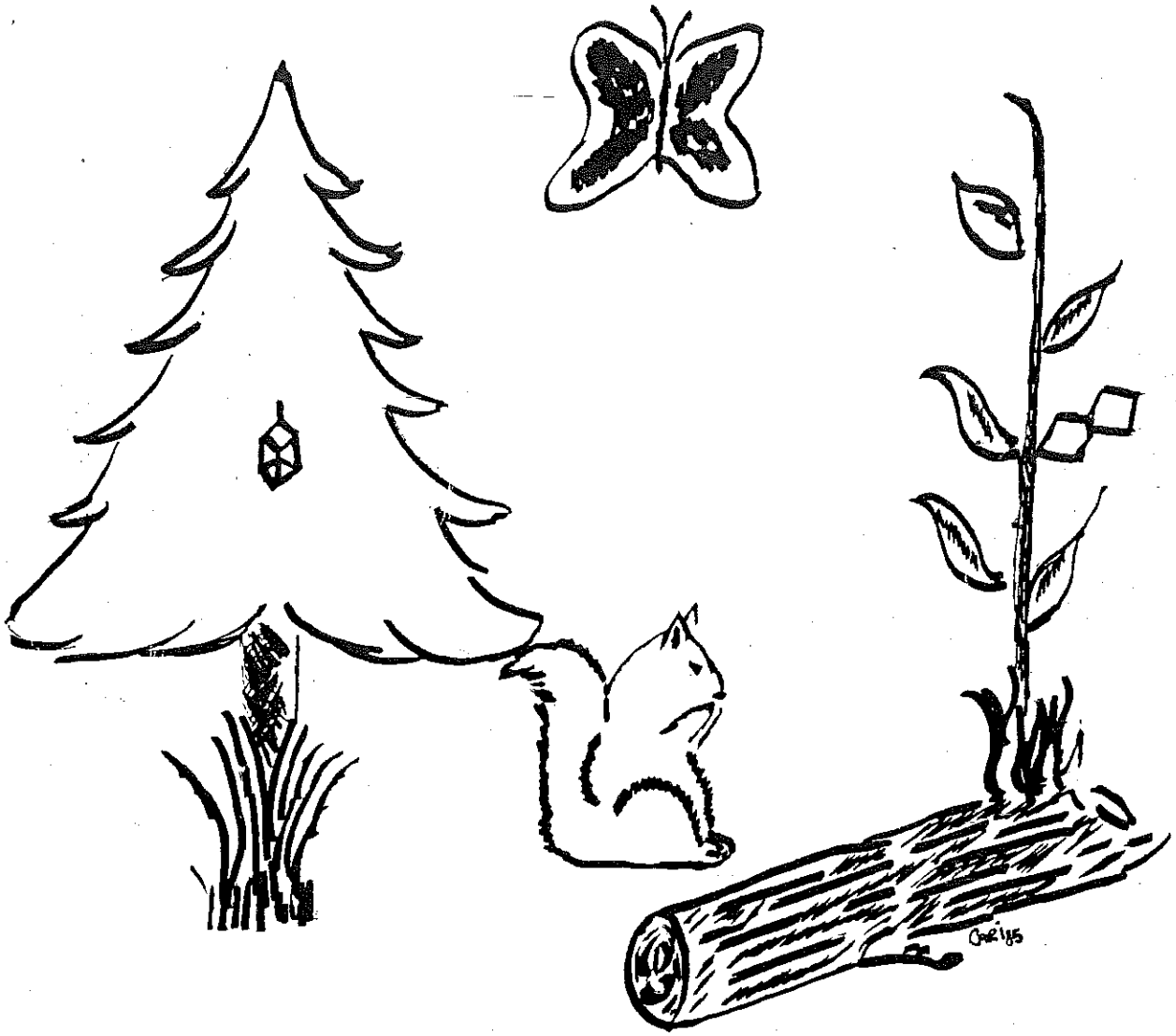
ISCE '85



MADISON, WI

SECOND ANNUAL MEETING

INTERNATIONAL SOCIETY OF CHEMICAL ECOLOGY

MEMORIAL UNION

THE UNIVERSITY OF WISCONSIN-MADISON

JUNE 8-12, 1985

233-5897

Daily Schedule
Second Annual Meeting
International Society of Chemical Ecology
Memorial Union - State Historical Society Bldg.
The University of Wisconsin-Madison
June 8-12, 1985

Day & Date	Time	Event	Location
Sat. June 8	2-5:00	Registration	Cafeteria
	7:30-9:30	Mixer	Cafeteria
Sun. June 9	7:00-8:00	Breakfast	Reception Room
	8:00-10:00	Registration	Historical Society Bldg.
	8:30-12:30	Invited Lectures	Historical Society Bldg.
	10:20	Break	
	12:30-1:30	Lunch	Tripp Commons
	2:00-5:00	Society Business	Reception Room
	3:00	Break	
	6:15-7:15	Dinner	Tripp Commons
	7:30-8:30	Rescheduled Lecture (Gerald Rosenthal)	Tripp Commons
	8:30-10:00	Reception	Tripp Commons
Mon. June 10	7:00-8:00	Breakfast	Reception Room
	8:30-12:30	Invited Lectures	Historical Society Bldg.
	10:20	Break	
	12:30-1:30	Lunch	Tripp Commons
	1:30-2:00	Informal Meetings	Board Room
	2:06-6:02	Contributed Papers	Old Madison
	3:54	Break	
	6:15-7:15	Dinner	Tripp Commons
	7:30-9:30	Poster Session	Reception Room
Tues. June 11	7:00-8:00	Breakfast	Reception Room
	8:30-12:30	Invited Lectures	Historical Society Bldg.
	10:20	Break	
	12:30-1:30	Lunch	Tripp Commons
	1:30-2:30	Informal Meetings	Board Room
	2:36-6:10	Contributed Papers	Old Madison
	4:24	Break	
	6:45-7:30	Cash Bar	Tripp Commons
	7:30-10:30	Banquet	Tripp Commons
Wed. June 12	7:00-8:00	Breakfast	Reception Room
	8:30-12:30	Invited Lectures	Historical Society Bldg.
	10:20	Break	
	12:30-1:30	Lunch	Tripp Commons

INVITED MORNING LECTURES

Sunday, June 9	CHEMICAL ASPECTS OF SYMBIOSIS	
Moderator:	DALE NORRIS, University of Wisconsin, Madison	
10 min. 8:30	Introduction	
50 min. 8:40	JEROME KUKOR University of Michigan	ROLE OF MICROBIAL ENZYMES IN INVERTEBRATE NUTRITIONAL ECOLOGY
50 min. 9:30	CLARENCE A. RYAN Washington State University	ACTIVATION OF PLANT DEFENSE GENES BY PLANT AND FUNGAL CELL WALL FRAGMENTS
20 min. 10:20	REFRESHMENT BREAK	
50 min. 10:40	WINSTON BRILL Agracetus Corporation	CHEMICAL INTERACTIONS BETWEEN NITROGEN-FIXING BACTERIA AND HIGHER PLANTS
50 min. 11:30	WILLIAM T. STARMER Syracuse University	COADAPTATION OF DROSOPHILA AND YEASTS IN THEIR NATURAL HABITAT
Monday, June 10	BEHAVIORAL ADAPTATIONS TO CHEMICAL CUES	
Moderator:	WENDELL BURKHOLDER, USDA, University of Wisconsin-Madison	
50 min. 8:30	RONALD PROKOPY University of Massachusetts	INTERACTION OF PLANT CHEMICAL AND PHYSICAL STIMULI IN INSECT HOST FINDING AND ACCEPTANCE BEHAVIOR
50 min. 9:20	ROBERT L. METCALF University of Illinois	BEHAVIORAL ADAPTATIONS OF CUCUMBER BEETLES & CORN ROOTWORM BEETLES (COLEOPTERA: DIABROTACINA) TO CUCURBITACINS
20 min. 10:10	REFRESHMENT BREAK	
50 min. 10:30	DANIEL SONENSHINE Old Dominion University	PHEROMONE-ALLOMONE MEDIATED BEHAVIOR IN THE ACARI: ADAPTATIONS FOR FINDING HOSTS AND MATES.
50 min. 11:20	PHILLIP MATSUMURA University of Chicago	BEHAVIORAL RESPONSES TO CHEMICAL CUES BY BACTERIA

Tuesday, June 11 MARINE CHEMICAL ECOLOGY

Moderator: DAN RITTSCHOF, Duke University Marine Laboratory

50 min. 8:30	GERALD BAKUS University of Southern California and NANCY TARGETT University of Delaware	AN OVERVIEW OF MARINE CHEMICAL ECOLOGY
50 min. 9:20	WILLIAM FENICAL and VALERIE PAUL Scripps Institute of Oceanography	ANTIHERBIVORY
20 min. 10:10	REFRESHMENT BREAK	
50 min. 10:30	WILLIAM CARR Whitney Marine Laboratory CHARLES DERBY Georgia State University	COMPLEX ODORANTS
50 min. 11:20	JOSEPH BONAVENTURA and DAN RITTSCHOF Duke University Marine Laboratory	MACROMOLECULES IN MARINE CHEMICAL ECOLOGY

Wednesday, June 12 THE EVOLUTION ECOLOGY OF CHEMICAL DEFENSE IN INSECTS

Moderator: MURRAY S. BLUM, University of Georgia

50 min. 8:30	LINCOLN BROWER, University of Florida CAROLYN NELSON, University of Sydney, and JANES N. SEIBER, University of California, Davis	THE CHEMICAL ECOLOGY OF CARDENOLIDES IN MILKWEED BUTTERFLIES
50 min. 9:20	MURRAY ISMAN, G.G.E. SCUDDER and LYNN MOORE, U. of British Columbia	SEQUESTRATION OF CARDENOLIDES IN (ONCOPELTUS:) MORPHOLOGICAL AND PHYSIOLOGICAL ADAPTATIONS.
20 min. 10:10	REFRESHMENT BREAK	
50 min. 10:30	MARTINE ROWELL-RAHIER, Universitat Basel, and J.M. PASTEELS, Universite Libre de Bruxelles	ECONOMICS OF CHEMICAL DEFENSE IN CHRYSOMELINAE.

SUBMITTED POSTERS

Reception Room, Memorial Union

Monday, June 10, 1985; 7:30-9:30 p.m.

Poster No.	First Author	Title	Abstract No.
1	E.A. Bernays	Relating Chemical Deterrance to Toxicity	6
2	R.W. Howard	Defensive Chemistry of *Tribolium* Spp.	16
3	D. Mebs	Macromolecules from Marine Sponges	21
4	H. Mehansho	Protective Response of Animals Ingesting Condensed Tannins	22
5	J.M. Pasteels	Recent Advances in the Chemistry of Adult Chrysomeline Defensive Secretions	28

SUBMITTED ORAL PAPERS
Old Madison Room, Memorial Union

Monday, June 10, 1985
Kenneth W. Vick, Chair, USDA-ARS, University of Florida

Time	First Author	Title	Abstract No.
2:06	S.B. Vinson	Chemical Symbiosis Between an Insect Parasitoid and its Host at the Molecular Level	39
2:18	Y. Naya	The Role of Intracellular Symbiotes in the Development of Planthoppers	24
2:30	M.S. Obin	Chemical Basis of Nestmate Recognition in Solenopsis invicta Buren (Hymenoptera:Formicidae): Alteration in Recognition Cues by Laboratory Rearing	26
2:42	J.R. Aldrich	Predaceous Stink Bug Pheromones and Attraction of Scavenging Yellowjackets	2
2:54	J. Anderson	The Role of Pyrrolizidine Alkaloids in the Bird Predation of Overwintering Monarch Butterflies	4
3:06	J.H. Cane	Predator Deterrence by Mandibular Gland Secretions of Bees (Apoidea)	10
3:18	J.P.J. Billen	Studies of Dufour Gland Constituents in Formicine Ants by Means of Solid Injection Gas Chromatography	7
3:30	C. Wall	Effect of Habitat on Orientation Behaviour to Pheromone Sources	41
3:42	C.A. Walgenbach	Sources of Variability in Maize Weevil Pheromone Response	40
3:54		REFRESHMENT BREAK	
		John Simeone, Chair, Syracuse University	
4:14	J.M. Bradow	Volatile Allelochemicals from Palmer Amaranth (Amarenthus palmeri S. Wats.) Residues	9
4:26	F.A. Einhellig	Effects of Allelpathic Chemicals on Photosynthetic Rate in Lemna Minor	13

Time	First Author	Title	Abstract No.
4:38	K.L. Mikolajczak	Sylvaticin, A New Insecticidal Acetogenin from Rollinia Sylvatica St. Hill	23
4:50	L.A. Swain	Retention of Seed Insecticidal Nonprotein S-Amino Acids by Young Leaves of Calliandra Tapirorum	34
5:02	O. Adeyeye	Effects of L-Azetidine-2-Carboxylic Acid on the Corn Earworm, Heliothis Zea (Boddie)	1
5:14	R.L. Lindroth	Do Induced Plant Defenses Cause Vole Population Cycles?	19
5:26	J.P. Christofferson	The Chemical Control of Feeding Behavior in Juvenile White Sturgeon, Acipenser transomontanus	11
5:38	J.C. Boudreau	Stimulus Chemistry of Rat Oral Taste Systems	8
5:50	L.R. Ayyagari	Fat Metabolism Changes Associated with Molting in Spiders.	5

Tuesday, June 11, 1985;
Ralph W. Howard, Chair, U.S. Grain Market. Research Lab,
Kansas State University

Time	First Author	Title	Abstract No.
2:36	G.E. Schatz	Floral Odors and Patterns of Visitation by Scarabaeidae: Dynastinae in a Costa Rican Tropical Wet Forest	30
2:48	J.F. Andersen	Identification of Potential Volatile Attractants for the Lesser Peach Tree Borer, *Synanthedon Pictipes*, from Peach Bark	3
3:00	F.C. Tingle	Behavior of *Heliothis virescens* (F.) in the Presence of Oviposition Deterrents Extracted from Elderberry	36
3:12	J.N. Seiber	The Cardenolide Connection Between Overwintering Monarch Butterflies from Mexico and Their Larval Foodplant, *Asclepias syriaca*	31
3:24	J.A. Coffelt	Oviposition Preference by the Sweet Potato Weevil, *Cylas formicarius elegantulus*	12
3:48	J.A.A. Renwick	Chemical and Physical Factors Affecting Oviposition by the Cowpea Weevil, *Callosobruchus maculatus* (Coleoptera: Bruchidae).	29
4:00	R.L. Lampman	Phenylacetaldehyde: A Potent Multiordinal Attractant	18
4:12	P.R. Hughes	Alteration of Insect Success by Environmentally-Induced Changes in Host Quality: Two Examples from Soybean	17
4:24		REFRESHMENT BREAK	
		Eric Erickson, Chair, UW-Madison	
4:44	W.S. Goldstein	Tannins: A New Role?	14
4:56	J.M. Horn	Quantitative Variation in a Willow Leaf Phenol Glycoside	15

Time	First Author	Title	Abstract No.
5:08	J.T. Smiley	Ecological Effects of Salicin at Three Trophic Levels	32
5:20	H.M. Van't Hof	A Comparison of Metabolic Costs of Processing Diets of High and Low Water Content	38
5:32	D.A. Nordlund	Host and Prey Selection Behavior of Entomophagous Insects -- The Role of Semiochemicals	25
5:44	P.D. Swedenborg	Hydrocarbon Components of the Sex Pheromone of Macrocentrus grandii (Hymenoptera: Braconidae). A Series of 9, 13 Dienes	35
5:56	R.K. Vander Meer	Fire Ant Trail Pheromone Species Specificity: A Chemical Explanation.	37

EFFECTS OF L-AZETIDINE-2-CARBOXYLIC ACID ON THE CORN EARWORM, *HELIOTHIS ZEA* (BODDIE)

Olushola Adeyeye and M. Blum, Department of Entomology, University of Georgia, Athens, GA 30602

Incorporation of L-azetidine-2-carboxylic acid into larval diets produced severely toxic effects in the corn earworm, *Heliothis zea*. The toxic effects included high larval mortality, retarded growth and development, inability of larvae to molt successfully to pupae, formation of deformed pupae and marked reduction in pupal weights. Larval response was dependent on azetidine concentration and on larval physiological age. Late instar larvae were better able to survive toxic effects of this non-protein amino acid.

PREDACEOUS STINK BUG PHEROMONES AND ATTRACTION OF SCAVENGING YELLOWJACKETS

J. R. Aldrich, USDA-ARS, Insect Physiology Lab., Beltsville, MD 20705

Foraging workers and queens of the eastern yellowjacket, Vespula maculifrons (Hymenoptera: Vespidae), are attracted to artificial pheromones of 2 predaceous stink bugs, Podisus maculiventris and P. fretus (Hemiptera: Pentatomidae). In each Podisus species 3 compounds account for over 90% of the total volatiles released by calling males: (E)-2-hexenal (45.1%), α-terpineol (45.1%), and benzyl alcohol (6.4%) in P. maculiventris; (E)-2-hexenal (36.8%), linalool (49.4%), and benzyl alcohol (8.5%) in P. fretus. Blends of (E)-2-hexenal/α-terpineol/benzyl alcohol and (E)-2-hexenal/linalool/benzyl alcohol attracted P. maculiventris and P. fretus adults, respectively, as effectively as more complete pheromone blends. A blend of (E)-2-hexenal/α-terpineol/linalool/benzyl alcohol attracted adults of both species. Mixtures (1:1) of (E)-2-hexenal/α-terpineol and (E)-2-hexenal/linalool were as attractive to V. maculifrons workers as the complete pheromones. All compounds tested singly were unattractive to yellowjackets, as were 1:1 mixtures of (E)-2-hexenal/geraniol, (E)-2-hexenal/terpinen-4-ol, (Z)-3-hexenol/linalool, and (E)-2-hexenol/linalool. Vespula germanica and V. flavopilosa also appear to be selectively attracted to these Podisus pheromones, as are several species of Podisus parasitoids.

IDENTIFICATION OF POTENTIAL VOLATILE ATTRACTANTS FOR THE LESSER PEACH TREE BORER, SYNANTHEDON PICTIPES, FROM PEACH BARK. J. F. Andersen and K. L. Mikolajczak, USDA-ARS, Northern Regional Research Center, 1815 N. University St., Peoria, IL 61604; and D. K. Reed, USDA-ARS Fruit and Vegetable Insects Research Lab, P.O. Box 944, Vincennes, IN 47591.

In studies of host selection by the lesser peach tree borer, Synanthedon pictipes, the volatiles of peach bark were fractionated by preparative GLC (3% OV-17) and assayed using the electroantennogram (EAG) technique. EAG assay indicated that two consecutive fractions (112-144°C) were the most active regardless of the method of volatile collection. The early fraction (112-128°C) contained the major components: methylbenzoate, phenol, guaiacol, benzyl alcohol, 2-phenylethanol and p-cymene-8-ol. The late fraction (128-144°C) contained mainly 2-phenylethanol, phenol, ethylbenzoate, p-cymene-8-ol, p-vinylphenol and benzoic acid. The active material was further fractionated by preparative capillary GLC. With this technique, the major sources of activity were found to lie in capillary fractions containing mixtures of benzyl alcohol, 2-phenylethanol, p-cymeme-8-ol, and guaiacol.

THE ROLE OF PYRROLIZIDINE ALKALOIDS IN THE BIRD PREDATION OF OVERWINTERING MONARCH BUTTERFLIES

James Anderson and John Glendinning, U. of Florida, Gainesville, FL 32611

Overwintering monarch butterflies (Danaus plexippus L.) in Mexico are heavily preyed upon by flocks of black-backed orioles (Icterus abeillei Lesson) and black-headed grosbeaks (Pheucticus melanocephalus Swainson). The grosbeaks reject many butterflies, but previous studies have shown that they ingest monarchs randomly with respect to their cardenolide content, which is generally low and decreases during the overwintering season. These studies have also revealed much higher predation of male monarchs. During the winter of 1984-1985, butterfly mortality was monitored underneath a major Mexican overwintering site and specimens were analyzed for content of pyrrolizidine alkaloids (PA). More butterflies were rejected (killed but uneaten) by birds in the latter part of the winter. Evidence indicates that female monarchs rejected by birds contain more PA than females who were partially consumed.

Fat metabolism changes associated with molting in spiders.
L. Rao Ayyagari, Dept. Biology, Lindenwood College, St. Charles, Mo 63301.
Glycerol-3-phosphate dehydrogenase (GPDH) activity was used as an indicator of fat metabolism in *Lycosa punctulata*. Highest activity was found in the leg homogenates (2120 *u*moles/ g protein.h) as compared to cephalothorax and abdomen homogenates (810 and 1450 *u*moles/ g protein.h respectively). Homogenates were made from spiders cooled at 4 C for 15 min in 0.1 M sucrose solution. The GPDH assay was carried out according to conditions determined by Prestwitch & Ing (Comp. Biochem. physiol. Z2b, 296,1982) and were the following: Triethanol amine buffer pH 7.7, 0.2 mM NADH, 0.2 mM KCN and 0.2 mM mercaptoethanol. Presently, GPDH levels are being assayed prior to- and immediately after molting (induced by an exogenous injection of *B*-ecdysterone). These data and the correlation of fat metabolism changes with molting will be discussed.

RELATING CHEMICAL DETERRENCE TO TOXICITY

E.A. Bernays, U. C. Berkeley, CA. 53999
P.K. Cottee and A.J. Mordue, U. of Aberdeen, Scotland, UK

An investigation into post-ingestional effects of feeding deterrents was undertaken using Locusta migratoria and Schistocerca gregaria. A number of different kinds of plant secondary compounds was employed. The growth and efficiency of food utilization over the fifth nymphal instar was measured. Short-term behavioral tests were used to monitor deterrence while chronic oral intake was used for monitoring post-ingestional effects. Cannulation into the foregut and dosing with miniature gelatin capsules were techniques used to overcome the problem of extreme deterrence. The significance of non-correspondence of deterrence and toxicity is considered.

STUDIES OF DUFOUR GLAND CONSTITUENTS IN FORMICINE ANTS BY MEANS OF SOLID INJECTION GAS CHROMATOGRAPHY

J.P.J. Billen, Limburgs Univesitair Centrum, B-3610 Diepenbeek (Belgium)
A.B. Attygalle, Universitat Erlangen-Nurnberg, D-8520 Erlangen (Germany)
M.F. Ali and E.D. Morgan, Keele University, ST5 5BG Staffordshire (England)

The Dufour gland, a source of various pheromones, is a sac-like organ that opens near the poison gland at the abdominal tip. It is equipped with a well developed muscular supply which regulates the discharge of secretion independently from the poison gland ejection mechanism. Species in the subfamily Formicinae frequently contain large amounts of hydrocarbons with undecane and tridecane as major components. The chemical composition has a species as well as a caste-specific profile. For example queens and workers of Camponotus aethiops have different profiles. Dufour glands of individual ants of the different castes can be analyzed by gas chromatography using a solid injection technique. Combined with GC-MS and occasionally with reaction gas chromatography (e.g. to locate the position of double bonds), full chemical identification and quantification at the nanogram level can be achieved. The relative simple procedure permits samples to be taken in the field and preserved for later analysis, or for materials to be transported by post for example, from tropical areas, to laboratories equipped for the analysis.

Stimulus Chemistry of Rat Oral Taste Systems

James C. Boudreau, Sensory Sciences Center, University of Texas at Houston

Rat oral taste systems were studied by recording single unit responses from the sensory ganglia of the facial and glossopharyngeal nerves. From these studies it was concluded that the rat taste system includes at least six subsystems: Four primarily in the glossopharyngeal (GP) nerve, and two in the facial. One GP System is almost exclusively responsive to alkaloids, the most active compounds being atropine, quinine, D-lupanine, L(-) sparteine, and colchicine. Another GP system is responsive to saccharin, sugar, and a variety of amino acids. A third GP system is only discharged by a few acids, with many low pH solutions of carboxylic acids being nonstimulatory. A fourth GP system is mainly stimulated by inorganic salts, although thresholds are high. These GP systems innervate the back of the tongue and mouth. The two facial nerve systems innervate mainly the fungiform papillae on the front of the tongue. One of the facial nerve taste systems fires primarily to acidic stimuli, but to a more diversified group of acids than the GP acid system. A second facial nerve system is only discharged by solutions containing Na^{+} or Li^{+}.

This work was supported in part by NSF Research Grants.

VOLATILE ALLELOCHEMICALS FROM PALMER AMARANTH (Amaranthus palmeri S. Wats.) RESIDUES.

J. M. Bradow and W. J. Connick, Jr. USDA Southern Regional Research Center, New Orleans, LA 70179

As part of a study of apparent allelopathic activity of Palmer amaranth residues, seed germination assays were used to test the bioactivity of volatiles emitted by aerial and root residues. Volatiles from aerial residues retarded or prevented germination of carrot, tomato, onion and Palmer amaranth. Volatiles from root residues were less active. Release of inhibitory volatiles persisted or increased after 2 weeks air-drying and partial rehydration of the residues. The volatile mixtures contained significant levels of methyl ketones (GC-MS analysis). Vapors of the authentic ketones prevented or strongly inhibited germination of the 4 assay species at less than 5 µM/L air. Exposure for 72 h to vapors of the authentic ketone vapors or to the residue volatiles led to a residual depression of germination after the volatile sources were removed.

PREDATOR DETERRENCE BY MANDIBULAR GLAND SECRETIONS OF BEES (APOIDEA)

J.H. Cane, Dept. Zoo-Ent, Auburn Univ., AL 36849

Volatile lipids from the mandibular gland secretions of bees (Hymenoptera: Apoidea) are potent olfactory repellents of foraging ants (Formica, Crematogaster) in biologically relevant contexts and quantities. In contrast, differential success in capture of bee and fly prey by predatory asilid flies (Efferia), reduviid bugs (Apiomerus), and arachnids (Agelenopsis, Argiope) is better explained by prey size rather than by chemical repellence, aposematism, or possession of a sting. Supernormal doses of some allomones, applied to worker honeybees (Apis mellifera) that were fed to Argiope aurantia spiders, elicited more frequent preenvenomation pauses following ensnarement, but did not significantly increment other prey-handling times. These pauses merely delayed the bee's demise.

Mandibular gland secretions of solitary bees augment their other secondary defenses in at least two contexts: 1) during intranest encounters when repelling intruding ants, and 2) retaliation delivered to their arthropodan predators which, if the bee is nearly too large for the predator to handle, may allow the bee to escape.

THE CHEMICAL CONTROL OF FEEDING BEHAVIOR IN JUVENILLE WHITE STURGEON, *Acipenser transmontanus*.

Jay P. Christofferson, California State University, Stanislaus, Turlock, Calif. 95380.

The survival and growth rates of white sturgeon fry are significantly reduced when the fish are fed artifical diets, while fry, fed live food (brine shrimp or tubifex worms) have good survival and growth rates. Fry fed live foods, however, become imprinted on this diet and will not, in any significant numbers, switch to artifical diets.

Fish respond to a feeding stimulus by performing a "search behavior". This behavioral pattern is elicited by extracts of both brine shrimp and tubifex worms. These fish showed a "search behavior" when tested with extracts that had been boiled, freeze-dried, dialyzed, filtered through a DIAFLO UM - 05 membrane, and after acid hydrolysis. The chemical stimulant(s) was soluble in methanol, ethanol, and butanol, but not soluble in petroleum ether until the pH was adjusted to 9.5. These preliminary results fit the generalization that most feeding stimulants are low molecular weight (under 1000), are non-volatile, nitrogenous and amphoteric chemicals.

OVIPOSITION PREFERENCE BY THE SWEET POTATO WEEVIL, Cylas formicarius elegantulus

J. A. Coffelt, USDA, ARS, Gainesville, FL 32604

When provided a choice of oviposition sites in the laboratory, female weevils laid eggs only on sweet potato. Over 80% of the eggs laid on sweet potato were deposited in the tissue immediately below the skin of the potato. Pre-oviposition behaviors that result in the formation of the oviposition site will be described. The possible chemical and/or physical nature of the host stimuli will be discussed.

EFFECTS OF ALLELOPATHIC CHEMICALS ON PHOTOSYNTHETIC RATE IN LEMNA MINOR

F. A. Einhellig[1], P. F. Nyberg[1], and G. R. Leather[2]; [1]Univ. of South Dakota, Vermillion, SD 57069; [2]USDA-ARS, Frederick, MD 21701.

Manometric techniques were employed to determine the action of several known inhibitory allelochemicals on photosynthesis. Bioassays were conducted with Lemna minor L. using a Gilson Differential Respirometer (GRP14) equipped with 15 ml capacity reaction vessels. Fifteen fronds were added to each vessel. Plants were treated by amendments to the nutrient growth medium 48 hr prior to monitoring net photosynthesis. Several flavanoids and derivatives of coumarin, cinnamic acid, and benzoic acid were tested using concentrations near the growth-inhibition threshold. The results showed the allelochemicals generally reduced photosynthesis. The threshold for inhibition of photosynthesis (per frond basis) was different for the several compounds tested. For example, photosynthetic rate was reduced to 50-75% of controls by 1.0 mM umbelliferone, 0.25 mM ferulic acid, and 0.1 mM salicylic acid. Photosynthesis of L. minor was typically below the controls in allelochemical treatments that reduced growth even though no visible injury may have been present.

TANNINS: A NEW ROLE?

W.S. Goldstein and J.M. Horn, U. California, Irvine, Irvine, CA 92717

Leaves of Sierra Willow, Salix orestra, C.K. Schneid, contain both the phenolglycoside salicin and tannins. The Sierra Willow is subject to herbivory by the Chrysomelid beetle Chrysomela aenicollis, which has been shown to sequester salicin for production of the defensive compound salicylaldehyde via a β-glucosidase. It has been shown that tannins can inhibit β-glucosidase mediated hydrolysis of cyanogenic glycosides (Goldstein and Spencer, 1985). Data demonstrating tannin interference with the β-glucosidase mediated hydrolysis of salicin will be presented. Results of insect feeding experiments will also be presented. Implications of tannin interference with plant defenses as well as with insect metabolism of sequestered plant compounds used in insect defense will be considered.

QUANTITATIVE VARIATION IN A WILLOW LEAF PHENOL GLYCOSIDE

Jonathan M. Horn and John T. Smiley. University of California, Irvine, CA and White Mountain Research Station, Bishop, CA.

In the Eastern Sierra Nevada clones of the willows Salix orestra C. K. Schneid. and S. lasiolepus Benth. var. lasiolepus grow on an elevational gradient from 8000 to 12000 feet above sea level. Leaves were collected every 100 ft. along a transect, dried, and analyzed for salicin content by thin layer chromatography. Salicin concentration varied from less than 0.32% to 5% of dry weight. Variation within a clone was significantly less than between clones. Salicin concentration increased with elevation and seasonally. Between site variations in salicin content may be a function of physical factors such as light and nutrient availability. The implications of quantitative variation in salicin for willow herbivores will be discussed.

DEFENSIVE CHEMISTRY OF TRIBOLIUM SPP.

Ralph W. Howard, U.S. Grain Marketing Research Lab, Manhattan, KS 66502

The defensive secretions of several species of Tribolium were quantitatively analysed in preparation for biosynthetic studies. Some species were found to contain previously unreported aromatic ketones whose structures were elucidated. Double bond locations in the defensive gland alkenes were located by methoxymercuration-demercuration.

ALTERATION OF INSECT SUCCESS BY ENVIRONMENTALLY-INDUCED CHANGES IN HOST QUALITY: TWO EXAMPLES FROM SOYBEAN

P. R. Hughes, Boyce Thompson Institute, Ithaca, NY 14853

Variable host quality can strongly affect the success of phytophagous insects. Two examples of such interactions and the mechanisms involved have been studied on soybean. Exposure of plants to very low concentrations of the air pollutant sulfur dioxide causes changes that increase the success of Mexican bean beetles. The beetles develop more rapidly, grow larger and are more fecund when fed on affected foliage. Additionally, adult beetles show a strong preference for feeding on the exposed leaves. Pollutant-induced increase in foliar glutathione concentration has been identified as the probable cause of the observed effects. Another environmental factor, soil salinity, can produce change in the plant that results in greatly increased population growth of the two-spotted spider mite. The primary cause appears to be decreased generation time as a consequence of elevated leaf temperature on stressed plants.

PHENYLACETALDEHYDE: A POTENT MULTIORDINAL ATTRACTANT

Richard L. Lampman, Dept. of Entomology, University of Illinois, Urbana, Illinois 61801

Field evaluation of several plant related benzenoid compounds in corn plots, cucurbit plots and along forested tracts revealed phenylacetaldehyde (PAA) attracts insects from at least four orders; Diptera, Lepidoptera, Coleoptera and Hymenoptera. The chemical specificity of attraction was investigated by baiting Delta sticky traps and cylindrical sticky traps with chemicals structurally related to PAA. Although numerous species were attracted to PAA, they exhibited species-specific response patterns to the PAA-related compounds. This indicates several unrelated insects possess different olfactory perception patterns which are apparently optimized for PAA. Data is presented and discussed for Diabrotica undecimpunctata howardi, D. virgifera virgifera, Cisseps fulvicollis, Heliothis zea, Autographa precationis, Danaus plexippus and Apis mellifera. Three non-exclusive, ecological hypotheses are briefly presented to explain the wide range of insect attraction:

1. Specific host location (particularly corn pests)
2. General nectar-pollen source location (possibly for the majority of lepidopterans, dipterans and hymenopterans attracted to PAA)
3. Pheromonal response (possibly for several lepidopterans)

DO INDUCED PLANT DEFENSES CAUSE VOLE POPULATION CYCLES?

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Rhoades and Haukioja recently hypothesized that population cycles of voles are caused by the induction and relaxation of chemical defenses in their food plants in response to grazing. I tested this hypothesis with populations of prairie voles (cyclic) and meadow voles (noncyclic) in central Illinois. I monitored population dynamics, forage quality, detoxication indices, and individual performance of voles in both populations. Results indicated that grazing by prairie voles at high population densities induced production of phenolics in alfalfa and lowered the quality of forage, and that chemical defenses may have lowered overall population densities by influencing forage quality for both populations. However, population cycling was not caused by changes in the levels of these compounds.

MACROMOLECULES FROM MARINE SPONGES.

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Aqueous extracts of 48 sponge species from the Red Sea, the Australian Barrier Reef and the Florida Keys were screened for hemagglutinating, hemolytic, ichthyotoxic and lethal activities. 42 % of the sponge species exhibited agglutinating properties to human erythrocytes. Hemagglutinating factors (lectins) were isolated from four species (Haliclona sp., Cinachyra tenuifolia, Callyspongia viridis, Terpios zeteki) exhibiting molecular weights between 22,000 and 24,000. The lectins were partly inhibited by D-lactose, but not by D-melibiose or other oligosaccharides indicating that they may react with terminal D-galactose β 1$\rightarrow$4 residues. Hemolytic activity to human erythrocytes was present in about 15 % of the sponge extracts showing close relationship to ichthyotoxic activity. More than half of the sponge extracts caused toxic symptoms in mice when injected i.p. Using various concentrations death occurred within 12 to 48 hrs. The lethal factors seem to be related to components of low molecular weight in the sponge extracts.

PROTECTIVE RESPONSE OF ANIMALS INGESTING CONDENSED TANNINS. H. Mehansho, T. Asquith, J. Rogler, D. Carlson, and L. Butler, Departments of Biochemistry and Animal Sciences, Purdue University, West Lafayette, Indiana 47907.

Diets of high-tannin sorghum cause hypertrophy of parotid glands with induction of synthesis of a series of proline-rich proteins in rats and mice, but not in hamsters (Mehansho, et al., (1983) Proc. Natl. Acad. Sci. 80, 3948). These unusual salivary proteins have high affinities for tannins. Hamsters are much more sensitive to dietary tannin, probably because they fail to protect themselves by producing these tannin-binding salivary proteins. On diets containing 4% condensed tannin, rats complete this protective response within 3 days and show good survival and growth rates; on the same diet hamsters usually die within 3 days. Both animals grow rapidly on the same diet from which tannin is omitted. Condensed tannins of varying degrees of polymerization, as well as tannic acid, induce the protective response in mice; catechin and gallic acid, monomers of condensed tannins and tannic acid, respectively, do not cause the response. Addition of propranolol, a β-antagonist, to the high-tannin diet blocks the response by inhibiting transcription of the genes for the salivary proteins. (Supported by grants from NIH (AM19175), Purdue Cancer Center, and Intsormil).

BEHAVIORAL ADAPTATIONS OF CUCUMBER BEETLES AND CORN ROOTWORM BEETLES (Coleoptera: Diabroticina) TO CUCURBITACINS

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The cucurbitacins are oxygenated tetracyclic triterpenoids produced as secondary plant compounds by nearly all genera of Cucubitaceae. The very bitter and toxic cucurbitacins are extremely effective semiochemicals acting ecologically as allomones to protect the Cucurbitaceae from attack by a variety of invertebrate herbivores. For the Luperini (Coleoptera: Chrysomelidae) the cucurbitacins have become kairomones for host selection, affecting the behavior of this large group of 1500 species of Aulacophorina (old world) and Diabroticina (new world) by arrest and compulsive feeding. These beetles when feeding on bitter cucurbits sequester large amounts of cucurbitacins in blood and tissues and these act as allomones to deter predation.

The behavioral, physiological, biochemical, and evolutionary aspects of ecological associations with cucurbitacins as allomones and kairomones are explored and illustrated.

SYLVATICIN, A NEW INSECTICIDAL ACETOGENIN FROM ROLLINIA SYLVATICA ST. HILL. K. L. Mikolajczak and R. V. Madrigal, USDA-ARS, Northern Regional Research Center, 1815 N. University St., Peoria, IL 61604; and D. K. Reed, USDA-ARS, Fruit and Vegetable Insects Research Lab, P.O. Box 944, Vincennes, IN 47591.

Certain Annonaceae plants produce cytotoxic linear acetogenins which have been isolated from their roots. The structures of these compounds all include a bistetrahydrofuran moiety, a γ-lactone ring, and various patterns of substitution involving hydroxyl, ketone, and acetate groups. A new member of this series has now been isolated from dried fruit of Rollinia sylvatica St. Hill. (Annonaceae) and has been shown to possess potent insecticidal activity against the striped cucumber beetle, Acalymma vittata (F.) (Coleoptera: Chrysomelidae).

THE ROLE OF INTRACELLULAR SYMBIOTES IN THE DEVELOPMENT OF PLANTHOPPERS

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Since planthoppers can be reared on an artificial diet devoid of steroids, it was hypothesized that the sterol requirements of these insects could be supplied by their intracellular yeast-like symbiotes.
A comparative study of steroids from a series of planthoppers, the dietary plants, and the cultured symbiotes(isolated from the insects' eggs) revealed that symbiotes provide ergosterol, which could be transformed by their hosts into cholesterol via 24-methylene-cholesterol and also into ecdysteroids, essential factors for growth and development of insects. In our studies, the planthoppers examined were Nilaparvata lugens (Japanese and Indonesian) and Laodelphax striatellus.

HOST AND PREY SELECTION BEHAVIOR OF ENTOMOPHAGOUS INSECTS -- THE ROLE OF SEMIOCHEMICALS

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The host and prey selection behavior of entomophagous insects is a complex series of behaviors involving the location of a suitable habitat in which to search, location of hosts or prey within that habitat, and acceptance or rejection of potential hosts or prey that are located. Semiochemicals from plants, host or prey, and other entomophages mediate this behavior. The various roles that semiochemicals play in the host and prey selection behavior of entomophagous insects will be reviewed.

CHEMICAL BASIS OF NESTMATE RECOGNITION IN Solenopsis invicta Buren (HYMENOPTERA:FORMICIDAE): ALTERATION OF RECOGNITION CUES BY LABORATORY REARING.

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Laboratory-reared S. invicta workers were tested for the ability to discriminate nestmates from non-nestmates. Aggressive response to workers from local field colonies was significantly greater than the response to lab-reared workers, even when the latter were selected from colonies collected hundreds of miles away. Observations indicate that a contact cue(s) mediates at least part of the behavioral response to non-nestmates. Gas liquid chromatography and multivariate statistical techniques were employed to test the hypothesis that recognition cues are provided by worker cuticle hydrocarbons.

RECENT ADVANCES IN THE CHEMISTRY OF ADULT CHRYSOMELINE DEFENSIVE SECRETIONS.

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The elytral and pronotal glands of adult Chrysomelinae produce a remarkable diversity of compounds whose specific distribution only partially match current taxonomical classifications. All studied species of the subtribes Chrysomelina (10 species belonging to 6 genera) and Phyllodectina (3 Phratora spp) secrete a mixture of isoxazolin-5-one glucosides and lipids, mainly hydrocarbons. Most Chrysolina species (genera Chrysolina and Oreina) secrete cardenolides. Among others, sarmentogenin, periplogenin and bipindogenin, free and in various combinations with pentose sugars have been identified. The aglycones are not sequestered from the host-plants and preleminary incorporation experiments with labelled compound strongly suggest that cholesterol can be used as a precursor in their biosynthesis. A notable exception is Chrysolina hyperici, which produces polyoxygenated steroid glucosides. Additionaly, ethanolamine is a major compound of the secretion of both C. hyperici and the cardenolide-producing species. The Colorado bettle, Leptinotarsa decemlineata (substribe Doryphorina) secretes a γ-glutamyl dipeptide containing a new non-protein amino-acid. The defensive role of these secretions will be discussed.

INTERACTION OF PLANT CHEMICAL AND PHYSICAL STIMULI IN INSECT HOST FINDING AND ACCEPTANCE BEHAVIOR.

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Over the past two decades, our understanding of the chemical ecology of insects has expanded greatly. In contrast, our knowledge of insect physical ecology has progressed to a lesser degree. Poorer still is our comprehension of the interaction between the chemical and the physical ecology of insects. Here, I will focus on (a) some behavioral adaptations of cabbage root flies and apple maggot flies to interacting chemical and visual stimuli that are used in resource location, and (b) the role in apple maggot flies and Mediterranean fruit flies that prior experience with interacting resource chemical and physical stimuli plays in future resource acceptance behavior. The results point clearly to a consideration of the total sensory ecology of an insect if we are to gain insight into factors that have shaped behavioral adaptations of insects to resource cues.

CHEMICAL AND PHYSICAL FACTORS AFFECTING OVIPOSITION BY THE COWPEA WEEVIL, Callosobruchus maculatus (Coleoptera: Bruchidae).

J.A.A. Renwick and Frank J. Messina, Boyce Thompson Inst., Ithaca NY 14853.

Cowpea weevils oviposit on pods and seeds of several legumes. A preference for smooth seed surfaces and green pods has been found, but chemical factors also affect discrimination. Ovipositing beetles distribute their eggs evenly on available seeds, and egg recognition involves both chemical and physical stimuli. The chemical marker associated with eggs has been separated from more general deterrents that result from other activities of males as well as females.

FLORAL ODORS AND PATTERNS OF VISITATION BY SCARABAEIDAE:DYNASTINAE IN A COSTA RICAN TROPICAL WET FOREST

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Floral odors play an important role in the structuring of a complex assemblage of 50-55 plant species in four different families (Annonaceae, Araceae, Arecaceae, and Cyclanthaceae), and the 16 species of dynastine scarabs (in the genera Cyclocephala, Erioscelis, and Mimeoma) that pollinate them. A survey of floral odors reveals both unique and shared compounds, present in a highly variable array of combinations and complexity. Overall similarity or dissimilarity in odor spectra correlates with the patterns of visitation observed, partially explaining the extent of specificity or overlap displayed by the scarab pollinators. Other parameters, including phenology of flowering time and adult beetle emergence, and the vertical stratification within the forest, also contribute to the overall structure of the community. The high diversity of the system can be partly attributed to the subdivision of the community into numerous narrow, but nevertheless, overlapping niches.

THE CARDENOLIDE CONNECTION BETWEEN OVERWINTERING MONARCH BUTTERFLIES FROM MEXICO AND THEIR LARVAL FOODPLANT, *Asclepias syriaca*.

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Monarch butterflies sampled from overwintering sites in Mexico contain the same epoxy cardenolide glycosides, including most conspicuously a novel polar glycoside with a single genin-sugar bridge, as occur in the milkweeds *Asclepias speciosa* and *A. syriaca*. This cardenolide commonality, when combined with the migratory pattern of monarchs and the distribution of these two milkweed species, indicates that *A. syriaca* is the major larval foodplant of the fall generation of monarchs in the eastern North American population. *A. syriaca* contributes less cardenolide and cardenolides of lower emetic potency to monarchs than most *Asclepias* species studied to date. Historical increases in the distribution and abundance of *A. syriaca*, together with its low toxicity cardenolides, may explain how birds and mice are able to eat extensive numbers of monarchs at the overwintering sites.

ECOLOGICAL EFFECTS OF SALICIN AT THREE TROPHIC LEVELS

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Salicin, a toxic phenol glycoside, is used by larvae of the beetle Chrysomela aenicollis as a substrate for producing defensive secretions. In the East-central Sierra Nevada mountains of California, dry weight concentrations ranged from 0.05 to over 5% dry weight in leaves different plants of Salix orestera, the Sierra Willow. We found that beetles produced more secretion and suffered less predation on willows containing more salicin. In addition, percent herbivore damage among 16 willow clones ranged from 0 to 20% leaf area, and was strongly positively correlated to salicin content ($r=0.81$). These results illustrate how a plant secondary chemical can become a problem for the plant when herbivores are adapted to use the chemical for their own benefit. The results also illustrate the direct effect of a plant chemical on three trophic levels, the producer, an herbivore, and the predators of the herbivore.

Pheromone-allomone mediated behavior in the Acari: adaptations for finding hosts and mates

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Ticks and mites respond to a limited spectrum of stimuli in their search for hosts and mates. Airborne chemical signals include carbon dioxide, ammonia, organic acids, terpenoids, 2,6-dichlorophenol, and other phenolic compounds. These are detected primarily by sensilla in and adjacent to Haller's organ. Most ixodid species examined have one or more multiporose sensilla that detect such volatiles. Other sensilla, probably mechano-gustatory in function, also occur on the tarsi. Collectively, these tarsal sensilla enable the ticks to respond to remote volatile chemicals from hosts and from other ticks, e.g., sex pheromones. Gustatory sensilla, on the palps, detect assembly pheromones that enable ticks and mites to respond to conspecific or heterospecific chemical stimuli in their environment. Responses to those stimuli in ticks results in clustering, i.e. arrestant behavior. Arrestant behavior also occurs in certain mites. Finally, cheliceral chemosensilla enable ticks to recognize specific phagostimulants in host blood, e.g., ATP and glutathione, that stimulate feeding. In Dermacentor variabilis and D. andersoni, these same cheliceral chemosensilla recognize species specific genital sex pheromones in the vulvas of conspecific mates, without which they do not copulate.

RETENTION OF SEED INSECTICIDAL NONPROTEIN S-AMINO ACIDS BY YOUNG LEAVES OF CALLIANDRA TAPIRORUM.

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The insecticidal nonprotein amino acid S-(β-carboxyethyl)-cysteine is the major free amino acid in the seeds of several Calliandra spp. Lessor amounts of other related S-containing amino acids and an array of nonprotein imino acids derived from pipecolic acid are other constituents. High concentrations of imino acids, which also show some insecticidal activity, are maintained in the mature leaves, but sulfur compounds are lacking. In this study the disappearance of the sulfur compounds from the germinating seeds and young seedlings of C. tapirorum was monitored over time. After ten weeks, S-(β-carboxyethyl)-cysteine continues to be found in high concentrations in the new leaves. As young leaves mature the S compounds quickly decrease in concentration and an accompanying rapid increase in concentration of imino acids occurs. Traces of S-containing amino acids are found in new leaves of seedlings up to nine months after germination. The ecological implications of these findings will be discussed.

HYDROCARBON COMPONENTS OF THE SEX PHEROMONE OF Macrocentrus grandii (Hymenoptera:Braconidae). A SERIES OF 9, 13 DIENES. Paul D. Swedenborg and Richard L. Jones, Dept. of Ent., Univ. of Minn., St. Paul, Mn 55108

Sex pheromones have proven useful as monitoring tools for insects. The objective of this study was to identify sex pheromone components of Macrocentrus grandii, a gregarious larval parasitoid of the European corn borer, Ostrinia nubilalis (Hubner) (Lepidoptera:Pyralidae). Preliminary studies indicated that female parasitoids emitted pheromones that elicited upwind anemotaxis, wing fanning and copulatory movements in males. Three florosil fracations, hexane and 5 & 7.5% ether in hexane, from column chromatography of virgin female extracts were active in laboratory wind tunnel bioassays. Active components from the hexane fraction were isolated via HPLC and GLC. Chemical identifications were derived from infrared and mass spectroscopy, ozonolysis of dienes to aldehydes and molecular sieve entrapment. The primary sex pheromone of M. grandii was found to include a series of straight chain Z,Z-9,13 dienes. The major active components were 27,29,31, and 33 carbons in length. The dienes were active individually. In laboratory bioassays they initiated flight and caused upwind anemotaxis by males and elicited wing fanning and mating attempts between males at the pheromone source. Synthesized dienes were active in the laboratory and the field. Identification of the 5 & 7.5% florosil fractions is in progress.

BEHAVIOR OF Heliothis virescens (F.) IN THE PRESENCE OF OVIPOSITION DETERRENTS EXTRACTED FROM ELDERBERRY

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Extracts prepared from elderberry leaves, Sambucus simpsonii Rehd, with acetone, dichloromethane, distilled water, ethanol, hexane, or methanol, deterred oviposition by Heliothis virescens (F.) on treated substrates in the laboratory. These extracts were not toxic to the moths, and they did not affect mating or reduce the number of landings on treated surfaces, although the duration of each visit was longer on the untreated surfaces. Doses as low as 62.5 and 125 mg of leaves/5 ml of solvent were effective. When the antennae, proboscis, or the metathoracic legs were removed from female moths, significant reductions in oviposition on paper towels were not attained in the laboratory with the elderberry leaf/water extract, but in the field cage, moths without these appendages deposited significantly fewer eggs on treated tobacco leaves, a preferred host.

FIRE ANT TRAIL PHEROMONE SPECIES SPECIFICITY: A CHEMICAL EXPLANATION.
Robert K. Vander Meer,[1] Francisco Alvarez,[2] and Clifford S. Lofgren,[1]
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Solenopsis invicta and S. richteri (Hymenoptera: Formicidae) have been reported to follow each other's trail pheromone. We report the separation of the trail pheromone response into the sub-categories of recruitment, orientation priming, and orientation. Isolation of the trail pheromone chemical components responsible for each behavioral sub-category provided an explanation of previous reports of non-species specific behavior and illustrates one behavioral sub-category where species specificity occurs.

A COMPARISON OF METABOLIC COSTS OF PROCESSING DIETS OF HIGH AND LOW WATER CONTENT

H.M. Van't Hof, U. Michigan, Ann Arbor, MI 48109

Direct measures of metabolic costs of processing diets of 82% and 65% water were made for an herb feeder, Manduca sexta. The shift of larvae from a diet of 82% water to one with 65% water resulted in equal consumption rates but a 9% increase in post-consumption respiratory rates. This rise in respiratory rate could not account for the dramatic decrease in ECD from 82% to 32% on the low water diet. Examination of the water budget of the larvae indicates that the primary effect of a low water diet is nutrient limitation and not respiratory cost. These results are compared with those from larvae which feed on drier, tree foliage.

CHEMICAL SYMBIOSIS BETWEEN AN INSECT PARASITOID AND ITS HOST AT THE MOLECULAR LEVEL

S. B. Vinson, M. D. Summers, G. W. Blissard, D. A. Theilmann and J. G. W. Fleming

The parasitoid Campoletis sonorensis injects a virus into it's host that enters host cells. Once the virus enters the cell, the virus produces messenger RNA which directs the production of novel proteins in host cells that appear important to the developing progeny of the parasitoid.

SOURCES OF VARIABILITY IN MAIZE WEEVIL PHEROMONE RESPONSE.

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Maize weevils that were 1 wk old or younger were attracted to synthetic pheromone, (R*S*)-5-hydroxy-4-methyl-3-heptanone, whereas it significantly repelled 8- to 10-wk-olds. Response by 10-wk-old weevils could not be restored by 48-hr starvation, nor by the addition of 3-pentanone, a trace component of crude extracts, although some attraction to 3-pentanone by itself was observed. One- to 2-day-old weevils showed some attraction to 3-pentanone alone, and its addition to the pheromone elicited a greater response by both sexes than the response to either compound alone. One- to 2-day-old weevils responded to synthetic pheromone over a 1000-fold range of doses, and a trend toward better response under higher density conditions was observed. Weevils held on cracked wheat generally required a higher dose to achieve a significant response than did those held on whole wheat. Starvation for as little as 3 hrs significantly increased responsiveness to pheromone. The pheromone likely plays a role in signalling desirable food sources and initiating feeding aggregations; weevils held on wheat that is cracked to make feeding easier, do not respond to pheromone, presumably because it would offer them no advantage. Starved insects, on the other hand, must search for food, and responding to pheromone odor should ultimately lead them to a food source.

EFFECT OF HABITAT ON ORIENTATION BEHAVIOUR TO PHEROMONE SOURCES

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Field experiments[1] have shown that males of the pea moth, *Cydia nigricana* (F.), respond to pheromone traps placed in a wheat crop by flying up the mean wind direction, not directly towards the traps. This is in contrast to insects flying over open ground where the dispersal of pheromone is not affected by the vegetation[2]. The important effects of habitat on pheromone dispersal and, therefore, insect behaviour will be discussed.

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