanisms could account for the observed pattern.

Lewis, W. J., J. H. Tumlinson. Roles and Functional Mechanisms of Semiochemicals Mediating the Foraging Behavior of Parasitoids: A Tritrophic Perspective. USDA-ARS, P. O. Box 748, Tifton, GA 31793 and P. O. Box 14565, Gainesville, FL 32604, respectively.

An abundance of chemical information is involved in mediating the interactions of plants, phytophages, and parasitoids. Many of the semiochemicals have overlapping roles in the tritrophic interaction as a result of extensive offensive and defensive natural selection maneuvers over evolutionary time. The parasitoids employ a sophisticated repertoire of foraging behavior utilizing plant- and phytophage-emitted semiochemicals and marking pheromones to optimize the location and attack of their phytophagous hosts. The respective roles of these semiochemicals and the function of learning and other mechanisms governing the foraging behavior of parasitoids will be discussed.

Lindgren, B. Staffan. Role of verbenone in the chemical ecology of bark beetles (Coleoptera: Scolytidae) Phero Tech Inc., 1140 Clark Drive, Vancouver, B.C., Canada V5L 3K3

The response by several species of scolytid beetles to the anti-aggregation pheromone verbenone was tested in trapping bioassays. Dose response was compared among species of differing aggressiveness to test the hypothesis that primary species would be more sensitive to verbenone than secondary species, which would indicate that verbenone is mainly a product of microbiological deterioration of the phloem, as indicated by previous studies on the mountain pine beetle. The significance of the results are discussed.

Leufven, A. et al. 1984. J. Chem. Ecol. 10: 1349-1361

Hunt, D.W.A., and J.H. Borden. 1989. J. Chem. Ecol. 15:1433-1463

The enantiomeric composition of the monoterpene hydrocarbons in the volatile part of termite defence secretions.

Mikael Lindström[a], Torbjörn Norin[a], Johan Roeraade[b], Irena Valterova[c], and Jan Vrkoc[c].

[a]Dept of organic chemistry, Royal Institute of Technology, S-100 44 Stockholm, Sweden.
[b]Dept of analytical chemistry, Royal Institute of Technology, S-100 44 Stockholm, Sweden.
[c]Institute of Organic and Biochemistry, Czechoslovac Academy of Sciences, Cz-166 10 Prague, Chechoslovakia.

Specific chemicals are involved in many of the various phases of termite life. The morphologically specialized soldier caste of termite societies undertake the defenseof the colony. Soldiers of the most advanced subfamily of the higher termites (*Nasutitermes, Nasutitermitinae*) can project the sticky frontal liquid with very high precision, and physical contact with the enemy can be totally avoided [1]. The *Nasutitermes* defense secretions consist of a complex mixture of monoterpene hydrocarbons and unique oxygenated diterpenes, sometimes together with sesquiterpenes. Chemical studies of African, Australian and South American genera indicate that the defense secretions have features that are specific to the species [2]. The biosynthetic ability of soldiers to produce *de novo* both monoterpenes and diterpenes has been demonstrated [3].

In this study we have used a GC column packed with α-cyclodextrin in a water/formamide matrix [4] in a simple multi dimensional GC system to determine the enantiomeric composition of the monoterpene hydrocarbons in soldier termites from different colonies of the termites *Nasutitermes nigriceps*, *N. ephratae*, and *Velocitermes velox*.

[1] Deligne, J., Quennedey, A., and Blum, M.S.: Social Insects (Herman H.R., Ed.). Vol II. The Enemies and Defense Mechanisms of Termites. Academic Press. New York 1981.
[2] Prestwich, G.D. : Ann. Rev. Entomol. 29, 201 (1984).
[3] Prestwich, G.D., Spanton, L. G., Lauher, J.W., Vrkoc, J.: J. Am. Chem Soc. 102, 6825 (1980)
[4] Lindstrom, M., Norin, T., and Roeraade, J.: J. Chromatography. Manuscript.

McDaniel, C. A. Major Antitermitic Components of Western Red Cedar. USDA, Forest Service, Southern Forest Experiment Station, P. O. Box 2008, GMF, Gulfport, Mississippi 39505 USA

Heartwood of western red cedar, Thuja plicata Donn, was exhaustively extracted. The major components were separated into acids, phenols and tropolones, and neutrals. Further separations were achieved by reverse-phase HPLC. Bioassays were performed using worker termites of the subterranean termite Reticulitermes flavipes (Kollar). Component identifications were based primarily on GC/MS and UV data.

Martinez, Lee Anne. The Use of Chemical Cues in Benefit-Sensitive Foraging by Stream-Dwelling Caddisfly Larvae (Trichoptera: Sericostomatidae)? Neurosciences Research Institute, Univ. of Calif., Santa Barbara, CA 93106 USA.

Chemical cues have been hypothesized to play an important role in the detection and recognition of food resources by stream-dwelling insects (Cargill et al. 1985. Freshwat. Biol. 15: 455-464.). Such sensory information could also allow discrimination between nutrient-poor and -rich food items. In a pilot field study, fatty and high-protein baits attracted large numbers of the case-building caddisfly Gumaga nigricula (McL.). This was unexpected since the larvae are reported to be leaf-shredders which feed on leaf material and the microbiota that colonizes it (Merritt & Cummins 1984. Aquatic Insects of North America, 2nd ed., p. 310). An in situ choice experiment showed larvae to be most attracted to rainbow trout (Salmo gairdneri) flesh, followed by Quercus agrifolia (oak) acorns, dead honey bees (Apis mellifera), and mixed alder (Alnus rhombifolia) and sycamore (Platanus racemosa) leaves. Larvae were least attracted to tiles colonized with algae (primarily diatoms). These results indicate that G. nigricula are opportunistic omnivores rather than leaf-shredders. Growth studies are in progress to test if bait preference corresponds to the relative nutritional value of the baits, and whether or not baits are selected on the basis of chemotactile and/or waterborne chemical cues. Such chemical information could be used by the insects to increase their growth, fecundity, and ultimately their evolutionary fitness.

ULTRASTRUCTURAL AND CYTOCHEMICAL EXPLORATIONS OF THE RAT'S OLFACTORY EPITHELIUM WITH FREEZE-ETCHING AND FREEZE-SUBSTITUTION. Bert Ph. M. Menco, Dept. of Neurobiology & Physiology, O.T. Hogan Hall, Northwestern Univ., Evanston, IL 60206-3520, USA

Membranes of olfactory receptor cell cilia contain the sites which receive, interact with, and initially transduce the odorous messages. For the visualization of these we use ultra-rapid freezing followed by freeze-etching or -substitution to preserve the situation of the living animal with a minimal loss of ultrastructural and cytochemical features. With deep-etching we found binding of the gold-conjugated lectin wheat germ agglutinin to olfactory receptor cell cilia but not to membranes of microvilli of surrounding supporting cells and to cilia of the nearby respiratory epithelium. Freeze-substitution and post-embedding cytochemistry with colloidal conjugated probes enabled us to visualize an olfactory receptor cell specific protein, olfactory marker protein, at the electron microscopic level with antibodies raised in both goat or rabbit. Using a ouabain probe we found Na^+, K^+-ATPase to be on the olfactory cilia, whereas binding sides for an antibody against an epithelial sodium channel (amiloride sensitive) were mainly found on supporting cell microvilli. Thus, the cytochemical studies enabled us to make a beginning with the dissection of the olfactory receptor/transduction process at an ultrastructural-cytochemical level and also began to supplement freeze-etch ultrastructural which showed that membranes of olfactory cilia differ from those of supporting cell microvilli and non-sensory respiratory cilia. *This work was supported by grants from NSF (BNS-8098839) and the Erna and Victor Hasselblad Foundation.*

CHEMICAL DEFENSES OF DIPTEROCARP TREES

Messer, A., K. McCormick, H. Hagedorn, and J. Meinwald
Departments of Entomology and Chemistry, Cornell University, Ithaca, NY 14853 USA

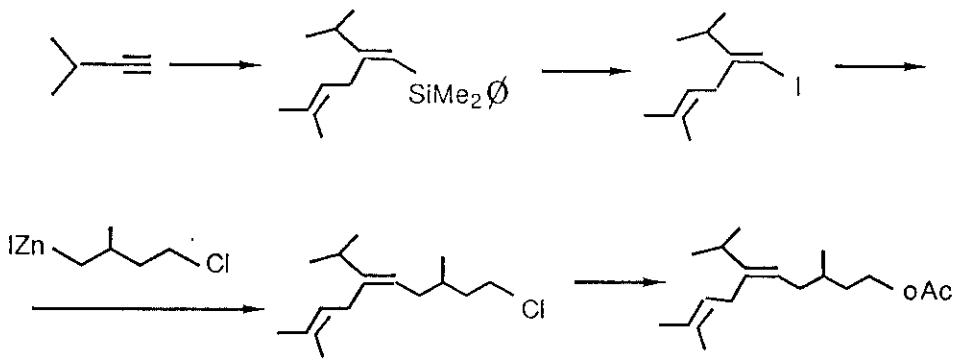
Bioassays of tree resins collected from trunk wounds of Southeast Asian Dipterocarpaceae demonstrated that these materials possess insecticidal and antifungal properties. Crude resins of Dipterocarpus hasseltii, D. retusus, and D. intricatus killed Cryptotermes termites, and inhibited growth of Cladosporium fungi. Biologically active fractions were isolated via flash column chromatography, and characterised by GC/MS and NMR spectroscopy. No biological activity was apparent in polar (pentane insoluble) fractions; toxic components eluted in pentane. These active fractions, chiefly nonpolar sesquiterpenes, contained alpha-gurjunene, beta-gurjunene, gamma-gurjunene, caryophyllene, caryophyllene oxide, and humulene. Toxicity and structural assignments were confirmed with authentic samples of these compounds. Though the resins and fractions eliminate symbiotic protozoa, bioassays with defaunated termites indicated that the poisons act directly on the termites. Dipterocarp tree resins thus represent an important defense against biological attack.

MILLAR[1]*, Jocelyn G., Michael Giblin, Dennis Barton, Anne Morrison, and Edward W. Underhill. **Unsaturated epoxides as sex pheromones and sex attractants for Geometrid moths: Interactions of enantiomers and regioisomers.** Plant Biotechnology Institute, National Research Council, 110 Gymnasium Road, Saskatoon, SASK. S7N 0W9 CANADA.[1] Current address, Dept. of Entomology, University of California, Riverside, CA 92521, USA.

The identification and synthesis of sex pheromones and sex attractants for the following species of Geometrid moths will be described: *Probole amicaria, Sicya macularia, Anavitrinella pampinaria, Lycia ursaria, Itame occiduaria, Itame brunneata, Epelis truncataria, Semiothisa ulsterata,* and *Lomographa semiclarata.* Attractive compounds were identified by a combination of field testing, electroantennogram studies, and mass spectrometry of pheromone gland extracts. The major compounds involved included $C_{17\text{-}21}$ 3Z,6Z,9Z-trienes and the corresponding monoepoxydienes. Many examples of synergistic and inhibitory interactions caused by enantiomers or regioisomers will be presented. The syntheses of the $C_{17\text{-}22}$ 6Z,9Z-cis-3,4-epoxydiene enantiomers will be described.

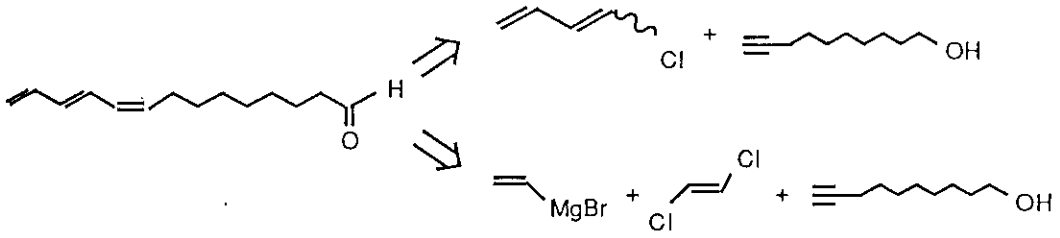
MILLAR, Jocelyn G. **Short, convergent synthesis of the sex pheromone of the Yellow Scale, *Aonidiella citrina* (Coquillet).** Dept. of Entomology, University of California, Riverside, CA 92521, USA.

A short and convergent synthesis of the female-produced sex pheromone of the Yellow scale has been completed. Key steps in the synthesis included the stereospecific introduction of the central trisubstituted double bond via a vinylsilane intermediate, and palladium-catalyzed coupling of a vinyl iodide with an organozinc reagent.



MILLAR, Jocelyn G. **Synthetic routes to the major component of the sex pheromone of the carob moth, *Ectomyelois ceratoniae*.** Dept. of Entomology, University of California, Riverside, CA 92521, USA.

Several synthetic routes to the major component, Z9, E11, 13-tetradecatrienal, of the sex pheromone of the carob moth have been investigated. Merits and disadvantages of each route will be discussed.



Morgan, E. David, Brian D. Jackson and Geoffrey W. Sales.
THE TRAIL PHEROMONE OF THE ANT *TETRAMORIUM IMPURUM* AND THE SPECIFICITY OF ITS STRUCTURE DEDUCED FROM STUDIES WITH RELATED COMPOUNDS. Department of Chemistry, University of Keele, Staffordshire, England ST5 5BG

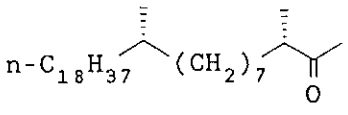
Insect trail pheromones are frequently shared by more than one species, but the ant genus *Tetramorium* appears to make an exception to this rule. Three species of *Tetramorium* are now known each to use a different group of chemicals as trail pheromones. That of *T. impurum* has been identified by microchemical methods to be methyl 6-methylsalicylate, a substance known in insects but not previously identified as a trail pheromone. A number of compounds of closely related structure have been tested in a trail-following bioassay, which has revealed some of the structural features necessary for activity.

MORI, Kenji

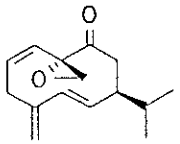
RECENT RESULTS IN THE SYNTHESIS OF SEMIOCHEMICALS

Department of Agricultural Chemistry, The University of Tokyo, Bunkyo-ku, Tokyo 113, Japan

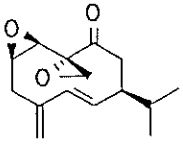
New enantioselective syntheses of cockroach pheromones such as the ketone 1, "Hauptmann's periplanone-A" 2, and periplanone-B 3 will be discussed. Biological activity of all of the four stereoisomers of 1 will also be discussed.



1



2



3

NAYA Yoko

CHEMICALS INVOLVED IN SYMBIOTIC RELATIONSHIPS

Suntory Institute for Bioorganic Research,
Shimamoto-cho, Mishima-gun, Osaka 618, Japan

The intimate association between organisms is a phenomenon of widespread occurrence. Nevertheless, the fact that mutualistic symbioses does not result in harmful effects is probably one of the reasons for the relatively low priority given to investigations of such chemicals involved in symbiotic relationships. Chemical investigations of mutualistic systems may reveal new insights into many basic parameters of interactions between organisms.

The inception of associations between sea anemone and anemone fish[1] and the subsequent integration between insects and micro organisms[2] will be discussed from the analytical point of view.

1) M. Murata, K. Miyagawa-Kohshima, K. Nakanishi and Y. Naya, *Science*, **234**, 585-587 (1986). 2) B. K. Eya, P. T. M. Kenny, S. Y. Tamura, M. Ohnishi, Y. Naya, K. Nakanishi and M. Sugiura, *J. Chem. Ecology*, **15**, 373-380 (1989).

NATION, JAMES L. BIOLOGY OF PHEROMONE RELEASE BY MALE CARIBBEAN FRUIT FLIES. Males of the Caribbean fruit fly fly, Anastrepha suspensa (Loew) form leks and attract females by releasing a multi-component volatile pheromone. Two 9-carbon alcohols, three lactones, a sesquiterpene and a monoterpene are present in the volatiles. Volatiles from males were trapped on Tenax, eluted, separated and quantitatively measured by gas chromatography. The volatiles were primarily released from mouth and anus. Sealing the anal opening or the mouth with melted beeswax resulted in up to 40% or greater reduction in most components, and sealing both mouth and anus further reduced release of volatiles, but some volatiles are possibly still released directly from the cuticle. Male flies entrained to a 14:10 L:D cycle showed a peak release of volatiles 11 - 12 hours into the photophase, but smaller quantities of the same volatiles were released over a broad period during daylight hours. Single males released significantly more of all components than did groups of males. The reduction by aggregations of males may be related to lekking behavior in this fruit fly. The pheromone probably serves to attract females to a lek site, but additional parameters are likely to enter into the choice of male made by the arriving female.

McNeil, Jeremy; Dumont, Stéphane; Royer, Lucie. Effects of temperature on male receptivity to the female sex pheromone: Studies on the true armyworm and the European cornborer. Département de biologie, Université Laval, Ste-Foy, P.Q., Canada, G1K 7P4.

Very little attention has been given to the effects of abiotic factors on the receptivity of male Lepidoptera to the female sex pheromone despite the fact that pheromone traps are widely used in management programmes of many pest species, and that trap captures are often used to estimate population densities . Data will be presented demonstrating that the receptivity of virgin armyworm (Pseudaletia unipuncta) and European cornborer (Ostrinia nubilalis) males may be markedly affected by adult and pupal temperatures respectively. These findings will be discussed within the context of the ecology and seasonal biology of these two species.

Hermann M. Niemeyer, Arturo Givovich and Sylvia V. Copaja

CHEMICAL BASIS OF WHEAT DEFENSE AGAINST PESTS AND DISEASES

Facultad de Ciencias, Universidad de Chile, Casilla 653, Santiago, Chile

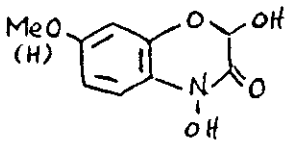
Hydroxamic acids derived from 1,4-benzoxazin-3-one (Hx) are involved in the defense of cereals against pests and diseases [Niemeyer, H.M. (1988) Phytochemistry 27: 3349-3358].

Antibiosis by Hx is related to the inhibition of various enzymic systems, an action which depends on the electrophilic character of the functional groups in the molecule.

A feeding deterrent effect of Hx against aphids was described, opening the possibility of diminishing virus transmission. Furthermore, aphid feeding increased the levels of Hx in the plant.

In order to exploit Hx as defense chemicals in agronomically relevant wheat cultivars, a germplasm screening was undertaken which has provided accessions with high Hx levels, persistance of Hx along plant development and high inducibility of Hx by aphid feeding.

Financed by IPICS (International Program in the Chemical Sciences), IFS (International Foundation for Science), CONICYT and Universidad de Chile.



Oehlschlager, Allan C., Sunaina Sharma and Robert G. May. "Increasing the Efficiency of Pheromone Synthesis." Simon Fraser University, Department of Chemistry, Burnaby, British Columbia, Canada V5A 1S6.

Stereospecific synthesis of unsaturated pheromones of the square necked grain beetle and the caribbean fruit fly will be described. These routes make pivotal use of chemistry developed in this laboratory which allow the construction of 1,2-dianion equivalents in a simple step.

Silylcupration of 1-butyne with mixed HO cuprate $PhMe_2SiMeCu(CN)Li_2$ followed by coupling with MeI and addition to ethyl vinyl ketone gave the intermediate which was elaborated to the desired product in two steps.

Stannyl zincation of 2 butyne-4-ol with subsequent protonolysis and transmetallation followed by coupling with alkynyl iodide afforded the intermediate which was then converted to the desired molecule by known chemistry.

Phelan, P. Larry, The evolution of male courtship pheromones in the Lepidoptera, The Ohio State University/OARDC, Dept. of Entomology, Wooster, OH 44691, USA.

In addition to a long-range female sex pheromone, many species of moths also have males that also emit a pheromone, but which usually functions only short range. The androconial organs responsible for producing these pheromones represent a diverse morphology of coremata, brushes, hairpencils, and wing folds, and their appearance and relative complexity bears little relation to lepidopteran phylogeny; this diversity is also reflected in the chemistry of the pheromones identified thus far. Research on this chemical communication system has lagged behind that of female long-range pheromones; nevertheless, they represent a unique opportunity for studying the evolution of sexual communication and of reproductive isolation. Although these scent structures have long been identified by taxonomists, the proximate function of the scent remains a matter of debate. Several possibilities have been suggested, but it is argued here that they have evolved primarily within the context of reproductive isolation. Furthermore, it is suggested that this sexual character has evolved through sexual selection as an adaptive response to interspecific mating errors, rather than evolving to increase the efficiency of specific mate recognition. A senario is hypothesized for the evolution of male courtship pheromones that has its basis in larval host plant chemistry, and a connection is drawn between the odors utilized by the female for ovipositional host finding and the male pheromone.

Pickett, John A.

AFRC Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, Herts., AL5 2JQ, U.K.

Aphid sex attractants and coleopteran host attractants

We have recently identified the sex pheromones for certain aphid species (e.g. Dawson et al., 1988, Entomol. Exp. Appl., 48, 91-93) and here we present chemical aspects of further studies. As part of a major effort towards providing targets for genetic engineering of oilseed rape to reduce pest and disease damage, we are investigating secondary metabolites influencing colonization by specialist herbivores (Dawson et al., 1989, Pestic. Sci., 27, in press). This will be exemplified by studies on the coleopteran oilseed rape pests Psylliodes chrysocephala and Ceutorhynchus assimilis.

POPPY, Guy M. **HAIR-PENCILS REVISITED: THEY ARE SEX PHEROMONES AFTER ALL.** Dept of Zoology, Oxford University, South Parks Road. OX1 3PS U.K.

The function of the male hair-pencils (HP's) in courtship was restudied, using a new stock of Mamestra brassicae, in moving air conditions in a wind tunnel. Males of the new stock, which have only spent 3-4 generations under artificial conditions and diet, were less successful in courtship if they had their HP's removed. Furthermore, the eversion of the HP's correlated with successful courtship and photographic and video proof of HP eversion will be presented.

Chemical studies using gas chromotography, show that the quantity of 2-Phenylethanol (the main HP component) changes with age and males of 1-2 days have the most chemical. The quantity of chemical in mated individuals was found to be less than that in virgin males. The original "inbred" stock also have large amounts of this chemical, which does not appear to have been lost despite many generations in the lab.

A brief summary of the possible functions of HP's during courtship will be discussed. Possible explanations for the apparent loss of courtship function in moths reared under artificial conditions will also be discussed.

Prestwich, Glenn D. **How Pheromones Work: Bio-organic Chemistry of Binding and Catabolic Proteins in Moths.** Department of Chemistry, State University of New York, Stony Brook, New York 11794-3400 USA.

How do small lipid molecules cause such profound behavioral changes in insects? On a molecular basis, proteins in insect sensory cells must bind the pheromonal signals and convert the chemical interactions to electrical impulses. Proteins from insect antennae can be purified and characterized using high specific activity, tritium-labeled pheromones and reactive pheromone mimics. Selected results with pheromone binding proteins, dendritic receptor proteins, and catabolic proteins will be described for *Antheraea polyphemus*, *Lymantria dispar*, and *Heliothis virescens*.

PERFLUORINATED MOTH PHEROMONES: SYNTHESIS AND ELECTROPHYSIOLOGICAL ACTIVITY. Sun, Wei-Chuan and Prestwich, Glenn D., Department of Chemistry, State University of New York, Stony Brook, NY 11794-3400; Mayer, M.S., IABBBRL, USDA/ARS Southern Region, P.O. Box 14565, Gainesville, FL 32604; Dickens, J.C., USDA Boll Weevil Research Laboratory USDA/ARS Mid South Region, P.O. Box 5367, Mississippi State, MI 39762 USA.

Perfluoroalkyl analogs of the pheromone constituents of three moths were synthesized and employed for single cell recordings from male antennae. In each analog, the hydrophobic terminus, either a butyl or hexyl substituent on the *(Z)*-alkenyl chain, was replaced with a perfluorobutyl (Pfb, C_4F_9) or perfluorohexyl (Pfh, C_6F_{13}) moiety. These perfluoroalkyl analogs showed significantly higher volatility, as demonstrated by a decrease in gas chromatographic retention time by 2 to 4 methylene equivalents in their Kovats retention indices. Sensilla of male *Heliothis zea* responded to 1 mg of Z11-16:Al and 250 mg of Pfb-Z11-16:Al with similar firing rates. Negligible post-stimulus firing activity was observed. Sensilla of *Diatraea grandiosella* showed 100 to 1000-fold greater sensitivity to Z9-16:Al compared with Pfh-Z9-16:Al. Specific sensilla of *Trichoplusia ni* showed similar responses to Z7-12:Ac and a 1000-fold higher vapor concentration of Pfb-Z7-12:Ac.

In each of the three insects examined, therefore, the replacement of terminal alkyl groups with perfluoroalkyl groups in pheromone components produced biologically-active compounds with increased volatility and unusual electrophysiological response profiles. Although stimulation is observed, the perfluoroalkyl groups confer a "slipperiness" to the pheromone analogs. That is, these fluorinated analogs show a weaker interaction between the hydrophobic protein binding site and the more rigid and polar perfluoroalkyl moiety.

Tasayco, Maria L. and Prestwich, Glenn D. CHEMICAL AND BIOCHEMICAL STUDIES OF ALDEHYDE OXIDASES AND DEHYDROGENASES IN *HELIOTHIS* MOTH ANTENNAE. Department of Chemistry, State University of New York, Stony Brook, New York 11794-3400 USA.

Aldehyde oxidase (AO) and aldehyde dehydrogenase (ALDH) enzymes have been identified in polyacrylamide gel electrophoresis (PAGE)-separated soluble proteins from tissues of both male and female moths in the genus *Heliothis* (Lepidoptera: Noctuidae). AOs are visualized using horseradish peroxidase to detect the hydrogen peroxide produced during oxygen-requiring aldehyde oxidation. ALDHs can be visualized using [^{3}H]-vinyl ketones, i.e., chemically reactive analogs on Z11-16:Al which specifically modify active site sulfhydryl groups. In solution, AO and ALDH activities can be measured using radio-TLC and spectroscopic assays with [^{3}H]-labeled and unlabeled Z11-16:Al, respectively. Six AO antenna-specific isozymes have been identified by IEF with pI values between 4.6 and 5.3. The most abundant ALDH isozyme in both heads and antennae shows a size of 50 kD and shows a more rapid turnover of Z11-16:Al than the AO complex from antennae.

Rittschof, Dan, Christine Kratt, Regan Huff, and Donald Gerhart. Peptide attractants of hermit crabs: Responses of three species of crabs to enzymatic cleavage products of purified proteins. Duke University Marine Laboratory and Department of Zoology, Pivers Island, Beaufort, NC 28516 USA.

Hermit crabs respond to chemical cues that signal the presence of shells that they occupy. Cues are generated from snail flesh by endogenous enzymes, enzymes from a predator or experimentally with serine proteases such as trypsin. Responses of crabs are snail species specific. We studied responses of three species of hermit crabs Pagurus longicarpus, P. policaris and Clibinarius vittatus to enzymatic cleavage products of purified snail muscle proteins and pure commercially available proteins. Peptides of <500 Daltons generated by trypsin digestion of snail muscle proteins were potent and specific attractants of crabs. Of the peptides, those with low affinity for reversed phase silica were most potent. The hexapeptide Val-Asp-Asp-Asp-Asp-Lys generated by the digestion of trypsinogen by enterokinase was as potent in attracting one species of hermit crab as digested snail flesh. The specificity of crab attraction appears to be based upon the protein substrate.

Roelofs, Wendell. The volcanic hypothesis for evolution of moth sex pheromones. Cornell University, Geneva, New York, U. S. A.

Selection studies with the redbanded leafroller moth for both E/Z ratios and for 12-carbon/14-carbon ratios of pheromone components indicate that the principal components of the pheromone blend may be more rigidly controlled than some of the minor components, and that selection to make biologically significant shifts in sex pheromone blends may not be possible. Experiments with interspecies hybrids have uncovered control of various aspects of this communication system by major genes. In the polymorphic communication system of European corn borers, three genes that have significant control have been described. One is an autosomal gene controlling the pheromone blend ratio in females, a second is an independent autosomal gene controlling male antennal responses of specific olfactory cells, and a third is sex-linked and influences the behavioral response of males. In New Zealand, a number of morphologically similar leafroller species are found throughout the two major islands that possess structurally different pheromone blends. These data taken together suggest that pheromone blends did not evolve by gradually shifting from one ratio of components to another. Speculation on this aspect of speciation with be provided.

Romeo, John T., May R. Arroyo, and Nancy K. Lane.
PHYTOCHEMISTRY AND ALLELOPATHY OF ZAPOTECA FORMOSA.
Dept. of Biology, Univ. of South Florida, Tampa, FL 33620 USA.

Zapoteca, a small Mimosoid genus of legumes, is native to Southern Mexico. Germinating seeds and roots of Zapoteca formosa emit a pungent sulphur odor similar to garlic. Seed extracts contain a number of known sulphur compounds including benzothiazole, djenkolic acid, taurine, a cyclic polysulphide tentatively identified as 1,2,4,6-tetrathiepane, and several uncharacterized sulphides. A number of benzene derivatives, napthalenes, phthalates, fatty acids, and amino acids have also been identified from aqueous extracts. Diethoxyethane and 2-octanol are major volatile constituents of root exudates. To test for allelopathic activity, bioassays were conducted in which germinating Zapoteca formosa seeds were paired with those of cucumber. Severe germination and growth inhibition of cucumber occurred. Time course studies showed decreasing activity as days post germination increased. A single 1-day old germinating seedling may effectively inhibit up to five cucumber seeds. Growth of Acacia farnesiana is also inhibited in such assays. The aqueous exudate is responsible for the bulk of the activity, with the volatile mixture producing notably less. The known compound 1,2,4,6-tetrathiepane, one of the compounds partially responsible for the sulphur odor, was found to be strongly allelopathic.

CALLING BEHAVIOR OF SINGLE ALMOND MOTH (EPHESTIA CAUTELLA) FEMALES IN A GLASS CAGE AND PHEROMONE BLEND TRAPPRD ON CAGE WALLS AND EXTENDED CAPILLARIES.

SHANI ARNON

Department of Chemistry, Ben-Gurion University of the Negev
Beer-Sheva 84105, Israel

The airborne pheromone emitted by calling almond moth (Ephestia cautella) females in individual glass cages was mainly (60-65%) adsorbed on the cage surface, but sufficient pheromone was transferred by the air flow to extended capillaries (attached to the cages)to be measured. Four calling positions of almond moth females in the glass cages were defined. The position in which the female faces the upwind flow and the gland was free to release the pheromone was more commonly adopted position (39% of calling females).No significant difference was found in the blend proportion between capillary and cage washings in each calling position or between calling positions. The pheromone blend and amount emitted from each of five individual females was measured for three consecutive days and both fluctuated during 11 hr of collection, starting 3 hr before the onset of scotophase and continuing for 8 hr into it.

AIR SAMPLING OF VOLATILE SEX PHEROMONE COMPONENTS IN A CLOSED JAR

SHANI ARNON

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A cotton wool plug, used as the source for pheromone release, was placed in closed 1-quart Mason jars, either at the mouth or at the rear of the jar. Air sampling of the two compomemts (total 2.2 mg at the source) of the sex pheromone of the almond moth (Ephestia cautella) female showed that the saturation period near the source, in still air was 20-22 hr and that far from the source was 40-50 hr. The ratio between the components (Z,E)-9,12-tetradecadienyl acetate, designated D, and (Z)-9-tetradecenyl acetate designated M, in the air was close to the original ratio for both sampling sites, albeit somewhat richer in the more volatile (Z)-9-tetradecenyl acetate (source 77.0:23.0 D:M,air 73.0-74.3:27.0-25.7; source 80.1:19.9, air 77.6: 22.4; source 25.1: 74.9, air 23.9:76.1 D:M). The total amount per ml of air was two to three times larger near the source than far from it at the early stages of the evaporation and saturation process. When the amount of pheromone applied to the source was tripled (7 mg), the amount far from the source was almost tripled, or the saturation time was cut by factor of 2-3.

D. Schneider/#, E. von Nickisch-Rosenegk/#* and M. Wink/*

FATE OF PYRROLIZIDINE ALKALOIDS IN THE MOTH Creatonotos

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Larvae of C. transiens (Arctiidae) were fed pyrrolizidine alkaloids (PA) (heliotrine, senecionine & seneciophylline) in a diet. Up to 1-2 mg PA/larva, it was mostly taken up (evidence for a specific carrier) and largely converted to PA N-oxides. At higher PA levels, part of it was excreted (faeces). At 2 mg PA/larva, between 90% (heliotr.) and 20% (seneciophyll.) of the PA was stored; the rest disappeared (degradation?). 60-90% of the resorbed PA was deposited in the integument. In male moths, 10-20% of PA was converted into the pheromone (hydroxydanaidal); in females, about 80% was transferred to the eggs.
The tissue deposition of heliotrine was similar in the larvae of other arctiid moths (Arctia caja, Diacrisia sannio, Thyria jacobaea, Spilosoma lubricipeda, Phragmatobia fuliginosa), yet the degree of degradion was much higher in these species than in C. transiens.

Schlyter, Fredrik. Dept. Ecology, Animal Ecology, Lund University, Ecology Building, S-223 62 LUND, SWEDEN.

Evolution of aggregation pheromones and mass-attack mechanisms.

First, a brief summary of ideas on the selective forces in and evolutionary background of aggregation pheromones *vs.* sex pheromones is presented. Secondly, a model[3,4] is given of how individual production[2] and reception[3] of pheromone may govern mass-attack behaviour in *Ips typographus*. One important prediction of the model, a decline in % males landing after the first attacks, was recently tested by observation of natural mass attacks in Denmark[1] and Czechoslovakia. The observed change in sex ratio conforms with the model and an adaptive interpretation of individual behaviour.

1) Anderbrant, O., Schlyter, F. and Lofqvist, J. 1988. Dynamics of tree-attack in the bark beetle *Ips typographus* under semi-epidemic conditions. pp. 35 -51 *in* T.L. Payne and H. Saarenmaa (eds.). Integrated Control of Scolytid Bark Beetles, Virginia Tech Press, Blacksburg, Virginia.
2) Birgersson, G., Schlyter, F., Bergström, G., and Löfqvist, J. 1988. Individual variation of pheromone content in the bark beetle *Ips typographus*. *Journal of Chemical Ecology*, 14: 1735 -1759.
3) Schlyter, F., Byers, J.A. and Löfqvist, J. 1987. Attraction to pheromone sources of different quantity, quality, and spacing: Density-regulation mechanisms in bark beetle *Ips typographus*. *Journal of Chemical Ecology*, 13: 1503-1523.
4) Schlyter, F. and Anderbrant, O. 1989. Mass-attack of trees in *Ips typographus* induced by sex-specific pheromone - a model of attack dynamics. *Holarct. Ecol.* (in press).

Seybold, Steven J., Toshikazu Ohtsuka, David L. Wood, and Isao Kubo; THE ENANTIOMERIC COMPOSITION OF IPSENOL AND IPSDIENOL FROM SELECTED SPECIES IN SUBGENERIC GROUPS OF *IPS* (COLEOPTERA: SCOLYTIDAE); Department of Entomological Sciences; University of California-Berkeley; Berkeley, CA 94720 USA.

Since the isolation of the first beetle pheromone by extraction of the frass of *Ips paraconfusus* Lanier some combination of the compounds ipsenol (2-methyl-6-methylene-7-octen-4-ol) and ipsdienol (2-methyl-6-methylene-2,7-octadien-4-ol) has been found in every species examined in the genus. We have isolated ipsenol and/or ipsdienol from most previously studied North American species (*I. pini*, *I. avulsus*, *I. grandicollis*, *I. confusus*, and *I. paraconfusus*) and from the unstudied species *I. latidens*, *I. spinifer*, *I. mexicanus*, *I. emarginatus*, *I. plastographus*, *I. tridens*, *I. lecontei*, and *I. montanus* using Porapak trapping of volatiles from infested logs and normal phase HPLC analysis of the extracts for quantity and stereochemistry. This survey represents seven of the nine subgeneric groups defined by S.L. Wood in 1982. In all species except for *I. tridens* (*tridens* group) males produced at least one of the two compounds. In collections from females alone, only *I. latidens* females produced one of the compounds (92% (+)-ipsdienol). In most cases the enantiomeric configuration of both compounds supports the laboratory behavioral studies by Lanier and Wood (1975) [J. Chem. Ecol. 1(1): 9-23] where frass produced by species in the same subgeneric group was generally attractive among members of the group, while cross-attraction between groups was minimal. However, we have found interesting differences in males from the *latidens* and *grandicollis* groups as well as between two host populations of *I. mexicanus*.

Smith, Mitchell; Koji Nakanishi. **Chemical respiration and metal ion metabolism: recurrent ecologic features uniting primitive eukaryotes and prokaryotes?** *Department of Chemistry, Columbia University, New York, N.Y., U.S.A.*

O_2 generation on primitive earth is considered to have led to the precipitation of oxidizable metal ions like iron and vanadium as hydroxide polymers. To enhance the bio-availability of such minerals, often essential to normal metabolic activity, many organisms possess selective, high-affinity metal ion assimilation systems.

Our total synthesis and stereochemical characterization of rhizobactin, a novel siderophore (Gr. *sidero* = iron; *phore* = bearer) excreted by the nitrogen-fixing, phytosymbiont *Rhizobium meliloti* DM4, corroborates the view that it is related to other imino acids termed opines in structure and activity. In general, NAD(P)H-dependent imino acid dehydrogenases generate such ligands via reductive amination of an α-keto acid with an L-amino acid; such systems may thus afford an electron and proton sink during O_2 deprivation, according to studies of Hochachka *et al.* on several marine invertebrates.

Our elucidation of "tunichrome" disclosed a family of metal ion complexing / reducing hydroquinonoid peptides present in the blood cells of V(III)- and Fe(II)-accumulating, invertebrate ascidians (sea squirts). To date, a physiologic role for V in animals remains conspicuously absent. Unlike previous attempts to explain the existence of O_2-sensitive V(III) and tunichrome in a living organism, both of which approach molar concentrations, we propose that chemical respiration during O_2 deprivation may be the recurrent issue, formally analogous to Fe(III)- and Mn(IV)-reduction by certain anaerobic bacteria. Additional ecologic and bioinorganic features of each system will be reported (M.J. Smith, *Experientia*, in press).

SOCIAL COMMUNICATION IN CALLITRICHIDS: COMPLEXITY OF SCENT IMAGES. SMITH, A.B., III, A. BELCHER, G. EPPLE, K. GREENFIELD, I. KUDERLING, L. SCOLNICK. Monell Chemical Senses Center and Chemistry Department, Univ. of Pennsylvania, Philadelphia, PA 19104; German Primate Center, 3400 Gottingen, FRG.

In the Callitrichidae, chemical signals are important in sexual and social communication. They are deposited into the environment as scent marks, complex mixtures of skin gland secretions, urine and possibly genital discharge. Long-term studies in Sanguinus fuscicollis have shown that these scent marks convey information relating to species, subspecies, gender, individuality, social status and hormonal condition. Comparative studies with S. o. leucopus suggest that the scent marks of these species function as chemical signals in a similar manner. Chemical studies have documented the presence of both volatile and high molecular weight components, including proteins, in the scent marks of S. fusciocollis. Scent marks from S. o. oedipus and S. leucopus are similarly complex in chemical composition, but differences between all three species exist. This complexity appears necessary for the full biological activity of the scent in these species.

Steinbrecht, Rudolf Alexander

Insect chemoreceptive sensilla

The comparative morphology of insect chemoreceptor sensilla is overviewed (*1,2*). According to the general *Bauplan* of arthropod sensilla, these organules consist of primary sensory cells and ion-transporting auxiliary cells which produce the extracellular sensillum lymph that surrounds the peripheral sensory processes. The functional significance of the sensillum lymph is still largely unknown, but a role in stimulus transport and inactivation is postulated, as well as a function in the electric events. The sensillum lymph may be also important for water conservation in these exposed organules. There exist characteristic differences in the sensillum-lymph spaces of different sensillum types even in the same species. Morphological, morphometrical, and cytochemical data are reported which may help to understand the complex composition and function of this "insect mucus".

(1) Steinbrecht RA (1984) In: Biology of the Integument (Bereiter-Hahn J, Matoltsy AG, Richards KS, eds). Vol I, pp 523-553. Berlin Heidelberg New York, Springer Verlag. *(2)* Steinbrecht RA (1987) In: Pheromone Biochemistry (Prestwich GD, Blomquist GJ, eds), pp 353-384. New York, Academic Press.

Storey, Greggory K.[1], and Robert K. Vander Meer[2]. Chemical Defenses of the Imported Fire Ant, Solenopsis invicta, Against Infection by the Fungal Pathogen, Beauveria bassiana.
[1]University of Florida, Entomology & Nematology Department, Gainesville, Florida 32611 USA, [2]USDA-ARS, Insects Affecting Man and Animals Research Laboratory, Gainesville, Florida 32611 U.S.A.

Beauveria bassiana is currently being developed commercially as a microbial insecticide against various insect pests, including the imported fire ant, Solenopsis invicta. Chemicals associated with the cuticle and mound soil of the fire ant were evaluated for antimycotic activity against this entomopathogenic fungus. Two major classes of compounds, venom alkaloids (C_{11}-C_{13}) and cuticular hydrocarbons (C_{27}), have been assessed.

Cuticular hydrocarbons were non-inhibitory (.0016 to 160 ug/cm^2) and concentrations higher than 1.6 ug/cm^2, supported germination and subsequent fungal development when present as the sole carbon source. At concentrations > 5 ug/cm^2, venom alkaloids delayed germination of B. bassiana in broth assays for 24 h post-treatment. However, within 72 h, 100% germination was observed. The developmental sequence of the fungus was also modified by the alkaloid resulting in the induction of the yeast phase. In solid media assays, scanning electron microscopy of agar surfaces 24 h post-treatment, revealed that the fungus germinated perpendicular to the agar surface when in contact with venom concentrations > 1 ug/cm^2. This type of negative chemotropic response to an inhibitor has not been previously reported for entomogenous fungi. Our study indicates that alkaloid compounds associated with the imported fire ant can delay germination, trigger a negative chemotropic response, and induce the yeast phase in this entomopathogen. The implications of these findings on the infection of S. invicta by B. bassiana are currently under investigation.

Takabayashi, J., M. Dicke & J. Kemerink. Department of Entomology Wageningen Agricultural University, P.O.Box 8031, 6700 EH Wageningen, The Netherlands.

ENVIRONMENTAL EFFECTS ON PRODUCTION OF PLANT SYNOMONE THAT ATTRACTS A PREDATORY MITE.

Spider mites are very ravageous herbivores. Infestation of plants by these mites in absence of predators such as predatory mites leads to overexploitation and thus to the death of the plant(1). If predatory mites invade spider mite colonies, the predators locally exterminate the herbivore population(2). Any plant genotype that increases predator invasion of spider mite colonies will have higher survival chances. Thus, plants may benefit from recruitment of bodyguards. Recent work shows that plants respond to spider-mite damage by producing volatile chemicals that lure predatory mites(3). In addition to such inducible bodyguard recruitment, we found that plants also attract predatory mites constitutively, i.e. before they are damaged by spider mites. Plant-species specific attraction of predatory mites may be expected because plants affect predatory-mite fitness in many ways, e.g. by hampering movement, by intoxication because of sequestration of toxins by the herbivorous prey, or by providing alternative food sources. Moreover, environmental conditions are known to affect production of volatile chemicals by plants. Thus, also intraspecific differences in predatory-mite attraction may be expected. We will present data on these aspects of plant-predatory mite interactions. (1) Helle,W. & Sabelis,M.W. (1985a) Spider mites. Their biology, natural enemies and control. World crop pests. Vol.1A. Elsevier, Amsterdam. (2) Helle, W. & Sabelis,M.W. (1985b) ibid. Vol.1B. (3) Dicke,M. & Sabelis, M.W.(1989). How plants obtain predatory mites as bodyguards. Neth. J. Zool.(in press).

Targett, Nancy M. ALLELOCHEMICAL CUES IN THE MARINE ENVIRONMENT. University of Delaware, College of Marine Studies, Lewes, Delaware, 19958, USA.

Focus will be given to current work in our lab on plant-herbivore defense strategies. Specifically, the effect of brown algal polyphenois on the assimilation efficiency of the herbivorous marine fish Xiphister mucosus will be examined. Although it is frequently speculated that the polyphenolic compounds, which are generally abundant in temperate phaeophytes, form complexes with proteins and reduce algal digestibility, such a role has not been domonstrated in any marine herbivore. Results will be discussed from experiments in which X. mucosus was fed the chlorophyte, Ulva lactuca coated with polyphenolic extracts from the phaeophytes Fucus distichus (high in polyphenolics) and Nereocystis Luetkeana (low in polyphenolics). A significant reduction in assimilation efficiency for X. mucosus feeding on Ulva coated with Fucus extracts at their naturally occurring concentration was observed. Assimilation efficiencies also showed a significant dose-dependent response to extract dilution, although no reduction was seen in the Nereocystis treatment. These results demonstrate that naturally occurring polyphenolic compounds in marine phaeophytes negatively affect herbivorous fish digestive energetics.

FLEXIBLE AUTOMATIZED SYSTEMS FOR AN DUSTED AIR CLEANING MANAGEMENT OF INDUSTRIAL FACTORIES INTEND FOR A HUMAN AND NATURE HEALTH CONSERVATION

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Moscow Geological Prospecting Institute, Moscow B-485,USSR

Polluted and gas-contained air of the industrial factory is considered. The results of comparison of the observed and optimal numerically calculated data allows for automatic switching in additional ventillation and systems for polluted air cleaning. All an equipment for a diagnostic of an air state of factory for ventillation and polluted air cleaning should be supply by means of microprocessors jointed in distributed network and included in computer set. It assures a high level of reliability and stability of a management system of polluted air cleaning of industrial atmosphere.

An offereble system of situational and adoptional management may be treated as a system for professional diseases prophylactic as well as for work and surrounding environment conservation.

The calculations are made using Pascal computer programs. The comparison of calculated and empirical date gives their good coexistance. Applied programms for a series of examples have been checked up on computer EC-1060.

THYMIDES, ANGELA; NICHOLAS SMIRNOFF and JO ANDERSON

DEPARTMENT OF BIOLOGICAL SCIENCES, UNIVERSITY OF EXETER, EXETER EX4 4PS

THE PHENOLIC PRODUCTION OF BETULA PENDULA (ROTH) IN RESPONSE TO NITROGEN STRESS.

Where light is non-limiting, but plants are nitrogen stressed, excess carbohydrate may be channelled into secondary carbon metabolism. This proposed mechanism may prove important in anti-herbivore defence due to the non-palatability and possibly toxic nature of some phenolic compounds.

The hypothesis has been examined by both field and glasshouse experiments Field work has been undertaken with mature and juvenile stands at two sites in Devon. The mature trees have not responded to fertilization over a two year period, and may be 'locked' into a within-tree nitrogen cycle. However, juvenile trees have rapidly responded to fertilization, five months after the first application of ammonium nitrate.

In glasshouse experiments, nitrogen stressed plants significantly increased their phenolic production. The effects of nitrogen source and shading were also examined. Comparable concentrations of ammonium and nitrate did not yield marked differences between samples, and this was probably due to the invasion of the growth medium by nitrifiers. Shading, however, has had a more significant effect on both primary and secondary metabolism.

Example.

Tollsten, L. & J.T. Knudsen.

Floral odour variations in the genus Platanthera.

Platanthera bifolia (L.) Rich and *P. chlorantha* (Custer) Reichb. (Orchidaceae) are pale strongly scented herbs pollinated mainly by night active moths. We have investigated post-pollination changes in odour composition and variations in floral scent whithin and between populations and between the two species. Scents were collected by adsorption on Porapak Q and analyzed by combined GC-MS. In unpollinated plants, the total amount of scent compounds collected, had decreased from 4.9 to 2.8 ug per flower after 7 days compared to a decrease from 4.7 to 0.023 in pollinated flowers. The difference in scent amount after 7 days was significant. Pollinated flowers also wilted faster than unpollinated and we conclude that pollination induce changes in both floral scents and visual display. The most abundant compounds varied between individual plants and were 6-methyl-5-hepten-2-one, linalool, lilac aldehyde, methyl benzoate or geraniol in *P. bifolia* and linalool or lilac aldehyde in *P. chlorantha*. Two different scent morphs could be distinguished in both species; i.e. plants containing linalool as a main compound or plants with lilac aldehydes and alcohols as main compounds. Only few plants were mixtures of these two morphs. The two species investigated are not distinctly separated by their floral scents, and we do not beleive that the scent is an effective barrier against hybridization. Natural hybrids do occur and some of the plants in our investigation might be of hybrid origin in their parental generations, which could explain some parts of the variation found. We conclude that in these two *Platanthera* species variation in floral odours are prominent between species, whithin and between populations and it is obvious that several plants must be investigated to obtain an acceptable picture of the floral scents.

Tompkins, Laurie. Analysis of sex pheromones in Drosophila melanogaster, a genetically tractable organism. Temple University, Philadelphia, Pennsylvania, U.S.A.

In Drosophila melanogaster, analysis of the courtship behaviors of mutant males with sensory deficits has revealed that males must perceive a hydrocarbon made by females to perform normal courtship, although perception of the pheromone is not required for any of the courtship behaviors. Observations of mutants have also confirmed that the female pheromone acts as a gustatory stimulus. Experiments in which the courtship elicited by sexually transformed flies has been monitored have revealed that small quantities of this pheromone can have dramatic effects on male courtship.

In addition, analysis of sensory mutants has shown that males synthesize pheromones that inhibit courtship. By monitoring the sex appeal of sexually transformed flies, 11-octadecenyl acetate, a compound synthesized in the male reproductive tract, has been identified as an inhibitory pheromone.

Ward, J. Evan and Nancy M. Targett. PRELIMINARY ISOLATION OF MICROALGAL ECTOCRINES THAT MEDIATE THE FEEDING BEHAVIOR OF MARINE BIVALVES. University of Delaware, College of Marine Studies, Lewes, Delaware 19958, USA.

The blue mussel, Mytilus edulis L., responds to ectocrines from certain species of marine microalgae by altering its feeding behavior. These responses include reduction in filtration rate, and rejection or preferential ingestion of artificial particles. The specific metabolites responsible for these effects, however, are not known. Here we describe a bioassay-guided approach to isolate ectocrines from one microalgal species that mediates the feeding behavior of blue mussels and other marine filter-feeding invertebrates.

Heterosigma akashiwo Hada Hada (= Olisthodiscus luteus Carter), a flagellated microalga which has been demonstrated to produce bioactive ectocrines, was used (Ward and Targett, 1989). Cultures were grown in the laboratory to the end of their exponential phase. Filtrates were prepared by passing cultures through an Acroflux filter capsule under low pressure. Ectocrines were removed immediately from filtrates using a polystyrene adsorbent (Biobeads SM-4). The crude extract was then fractionated using vacuum liquid chromatography. Fractions were tested in filtration rate bioassays to determine their activity. Concentrations of microalgal ectocrines used in the bioassays were comparable to those found in laboratory cultures.

Whitman, D. W.[1], W. J. Lewis[2], and F. Eller[2]. Tritrophic chemical communication: Parasitic wasps respond to chemical "SOS" from plants. [1]Department of Biology, Illinois State University, Normal, IL 61761. [2]Insect Biology and Population Management Research Laboratory, ARS-USDA, Tifton, GA 31793.

The "green leaf odors," six-carbon alcohols and aldehydes, and their derivitive esters, are volatile constituents of many green plants. Relatively low amounts of these substances are released from undamaged leaves, whereas damaged leaves release relatively high amounts. In the laboratory, parasitic wasps from two families (Microplitis croceipes: Braconidae and Netelia heroica: Ichneumonidae) orient to certain of the green leaf odors in wind tunnnels. In nature these substances may function as tritrophic synomones, allowing plants to notify parasitoids that they are under herbivore attack, and serving as chemical road maps for searching parasitoids.

Folke Carl[1], Håkan Olsén[2], Svante Winberg[2] and Lars Karlsson[3]

Differences in attraction and rheotactic responses towards population-specific odours in Baltic salmon (Salmo salar L.)

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2. Department of Zoophysiology, Uppsala university, Uppsala, Sweden
3. Institute of Salmon Research, LFI, Älvkarleby, Sweden

Responses to chemical cues in two river populations of Baltic salmon (Salmo salar L.) parr were studied in a large Y-maze to determine whether intraspecific odours are present in this reproductively isolated race of Atlantic salmon.

The experiments were preformed in home river water of one of the two populations. Immature parr tested in nonfamiliar river water had a significantly stronger motivation for upstream movement and, in contrast to the population tested in their home river water, responded also to intraspecific odours.

The results give evidence for the occurence of intraspecific odours in Baltic salmon parr, but there are population differences in motivation or capacity for discrimination.

Olsén Håkan[1], Lars Bohlin[2] and Svante Winberg[1]

Initial attempts to isolate and identify conspecific attractants in juvenile Arctic charr (Salvelinus alpinus L.)

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2. Department of Pharmacognosy, Uppsala Biomedical Center, Uppsala, Sweden

Juveniles of Arctic charr are attracted to water scented by con-specifics. Experiments have also given support for the existence of olfactory cues carring information about kinship and genetic identity.

An active crude extract have been obtained by pumping charr scented water through a column contaning Amberlite XAD-4. The organic material adsorbed to the resin was extracted with a mixture of methanol and acetic acid (95:5) followed by methanol.

In fluviarium-tests the test fishes were allowed to chose between pure water and water scented by an extract. In most experiments the charr were attracted to the MeOH/HAc-fraction, but the MeOH-fraction has only occasionally been attractive.

De Vries, Mona C., Dan Rittschof and R. B. Forward, Jr. Rhizocephalan parasitized crabs respond to analogues of crab larval release pheromones. Duke University Marine Laboratory, Beaufort, North Carolina USA 28516-9721.

At the time of larval release by the crab Rhithropanopeus harrisii, the attached eggs release peptide pheromones that induce the female to undergo stereotypic larval release behavior entailing vigorous pumping of the abdomen (pumping response). R. harrisii is parasitized by the rhizocephalan Loxothylacus panopei, which has its reproductive body section or externa in the position normally occupied by the crab's egg mass. The pumping response by the host crab is observed at the time of larval release by the rhizocephalan parasites when they infect other crab species. Similar behavior was observed in R. harrisii. Parasitized R. harrisii show the pumping response upon exposure to peptides that are similar to the pheromones released by their eggs. Peptide sensitivity, however, was enhanced in the parasitized crabs in two ways. First, the threshold concentrations were lower. Second, the types of active peptides were expanded from peptides having a neutral amino acid at the amino terminus and a basic amino acid at the carboxy terminus (neutral-basic) to include acid-basic and basic-basic peptides. The preconditions for responsiveness to the pheromone peptides are probably the presence of material on the underside of the abdomen and an internal sense that a crab is ovigerous or pseudo-ovigerous.

Weston, Leslie A. and Roselee Harmon. Allelopathic Potential of Sorghum-Sudangrass Hybrid (Sudex) Shoot Tissue and Phytotoxins. University of Kentucky, Lexington, KY 40546-0091

Experiments were conducted under controlled conditions to investigate the apparent allelopathic effects of sudex (Sorghum bicolor (L.) Moench x Sorghum sudanese (P.) Stapf. cv. FFR 201) on woody and herbaceous species. Allelopathic potential, as measured by radicle elongation of herbaceous indicator species, decreased with increasing sudex age. Greatest toxicity of sudex shoot tissue to woody and herbaceous species was observed when sudex was collected at 7 days of age. Small-seeded broadleaf species were more inhibited in the presence of sudex shoot tissue than were grass species. Two major phytotoxins were isolated from aqueous extracts of sudex shoot material by partitioning with diethyl ether, followed by thin layer and liquid column chromatography. Phytotoxins were identified as p-hydroxbenzoic acid and p-hydroxbenzaldehyde, potentially the enzymatic breakdown products of the cyanogenic glycoside dhurrin. The I_{50} values of these compounds using a cress (Lepidium sativum L.) seed bioassay were 140 and 113 µg/ml. Sudex tissue collected at 7 days of age possessed a greater percentage of these phytotoxins on a per gram basis than did older sudex tissue. As sudex tissue age increased, the percentage of p-hydroxbenzaldehyde in ether extracts of tissue also increased, while the percentage of p-hydroxybenzoic acid decreased.

Weston, Paul A. and John C. Snyder. Role of Sesquiterpenoids in Resistance of Tomato (Lycopersicon hirsutum) to Spider Mites (Tetranychus urticae). University of Kentucky, Lexington, KY 40546 Arthropod resistance of Lycopersicon hirsutum Humv. & Bonpl., a wild tomato from Peru and Ecuador, has been attributed in the past to the presence of glandular trichomes covering foliar surfaces. Because arthropods feed only rarely on L. hirsutum, we suspected that trichome gland secretions might be repellent. Therefore, we sought to characterize the trichome secretions, and to measure their influence on movement behavior of two-spotted spider mites, Tetranychus urticae Koch. Foliage of L. hirsutum was surface extracted with hexane. In vitro bioassays designed to measure avoidance behaviors of mites revealed these extracts to be repellent. Following separation on silica gel, the major constituents were identified (using GC-MS, UV, and IR spectroscopy) as the sesquiterpene hydrocarbons zingiberene, elemene, and curcumene. However, fractions containing these compounds were behaviorally inactive towards mites; repellent activity was associated strictly with slightly polar fractions. We have characterized the active compounds as di-oxygenated sesquiterpenes; all appear to be structurally related to the predominant sesquiterpene, zingiberene.

Wood, D.L., J.W. Fox, I. Kubo, L.D. Merrill, J.H. Cane, M. Stock. EVOLUTION OF HOST AND CONSPECIFIC DISCRIMINATION AMONG SIBLING IPS SPP. (COLEOPTERA: SCOLYTIDAE). University of California, Department of Entomological Sciences, Berkeley, CA 94720, USA.

Certain southwestern U.S. pines, their associated sibling species of Ips, and perhaps their close associates (predators, parasites, and microorganisms), occupy only narrow zones of sympatry today, but likely were more broadly sympatric in recent geological time. The mechanisms by which these Ips species presently distinguish (or fail to distinguish) both conspecifics and their host pines may be of considerable significance for reconstructing their recent evolution. The important host and species premating discrimination (host finding, pheromone composition, stridulation) and postmating isolation (hybrid inviability, nutritional inadequacy of phloem) mechanisms presently functioning in parapatric pairs of Ips species have been investigated. These species pairs are: confusus–paraconfusus, hoppingi-lecontei, confusus-lecontei, and confusus-hoppingi. Our goal is to organize these mechanisms into a phylogenetic framework developed from morphological, karyological and allozymic data. In so doing, we can hierarchically order the present distribution of these characters possessed by extant Ips taxa and develop parsimonious evolutionary hypotheses of ancestral derivation and transformation. In short, how have the semiochemical communication systems, discrimination behaviors, host associations, etc. evolved?

METABOLISM OF PLANT ALLELOCHEMICALS IN INSECTS: THE BENEFITS OF DIVERSITY

Lena B. Brattsten, Rutgers University, Cook College, Department of Entomology, New Brunswick, New Jersey.

Insects are thought to derive from carnivorous arthropod ancestors. Therefore their ability to utilize plant tissues as food is a condition made possible by the evolution of defenses against plant defenses. Herbivorous insects have evolved a great diversity of defenses including phenological, behavioral, physiological such as storage and excretion, and biochemical, notably target site insensitivity and detoxification.

Of all possible defenses in insects, detoxification may be most important especially against fast acting acute toxicants. Insecticide resistance data, when available, strongly imply that metabolic resistance precedes all other resistance mechanisms.

Many enzymes are involved in detoxification. Of these, the cytochrome P-450 system is often the most important one. The defensive versatility of cytochrome P-450 resides in its reaction mechanism, its occurrence in multiple molecular forms with overlapping substrate preferences, its inducibility in response to xenobiotics including substrates, and other factors.

Carboxylesterases, glutathione transferases, and other detoxifying enzymes undergo adaptive evolution similar to that of cytochrome P-450. Together these enzymes constitute a defense the most outstanding characteristic of which is its diversity.

Even this potent defense can be foiled by a relaxed selection pressure such as provided in nature by the great diversity of defensive allelochemicals often cooccurring in any species of plants. Individual plants biosynthesize a series of chemically related compounds and also often contain chemically unrelated compounds. Furthermore, the concentrations of the compounds can be highly variable.

Diversity is highly visible in nature. Additional layers of diversity reside in the allelochemistry of plants. The possibility for crop protection in agricultural fields by bioengineering crop plants is feasible and imminently achievable. This will provide crop protection with considerably reduced risks for environmental contamination and human health. However, this is chemical control in disguise and will cause equally rapid evolution of defenses in competing species as synthetic chemicals applied out of a spray nozzle. The challenge is to convince the bioengineers and the users of their products that a diversity of plant defensive mechanisms must be employed so as to dilute the selection pressure of any one. These efforts require the availability of both models and raw materials from natural systems.

EVERAERTS, Claude, ROISIN, Yves, BONNARD, Odile & PASTEELS, Jacques Marie. CHIRAL ALARM PHEROMONE AND CASTE-SPECIFIC REACTION IN Nasutitermes princeps. Laboratoire de Zoologie -CNRS URA55- Fac.Sciences, Université de Bourgogne, 6Bd.Gabriel- F21000 Dijon.

The frontal gland secretion of Nasutitermes consists of a gluey terpenic mixture (mainly mono- and diterpenes), ejected through the nasus onto all potential foe which is quickly incapacited. Beside its entangling function, in some species, this viscous defensive secretion acts as alarm pheromone; this role has been imputed to the monoterpenes.

The monoterpenic fraction of Nasutitermes princeps consists upto of 95% of alpha-pinene; after isolation, its absolute configuration has been elucidated by measurement of rotatory power and gas chromatography using modified cyclodextrin as stationary phase (*): these measurements revealed an optical purity of (+)-alpha-pinene of at least 99.5%.

We have focused our attention on the behavioural action of this compound on the various castes of N. princeps, and in addition we have studied the reaction of N. princeps to both enantiomers of alpha-pinene and to monoterpenes of other species secretions.

The (+)-alpha-pinene elicit a quick alarm reaction in N. princeps, and this action is caste-dependent and specific.

(*): We are indebted to Prof.W.A.König who carried this chromatographic analysis.

Camps, F., Gasol, V., Guerrero, A.*

Inhibitory pheromonal activity promoted by some analogs of the sex pheromone of the pine processionary moth *Thaumetopoea pityocampa*.

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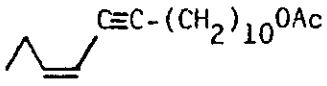
New thio-, thia- and haloacetate analogs of the sex pheromone of the pine processionary moth *Thaumetopoea pityocampa* 1 have been prepared for the first time and found to be effective inhibitors of the natural pheromone activity both in laboratory bioassays and field tests. Structures of the sulfur analogs derive from replacement of the oxygen atom(s) of the acetate group by sulfur and the olefinic moiety of the enyne function by the isosteric SCH_2 group. The haloacetate analogs tested have been the corresponding mono-, di- and trifluoroacetates and chloroacetates. In the laboratory assays, the inhibition was determined by recording the EAG response of the natural pheromone after presaturation of the male antennae with variable amounts (0.1-1000 µg) of the analogs. In the field, most of the analogs exhibited a high inhibitory effect when mixed with the pheromone in 0.1:1, 1:1 and 10:1 ratios.



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Linn, Charles & Roelofs, Wendell. MULTICOMPONENT BLENDS, SIGNAL SPECIFICITY, AND THE LONG RANGE ATTRACTION OF MALE MOTHS. Department of Entomology, New York State Agricultural Experiment Station, Geneva, New York 14456.

Numerous species of moths utilize multicomponent blends for the purpose of attracting mates. From an awareness of the specificity of the female-produced signals the concept developed that these pheromone blends function as species-specific communication channels. At the same time, however there has been a search for the functional role of pheromone components in the male flight response, leading to the development of a behavioral paradigm stating that individual components function to trigger or sustain specific behaviors in the sequence of male behaviors. In this talk I will review the evidence for this concept and discuss new evidence showing that male response thresholds, and male response specificity are functions of male perception of the female-produced blend of components, and that individual components do not function to trigger specific behaviors at varying distances from a female. The talk will emphasize the important relationships between the technical advances in chemical analyses, our knowledge of the pathways by which pheromones are synthesized, and their impact on behavioral assays. The talk will conclude with a discussion of the impact of our new paradigm, emphasizing the role of multicomponent blends as units effecting optimal male behavior, on neurophysiological and neuroethological studies.

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EVOLUTION OF SPECIFICITY IN MOTH PHEROMONE COMMUNICATION SYSTEMS AND ITS GENETIC CONTROL

Geographically different populations of the turnip moth *Agrotis segetum* produce and respond to different ratios of three homologous acetates. New data on African, Asian and several European populations give striking examples of population association between matching production and response traits in this communication system. Native males of other species are frequently attracted by blends produced by females from other areas, which suggests that interspecific selection is important for local adaptation of the communication system. When confined in cages in the laboratory, closely related moth species frequently mate and produce viable and fertile offspring. Among many naturally co-occuring species, pheromone components of one species act as specific behavioural antagonists in others, which suggests a definite role of pheromones in reproductive isolation in moths.

Pheromone differences between pheromonal strains or closely related species are in many cases controlled by a small number of Mendelian genes. Recent analyses of interspecific hybrids between European and Asian cornborers, *Ostrinia nubilalis* and *O. furnacalis* extend this picture. The production of both Z and E pheromone component precursors is coded for by the same locus (or closely linked loci), but this gene occurs in many unlinked copies with additive effects.Theoretical and empirical studies of the fate of sender and receiver mutants in otherwise monomorphic populations are required to advance our understanding of how pheromone communication systems evolve.

PHEROMONES AND INTERSPECIFIC CHEMICAL SIGNALS: Function, Receptor specificities and CNS processing.

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Natural selection has favoured multicomonent pheromone systems in insects, where compounds might also have an interspecific effect. Inhibition, synergism as well as food attraction are some functions known in bark beetles. We have focused on receptor specificities for the various pheromones in different populations of a species, different species of the same genus, of different genera and families. Regardless of taxonomic groups and function, a compound is received by similar types of receptor cells. It suggests that the membrane receptors in this system are concerved through evolution. What may rather have become differenciated is the CNS processing of the information from these chemical signals.

Receptor cells and antennal lobe (AL) neurons have been studied in two species of moths, Heliothis virescens and H.zea, where interspecific inhibtion is present. The pheromone receptor cells, show a labelled-line mechanism. Intracellular recordings from AL neurons reveal that information from pheromones and the interspecific inhibitor leave the AL in separate pathways, suggesting that protocerebrum might be the area where the integration process differ in the two species.

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Possible Allelochemical Effects on Algae of Aquatic Plants

The investigation of the allelochemistry in aquatic ecosystems will promote understanding of the aquatic eco-phenomena and would help in solving the serious problems, such as disgustful algae blooms. Allelochemical effects of higher aquatic plants on algae are studied. The aqueous extracts of about twenty samples of plants, auch as Marsilea guadsifolia L., Ceratophyllum demersum L., Potamogeton distinctus A.Benn Polygonum hydropiper, Phragmites communis Trin, Typha angustifolia L., etc. were bioassayed. Inhibitory effects on the growth of the blue-green alga Anabaena were observed using the extracts obtained from some of the plants, eg. Potamogeton distinctus A.Benn and Typha angustifolia L.. The futher investigation is being conducted.

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