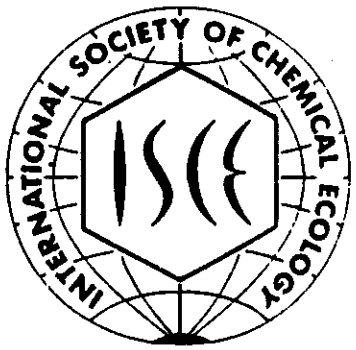
8th Annual Meeting

International Society of Chemical Ecology

Dijon, France
July, 2 - 7, 1991

* Programme Schedule
* Detailed Programme
* Abstracts: Oral Communications
* Abstracts: Posters
* List of Participants
* Acknowledgements



FRIDAY, 5 :

SEMIOCHEMICALS IN VERTEBRATES — CRDP

Moderator : E.S. Albone

14:00 - 14:40	*J.P. SIGNORET* (France)
14:40 - 14:55	*B.Å. TØMMRÅS* (Norway)
14:55 - 15:10	*P. STEULLET* (Switzerland)
15:10 - 15:25	*S. CORK* (Australia)
15:25 - 15:40	*M.E. ALONSO* (Venezuela)
15:40 - 15:55	*J.I. GLENDINNING* (USA)
15:55 - 16:25	**COFFEE BREAK**

EVOLUTIONARY PERSPECTIVES ON SEMIOCHEMICALS IN INSECTS

Moderator : K. Dettner

16:25 - 17:05	*S. TAKAHASHI* (Japan)
17:05 - 17:45	*J.P. FARINE* (France)
17:45 - 18:00	*E. BAUTISTA* (France)
19:00	**BANQUET**

SATURDAY, 6 :

EVOLUTIONARY PERSPECTIVES ON SEMIOCHEMICALS IN INSECTS — CRDP

Moderator : Ch. Noirot

8:30 - 9:10	*M. BOPPRÉ* (Germany)
9:10 - 9:25	*R. NISHIDA* (Japan)
9:25 - 9:40	*M. HILKER* (Germany)
9:40 - 9:55	*D. DALOZE* (Belgium)
9:55 - 10:10	*A.B. ATTYGALLE* (USA)
10:10 - 10:25	*K. DETTNER* (Germany)
10:25 - 10:55	**COFFEE BREAK**

Moderator : D.L. Wood

10:55 - 11:35	*J.L. CLÉMENT* (France)
11:35 - 11:50	*A.G. BAGNÈRES* (France)
11:50 - 12:30	*J.M. JALLON* (France)
12:30 - 14:00	**LUNCH** — Restaurant

SATURDAY, 6 :

PLANT INSECT INTERACTIONS - EVOLUTIONARY PERSPECTIVES ON SEMIOCHEMICALS IN INSECTS

Moderator : R. Nishida

14:00 - 14:40	*C. LÖFSTEDT* (Sweden)
14:40 - 15:20	*W. BOLAND* (Germany)
15:20 - 15:35	*M. FRENZEL* (Germany)
15:35 - 15:50	*S.B. MALCOLM* (UK)
15:50 - 16:05	*D. JONES* (USA)
16:05 - 16:20	*P. ESCOUBAS* (Japan)
16:20 - 16:35	*R. RAMACHANDRAN* (USA)
16:35 - 16:55	**COFFEE BREAK**

Moderator : A.B. Attygalle

16:55 - 17:10	*J.L. LE QUÉRÉ* (France)
17:10 - 17:25	*J. ZHU* (Sweden)
17:25 - 17:40	*J.A. PICKETT* (UK)
17:40 - 17:55	*C. BORDEREAU* (France)

Moderator : J.N. McNEIL

17:55 - 18:10	*F. SCHLYTER* (Sweden)
18:10 - 18:25	*E. DUNKELBLUM* (Israel)
18:25 - 18:35	*D. THIERY* (France)
18:35 - 18:50	*G. POPPY* (UK)
18:50 - 19:00	*B. GABEL*(France)
19:00 - 20:00	**DINNER** — Restaurant
20:00 - 21:00	**POSTER SESSION** — CRDP

SUNDAY, 7 :

EVOLUTIONARY PERSPECTIVES ON SEMIOCHEMICALS IN INSECTS — CRDP

Moderator : C. Everaerts

8:30 - 8:45	*A. BLACKWELL* (UK)
8:45 - 9:00	*H. LJUNBERG* (Sweden)
9:00 - 9:15	*B.S. HANSSON* (Sweden)
9:15 - 9:30	*J.O. SCHMIDT* (USA)

Moderator : M.S. Silverstein

9:30 - 9:45	*J. TROUILLER* (France)
9:45 - 10:00	*P. VALEUR* (Sweden)
10:00 - 10:15	*C. BOLTER* (Canada)
10:15 - 10:30	*A. DEJEAN* (Cameroun)

ORAL COMMUNICATIONS

WEDNESDAY, 3 :

PLANT INSECT INTERACTIONS
Mini-symposium organised by M.S. Blum :
"The Roles of Allelochemicals on Insect-Plant Interactions"
Moderator: J.M. PASTEELS

8.40-9.20 *M.S. BLUM,* The Sequestrative Versatility of a Generalist Enduring Monophagy.

9.20-9.35 *D.WHITMAN* Green leaf volatiles : tritrophic chemical ecology.

9.35-9.50 *F.P. HAIN & COOK S.P.,* Monoterpenes in Conifer-Bark Beetle Systems.

9.50-10.05 *M. BARNBY & KLOCKE J.,* Systemic Translocation of Insect Growth Inhibition following Soil Drenches with Azadirachtin and Neem Seed Extracts.

Moderator: T. HARTMANN

10.40-11.20 *S.S. DUFFEY,* Plant Oxidative Processes as Multicomponent Defences Against Herbivorous Insects.

11.20-11.35 *L.M. MOTA-BRAVO & RODRIGUEZ E.,* Divergent Defence Strategies Among Coexisting *Salix* Species.

11.35-11.50 *D.M. NORRIS & NEUPANE F.P.,* Alpha-Tocopherol Alteration of *Trichoplusia ni* Herbivory in *Glycine max.*

11.50-12.05 *J. MIZUTANI,* Plant Ecochemicals and Their Roles in Plant-Insect Interactions.

12.05-12.20 *H.M. KIRK,* Chemical protection of eggs against cannibalism in the chrysomelid beetle, *Gastrophysa viridula.*

12.20-12.35 *J.A.A. RENWICK, RADKE C.D. & SACHDEV-GUPTA K.,* Plant surface chemicals mediating oviposition by the cabbage butterfly, *Pieris rapae.*

THE ODOUR OF FLOWERS - PLANT INSECT INTERACTIONS
Moderator: G. BERGSTRÖM

14.00-14.40 *D. JOULAIN,* The odour of flowers.

15.30-15.20 *G. BERGSTRÖM,* Pollimones...

15.20-15.35 *H.E.M. DOBSON,* Effect of pollen odors on flower visitation by bees.

EVOLUTIONARY PERSPECTIVES ON SEMIOCHEMICALS IN INSECTS

Moderator: J.G. MILLAR

15.45-16.00 *P.R. WHITE & POPPY G.M.*, Evolution of male "pheromones" in moths for reproductive isolation : testing the hypothesis.

16.00-16.15 *J.N. MacNEIL & ER-NING Han*, Genetics of calling behaviour in the true armyworm, *Pseudaletia unipuncta.*

16.15-16.30 *S. SCHULZ, TOFT S.*, Identification of a sexual pheromone of *Linyphia* spiders.

SEMIOCHEMICALS IN VERTEBRATES

Moderator: J.J. LEPRI

17.00-17.40 ***E.S. ALBONE*** *& NATYNCZUK S.E.*, Chemical Images and Chemical Information.

17.40-18.20 ***P.M. KAPPELER,*** Chemica Signals and Lemur Behavior.

18.20-18.35 *D. JOULAIN & LAURENT R.*, The catty odour in black-currant extracts versus the black-currant odour in cat's urine.

18.35-18.50 *C. EVANS* Contact olfaction in the ring-tailed lemur.

18.50-19.05 *C. ARNOULD & SIGNORET J.P.*, Investigations on repellents in Ungulates.

THURSDAY, 4 :

PLANT INSECT INTERACTIONS

Mini-symposium organised by J.M. Pasteels :
"Use, Non-Use and Misuse of Plants Secondary Compounds by the Second and Third Trophic Levels"
Moderator: D. THIERY

8.30-9.10 ***J.M. PASTEELS,*** *ROWELL-RAHIER M. & DALOZE D.*, Use and non -use of plant toxins for defence in leaf beetles.

9.10-9.25 ***T. HARTMANN,*** Physiology of Pyrrolizidine Alkaloids in Plants and Insects.

9.25-9.40 ***B. SPEISER*** *& ROWELL-RAHIER M.*, Effects of alkaloids, food availability and nutritional value on food choice in the generalist herbivorous snail *Arianta arbustorum.*

9.40-9.55 ***J.C. GRÉGOIRE,*** *BAISIER M., COUILLIEN D., DRUMONT A., MEYER H. & FRANCKE W.*, Semantic drifts in chemical signals through three trophic levels in conifer forests. An example from the *Picea excelsa/Dendroctonus micans/Rhizophagus grandis* system.

9.55-10.10 ***M. DICKE,*** *TAKABAYASHI J. & POSTHUMUS M.A.*, Induction of indirect defence of plants : recruitment of bodyguards.

SEMIOCHEMICALS IN VERTEBRATES
Moderator: J.P. SIGNORET

10.40-11.20 *D. MULLER -SCHWARZE,* Mammalian pheromones : New Results on the Chemical Composition and Behavioral Role of the Castoreum of Beaver (*Castor canadensis*).

11.20-12.00 *F. ROZENFELD,* Olfactory assessing in rodents.

12.00-12.15 *J.J. LEPRI, STRITTMATTER C.E. & GARDNER R.R.,* The Development and Function of the Vomeronasal System in Prairie Voles : A Model for Reproductive Coodination.

12.15-12.30 *E. VERNET-MAURY & BROUETTE-LAHLOU I.,* The regulating factor from pup's preputial glands secretion as a cyberomone.

FRIDAY, 5 :

PERSPECTIVES ON OLFACTION
Moderator: M.H. PHAM DELEGUE

8.30-9.10 *G.R. BEAUCHAMP,* Genetic Determination of Olfactory Individuality.

9.10-9.50 *G.D. PRESTWICH,* Molecular Studies of Pheromone Perception and Transduction.

SEMIOCHEMICALS IN VERTEBRATES
Moderator: E.S. ALBONE

14.00-14.40 *J.P. SIGNORET,* The effect of sexual pheromones and socio-sexual interactions on reproductive physiology of the domestic sheep.

14.40-14.55 *B.Å. TØMMRÅS, WIBE A. & NILSSEN A.,* The olfactory system of the reindeer parasite, the nose bot fly *Cephenemyia trompe*, is sensitive to components both from reindeer interdigital pheromone gland and host urine.

14.55-15.10 *P. STEULLET & GUERIN P.,* Perception of vertebrate breath components by the tropical bont tick *Amblyomma variegatum.*

15.10-15.25 *S. CORK & BRAITHWAITE L.W.,* Resource-availability, plant chemical defense, and the utilization of *Eucalyptus* by folivorous marsupials.

15.25-15.40 *M.E. ALONSO, PEREZ-MENA M. & CALCAGNO M.P.,* Quantitative determination and Dynamics of Ptaquiloside, the main carcinogen of *Pteridium aquilinum var. caudatum*, in a population of the tropical Andes.

15.40-15.55 *J.I. GLENDINNING,* Ingestive responses of five congeneric species of mouse to diets laced with cardiac glycosides that differ in toxicity.

EVOLUTIONARY PERSPECTIVES ON SEMIOCHEMICALS IN INSECTS

Moderator: K. DETTNER

16.25-17.05 *S. TAKAHASHI, FUKUI M. & TAKEGAWA H.*, A comparative Study of Semiochemicals in the Blattaria.

17.05-17.45 *J.P. FARINE*, Sexual behavior and semiochemicals in cockroaches: an evolutionary approach.

17.45-18.00 *E. BAUTISTA , R. JULLIEN, MORENO E., BIEMONT J.C. & POUZAT J.*, Cuticular Lipids from the Coffee Weevil, *Araecerus fasciculatus* : Important specificities.

SATURDAY, 6 :

EVOLUTIONARY PERSPECTIVES ON SEMIOCHEMICALS IN INSECTS

Moderator: Ch. NOIROT

8.30-9.10 *M. BOPPRÉ & VANE-WRIGHT R.I.*, Some chemoecological aspects of mimicry in Lepidoptera.

9.10 - 9.25 *R. NISHIDA, C.S. KIM & H. FUKAMI*, Novel Association of a Danaine Butterfly, *Idea leuconoe*, with Non-Pyrrolizidine Aromatic Substances.

9.25-9.40 *M. HILKER*, Anthraquinones in different developmental stages of *Galeruca tanaceti* and other galerucinae (Coleoptera, Chrysomelidae).

9.40-9.55 *D. DALOZE, MERLIN P., BREAKMAN J.C., PASTEELS J.M. & DEJEAN C.*, New C_{26} δ-lactones from the Dufour's gland of the ant *Tetramorium aculeatum*.

9.55-10.10 *A.B. ATTYGALLE, MEINWALD J. & EISNER T.*, Defensive chemistry of some carabid beetles.

10.10-10.25 *K. DETTNER & BERAN H.*, Are defensive glands of herbivorous *Gonioctena*- leaf beetle larvae also excretory organs ?

Moderator: D.L. WOOD

10.55-11.35 *J.L. CLÉMENT*, The chemical signature in social insects : role, identification, production and regulation.

11.35-11.50 *A.G. BAGNÈRES, CLEMENT J.L., BLUM M. & LANGE C.*, Intracolonial polymorphism of cuticular hydrocarbons in Termites of the genus *Reticulitermes* : a possible role in caste differenciation ?

11.50-12.30 *J.M. JALLON, FERVEUR J.F., PENNANEC'H M., ARIENTI M. & VENARD R.*, The melanogaster subgroup pheromonal system.

PLANT INSECT INTERACTIONS
EVOLUTIONARY PERSPECTIVES ON SEMIOCHEMICALS IN INSECTS

Moderator: R. NISHIDA

14.00-14.40 *C. LÖFSTEDT,* Species specificity and population variation in moth sex pheromones.

14.40-15.20 *W. BOLAND,* From Flowers, Leaves and Spider Mites ; Biosynthesis of Homoterpenes.

15.20- 15.35 *M. FRENZEL, DETTNER K. & BOLAND W.,* Attractancy of cantharidin and few analogues to the ceratopogonid midge *Atrichopogon oedemerarum* (Diptera, Ceratopogonidae).

15.35-15.50 *S.B. MALCOLM,* Cardenolides and molecular parsimony of plant chemical defences.

15.50-16.05 *D. JONES & S. ZONA,* Chemical defence by cyanogenesis : cyanogenesis in some Florida plants.

16.05-16.20 *P. ESCOUBAS , FUKUSHI K., LAJIDE L. & MIZUTANI J.,* A novel bioessay for rapid isolation of insect antifeedant compounds.

16.20-16.35 *R. RAMACHANDRAN & NORRIS D.M.,* Volatiles mediating plant-herbivore-natural enemy interactions.

Moderator: A.B. ATTYGALE

16.55-17.10 *J.L. LE QUÉRÉ, BROSSUT R.,* Identification and stereochemistry of 4,6,8-trimethyl-7,9-undecadien-5-ol, a female specific compound of the woodroach *Cryptocercus punctulatus.*

17.10-17.25 *J. ZHU, LJUNGBERG H., HANSSON B.S., RYRHOLM N. & LÖFSTEDT C.,* Chemical identification and electrophysiological analysis of sex pheromone components of two geometrid moths *Idaea straminata.*

17.25-17.40 *J.A. PICKETT, CAMPBELL C.A.M., DAWSON G.W., HARDIE J., NOTTINGHAM S., PETTERSON J., POWELL W., WADHAMS L.J. & WOODCOCK C.M.,* New evidence for the importance of volatile semiochemicals in aphid ecology.

17.40-17.55 *C. BORDEREAU, ROBERT A., BONNARD O. & LE QUERE J.L.,* Dispersal flights and sex pheromones in two species of fungus-growing termites, *Pseudacanthotermes spiniger* and *P. militaris.*

Moderator: J.N. McNEIL

17.55-18.10 *F. SCHLYTER, BYERS J., BIRGERSSON G., FRANCKE W. & BAKKE A.,* The pheromone of *Ips duplicatus* ; interacting with the competitor *I. typographus.*

18.10-18.25 *E. DUNKELBLUM & MAZOR M.,* Sex pheromone components of *Cornutiplusia circumflexa* ; the role of Z7-12:OH in the pheromone complex of Plusiinae moths.

18.25-18.35 *B. GABEL, THIERY, D., SUCHY V., MARION-POLL F., HRADSKY P. & FARKAS P.,* Tansy semiochemicals detected by females of *Lobesia botrana* Den. et Schiff. (Lepidoptera, Tortricidae).

18.35-18.50 *G. POPPY & BIRCH M.*, The function of hair-pencil in *Mamestra brassicae* - the difference between an "inbred" and a "wild" strain.

18.50-19.00 *D.THIERY & GABEL B.*, Biological evidence of an oviposition-deterring pheromone in *Lobesia botrana* Den. et Schiff. (Lepidoptera, Tortricidae).

SUNDAY, 7 :

EVOLUTIONARY PERSPECTIVES ON SEMIOCHEMICALS IN INSECTS

Moderator: C. EVERAERTS

8.30-8.45 *A. BLACKWELL, MORDUE A.J., WADHAMS L.J. & MORDUE W.*, Olfactory sensilla of biting midges of the genus *Culicoides*.

8.45-9.00 *H. LJUNBERG, HANSSON B.S., HALLBERG E. & LÖFSTEDT C.*, Cobalt filling of physiologically identified pheromone receptor neurons in the male turnip moth *Agrotis segetum* (Lepidoptera : Noctuidae).

9.00-9.15 *B.S. HANSSON, VAN DER PERS N.C., HÖGBERG H.E., HEDENSTRÖM E., ANDERBRANT O. & LÖFQVIST J.*, Sex pheromone perception in male pine sawflies, *Neodiprion sertifer* (Hymenoptera ; Diprionidae).

9.15-9.30 *J.O. SCHMIDT*, Pheromonal Mediation of Nest Site Location by Honey Bees.

Moderator: M.S. SILVERSTEIN

9.30-9.45 *J. TROUILLER, ARNOLD G., LE CONTE Y., CHAPPE B. & MASSON C.*, Secretion of capping pheromones as a function of age in the honey-bee larvae.

9.45-10.00 *P. VALEUR & LÖFSTEDT C.*, Behaviour of male *Grapholita molesta* in overlapping pheromone plumes in a wind tunnel.

10.00-10.15 *C. BOLTER, LAZAROVITS G. & COHEN R.*, Relationship between glutathione concentration and resistance to *Fusarium* wilt in melons and tomatoes.

10.15-10.30 *A. DEJEAN, NONEGUBU P. & DJUIKWO F.*, Dominant and non-dominant arboreal ants of African rain forest : Comparison of alimentary behaviour.

POSTERS:

ABED Dehbia
Université de Bourgogne
DIJON, France

Composition of The tergal and cercal protenaceous secretion of *Blatta orientalis*.

ANAYA-LANG A.L. et al.
Universidad Autonoma
MEXICO, Mexique

Phenylacetic acid as a main phytotoxic compound of corn pollen.

ANDERSON P. & LOFQVIST J.
Lund University
LUND, Sweden

Ovipositional deterrents from larval frass and artificial diet in the turnip moth, *Agrotis segetum* (Lepidoptera : Noctuidae).

AUGER J. et al.
URA CNRS 1298
TOURS, France

HPLC analysis in *Allium* leaves of sulfur amino-acids partly responsible of *Acrolepiopsis assectella* oviposition.

BELLEROSE Sylvie et al.
Université de Montréal
MONTREAL, Canada

Effects of Azadirachtin on the biology of the Oblique-banded leafroller, *Choristoneura rosaceana* Harris (Lepidoptera : Tortricidae).

BENGTSSON M. & LILJEFORS T.
Lund University
LUND, Sweden

Semiochemical release from filter paper sources in electrophysiological activity measurements.

BILLER Andreas et al.
Technischen Universität
BRAUNSCHWEIG, Germany

Sequestration and Partial Biosynthesis of Pyrrolizidine Alkaloids by the Arctiid Moth *Tyria jacobaeae* L.

BILLER A. & HARTMAN Th.
Technischen Universität
BRAUNSCHWEIG, Germany

Are Pyrrolizidine Alkaloids Toxic for Insects ?

BOLTER Caroline et al.
Agriculture Canada
LONDON, Canada

Relationship between glutathione concentration and resistance to *Fusarium* wilt in melons and tomatoes.

BONAVITA-COUGOURDAN A. et al.
CNRS-LBN8
MARSEILLE, France

Comparison of cuticular hydrocarbons in slave and slave making ants : *Formica rufibarbis* and *Polyergus rufescens*.

BONAVITA-COUGOURDAN A. et al.
CNRS-LBN8
MARSEILLE, France

Polyethism and cuticular hydrocarbons in *Polistes gallicus*.

BROSSUT Rémy et al.
Université de Bourgogne
DIJON, France

Periplanone, the female sex pheromone of *Periplaneta americana:* but where does it come from?

BROWN Keith S. Jr et al.
Univ Estadual de Campinas
CAMPINAS, Brazil

Chemical ecology of larval hostplants of neotropical swallowtails.

BURKHOLDER W.E. et al. University of Wisconsin MADISON, USA	Food Odor Attrractants and Pheromone Synergists for Stored-Product Coleoptera.
CAMPS Francisco et al. CID-CSIC BARCELONA, Spain	Synthesis of potential biosynthetic inhibitors of the sex pheromone of the Egyptian armyworm *Spodoptera littoralis*.
CARDOSO M.Z. & BROWN K.S. Jr Univ Estadual de Campinas CAMPINAS, Brazil	Chemical defence, warning coloration and learning in the system pyrrolizidine alkaloids - vertebrate predator.
CARLSON David A. USDA-ARS GAINESVILLE, USA	Human produced kairomones for Mosquitoes.
CLEMENT Jean-Luc et al. CNRS-LBN8 MARSEILLE, France	Chemosystematics in Leptothoracine ants.
DALOZE Désiré et al. Université de Bruxelles BRUXELLES, Belgique	The chemical defence of Doryphorina beetles (Coleoptera : Chrysomelidae).
DEJEAN A. et al. Faculté de Sciences YAOUNDE, Cameroun	Sub-presocial and social insects : an evolutionary approach.
EIRAS Alvaro E. University of Southampton SOUTHAMPTON, U.K.	Bhavioural responses of *Aedes aegypti* (L.) (Diptera : Culicidae) to human odour stimuli.
EVERAERTS Claude et al. Université de Bourgogne DIJON, France	*Microcerotermes - Megaxenus* relationships: chemical resemblances and differences between the termitophile and its host.
FILIATRE Jean-Claude Université de Franche-Comté BESANCON, France	Olfactory exploration mechanisms of the dog in relation to human.
GONZALEZ-COLOMA A. et al. Universidad de La Laguna TENERIFE, Canary Islands Spain	Seasonal variations in diterpene content of *Persea indica*. Within and between populations considerations.
HARMATHA Juraj et al. Czechoslovak Academy PRAGUE, Czechoslovakia	Antifeeding and synergistic effect of lignans with insecticides towards insect pests.
HOBSON Kenneth et al. University of California BERKELEY, USA	Stereospecific Attraction of the Red Turpentine Beetle *Dendroctonus valens* Leconte to Host Volatiles of Ponderosa Pine *Pinus ponderosa* Lawson.

KLITZKE C.F. & BROWN K.S. Univ Estadual de Campinas CAMPINAS, Brazil	Chemical aspects of neotropical troidini/*Aristolochia* relationships.
LEGAL Luc et al. BGE-CNRS BURES-sur-YVETTE, France	Cuticular hydrocarbons and sexual stimulation in the species *D. mercatorm.*
MAUSER J. & PESCHKE K. Institut für Biologie I FREIBURG, Germany	Cuticular hydrocarbon patterns of the tenebrionid beetle genus blaps as a chemotaxonomical tool.
MILLAR Jocelyn et al. University of California RIVERSIDE, USA	Identification of the sex pheromone of the hessian Fly, *Mayetiola destructor* (Say).
MILLAR Jocelyn et al. University of California RIVERSIDE, USA	Sex attractants and sex pheromone components of the noctuid moths *Euclidea cuspidea, Caenurgina distincta*, and the geometrid moth *Eupithecia annulata.*
MORGAN David E. et al. University of Keele KEELE, U.K.	The chemical nature and origin of the abdominal substance of the social wasp *Liostenogaster flavolineata.*
MULLER E. & NAHRSTEDT A. Westf. Wilhelms-Universität MÜNSTER, Germany	Do Ca++ and Mg++ ions regulate the activity of the β-glucosidase involved in the cyanogenic system of the larvae of *Zygaena trifolii* (Insecta : Lepidoptera) ?
NAYA Yoko et al. Suntory Institute Bio Res OSAKA, Japan	A key sterol produced by intracellular symbiotes in planthoppers.
NISHIDA R. & FUKAMI H. Kyoto University KYOTO, Japan	Oviposition stimulant of a Zerynthiine Swallowtail Butterfly, *Luehdorfia japonica.*
NDIEGE Isaiah O. et al. Int Ctr Insect Physiol Ecol NAIROBI, Kenya	Host Location and Aggregation Mechanisms in the Banana Weevil (*Cosmopolites Sordisus*) : a preliminary study.
ORDONEZ-GIRALDO A.I. & FARINE J.P. Université de Bourgogne DIJON, France	Sexual behavior and chemical signals in *Eurycotis floridana* walker (Dictyoptera, Polyzosterinae).
PENNANEC'H Maryse et al. BGE-CNRS BURES-sur-YVETTE, France	Biosynthetic studies of contact pheromones of *Drosophila melanogaster* and related species.
PHAM-DELEGUE M.H. et al. INRA-CNRS URA 1190 BURES-sur-YVETTE, France	Study of honeybees-rapeseed interactions : behavioral and chemical approaches.

PHO Dang Ba Lab Biol et Gén. évolutives GIF-sur-YVETTE, France	Antennal proteins in *Drosophila melanogaster.*
REGNAULT-ROGER C. & HAMRAOUI A. IBEAS/LBPI PAU, France	Effects on ten mediterranean botanicals as protectants of Kindney Bean (*Phaseolus vulgaris* L.) against the pulse borer Acanthoscelides obtectus Say.
ROCHAT Didier et al. INRA, Domaine Brouessy MAGNY-les-HAMEAUX, France	New aggregation pheromone in a Curculionidae species : *Rhynchophorus palmarum.*
SCHAAL Benoît et al. Lab de Psychobiologie PARIS, France	First data on nasal chemoreception in the fetal sheep.
SIRUGUE Daniel et al. Université de Bourgogne DIJON, France	Identification of the male sex pheromone of the cockroach *Leucopaea maderae* F.
SMITH Tessa Institute of Zoology LONDON, U.K.	The importance of non-volatile components in the circumgenital scent secretion of the common marmoset (*Callithrix jacchus jacchus*).
SOETENS Philippe Université Libre de Bruxelles BRUXELLES, Belgique	Host plant sultability of willows and poplars for two Salicaceae specialists : *Phratora vitellinae* and *Ph. tibialis* (Coleoptera : Chrysomelidae).
SOLTANI Noureddine Université de Annaba ANNABA, Algérie	Ecological study on codling moth in Annaba (Algeria) : efficiency of traps, fluctuation of population and infestation of quince varieties.
SRENG Leam CNRS-LBN8 MARSEILLE, France	Male sex pheromone and calling or aggressive posture in the cockroach *Nauphoeta cinerea.*
STERMITZ Frank R. et al. Colorado State University FORT COLLINS, USA	Alkaloids of Spruce (*Picea*) Species.
SVENSSON M. & LOFQVIST J. Lund University LUND, Sweden	The attraction width of a three-component pheromone biend for the turip moth *Agrotis segetum* (Lepidoptera : Noctuidae).
TRIGO J.R. et al. Technischen Universität BRAUNSCHWEIG, Germany	Pyrrolizidine Alkaloids (PAs) in the Primitive Ithomiinae (Lep.: Nymp.) and Chemical Defense Against the Spider *Nephila clavipes* (Araneidae).
VAN DAM Nicole M. State Univ of Leiden LEIDEN, Netherlands	Inducible chemical defence in *Cynoglosum officinale* L. and *Senecio jacobaea* L.

VAN DIJK Marinke J.
State Univ of Leiden
LEIDEN, Netherlands

Factors explaining within plant distribution of eggs and larval survival of *Liriomyza trifoloo* (Diptera) on the cut chrysanthemum (Dendranthema grandiflora).

VIEUILLE-THOMAS C. & SIGNORET J.P.
INRA/CNRS URA 1291
NOUZILLY, France

Social spatio-temporal transmission of an aversive experience in the domestic pig.

VRIELING K. & VAN DER MEIJDEN E.
State Univ of Leiden
LEIDEN, Netherlands

Genetic variation in chemical defence in ragwort.

VRKOC Jan et al.
Czechoslovak Academy
PRAGUE, Czechoslovakia

Sex Pheromone Components of the Synanthedon Species and their Analogs : Synthesis and Biological Tests.

WALRAVEN V. et al.
University of Lund
LUND, Sweden

Scent marking behaviour in Golden-headed Lion Tamarins (*Leontopithecus chrysomelas*) (Primates, Callitridae) in captivity.

WENQI Wu et al.
University of Antwerpen
WIRIJK, Belgium

The Behavioural and Electrophysical Response of Turnip Moth Males *Agrotis segetum* to Fluorinated Pheromone Analogues.

WOOD D.L. et al.
University of California
BERKELEY, USA

Aggregation behavior of the pine engraver beetle, *Ips pini* (Say) in response to enantiomerically pure ipsdienol.

ZAGATTI P. et al.
INRA, Domaine Brouessy
MAGNY-les-HAMEAUX, France

Semiochemicals emitted by pine weevils, *Hylobius abietis*, feeding on Scots pine.

ABSTRACTS:

Oral communications

Blum, Murray S. The Sequestrative Versatility of a Generalist Enduring Monophagy. Department of Entomology, University of Georgia, Athens, Georgia 30602 USA

The extreme generalist Romalea guttata is an ideal paradigm for studying the systematic processing of allelochemicals by a herbivore. This acridid has eminently catholic tastes as a polyphage, and as a consequence ingests a potpourri of natural products that must be effectively processed, so as to avoid their toxicities. In addition, this aposematic grasshopper possesses paired defensive glands in the metathoracic spiracles which produce a characteristic defensive exudate that exhibits considerable quantitative variation between individuals. Significantly, this pronounced generalist can be transformed facilely into a true specialist by presenting adults with only a single species of host plant which, in effect, converts these acridids into monophages. This artificial monophagy can result in the selective sequestration of a host of natural products – and their metabolites – in the metathoracic defensive glands. The biochemical and physiological strategies utilized by R. guttata will be analyzed in terms of the interplay of excretion, metabolism, and selective sequestration, following ingestion of allelochemicals spanning a wide range of chemical classes.

Whitman, Douglas. **Green leaf volatiles: tritrophic chemical ecology.** Department of Biology, Illinois State University, Normal, IL 61761, USA.

Plants, herbivores, and members of the 3rd trophic level are interconnected by complex and subtle semiochemical relationships that are yet to be fully understood. Caterpillars feeding on green leaves cause the release of green leaf volatiles (GLVs) (six-carbon alcohols, aldehydes and derivative esters), and different plant-caterpillar combinations produce different GLV blends. Parasitoid wasps use these odors to orient to their caterpillar prey. The parasitoids possess highly refined and innate propensities to respond to these odors at extremely low concentrations. Different parasitoid species respond to different blends, enhancing habitat segregation. Innate parasitoid responses are tempered by experience: Not only can wasps be sensitized by contact with host cues, but they can learn to respond to certain GLVs via classical Pavlovian conditioning. These multilayered processes provide wasps with flexibility to meet the challenges of their variable and unpredictable habitat.

Hain, Fred P. and Stephen P. Cook.
Monoterpenes in Conifer-Bark Beetle Systems. North Carolina State University, Raleigh, NC 27695-7626 USA

Monoterpenes are a primary and volatile component of the oleoresin of conifers. They play an important role in a tree's ability to resist bark beetle attack. Ironically, monoterpenes are frequently an important component of a bark beetle's pheromone system. The duel role of monoterpenes as both a component of host resistance and bark beetle attraction is discussed for a number of conifer-bark beetle systems.

Barnby, Mark, James Klocke.* Systemic Translocation of Insect Growth Inhibition following Soil Drenches with Azadirachtin and Neem Seed Extracts. ISK - Mountain View Research Center, 1195 W. Fremont Avenue, Sunnyvale, California 94087, USA.

Azadirachtin, a liminoid isolated from the neem tree Azadirachta indica A. Juss., deters insect feeding via sensory detection and behavioral avoidance, and by a toxic effect unrelated to sensory detection. Azadirachtin also disrupts molting hormone titers, in part, by an interruption in the neuroendocrine cascade of molting hormone synthesis. In this case, azadirachtin may be acting as a molting hormone agonist / antagonist.

The toxic effects of azadirachtin are translocated systemically to foliage feeding insects following soil drenches with pure azadirachtin and with neem seed extracts containing azadirachtin. Our greenhouse studies examining the efficacy of soil drenches on tomato, potato, and sorghum suggest that growth inhibition, more than antifeedancy, provides plant protection. Translocation of biological activity into the phloem is also suggested by population reductions of the phloem-feeding aphid Shizaphis graminum on Sorghum bicolor. Antifeedants with multiple actions, such as azadirachtin, have the potential to provide significant plant protection.

*** Deceased.**

Duffey, Sean. **Plant Oxidative Processes as Multicomponent Defences Against Herbivorous Insects.** Department of Entomology, College of Agricultural and Environmental Sciences, University of California, Davis, California 95616, U.S. A.

The tomato plant Lycopersicon esculentum contains a variety of constitutive and inducible chemicals that, in concert, have the potential to severely impair the growth of larval insects (the tomato fruitworm Heliothis zea and the beet armyworm Spodoptera exigua). The mechanism of impairment of growth resides in the ability of these constitutive and inducible defences to destroy essential nutrients. Upon mastication of foliage by the insects, oxidative enzymes (e.g., polyphenol oxidase, peroxidase, lipoxygenase) are released from the damaged cells; these enzymes rapidly oxidize a variety of substrates (e.g., phenolics and lipids) to potent alkylating agents which subsequently chemically destroy essential nutrients (essential amino acids, lipids, and vitamin C). Hence, plant defence arises from an array of enzyme-driven oxidative processes that severely degrade the nutritive quality of the foliage. The complicating impact of coingested plant proteinase inhibitors and ascorbic acid oxidase upon this antinutritive defence is discussed in terms of the insects' metabolism of sulphur amino acids and glutathione, and subsequent potential to maintain reducing power for detoxicative metabolism. The role of midgut pH in overcoming these oxidative plant defences is discussed. Finally, It is demonstrated that the above plant oxidative defences are differentially inducible by different herbivorous arthropods. The implication of this differential inducibility on competition between herbivores is discussed.

Mota-Bravo, Luis M. and Eloy Rodriguez. Divergent Defense Strategies Among Coexisting Salix Species. Dept. of Ecology and Evolutionary Biology. University of California, Irvine. Irvine CA 92717. USA.

Several studies on plant-herbivore interactions have suggested that closely related species of plants may escape from predators in evolutionary time by producing divergent defenses. While qualitative differences in defense investment poses significant problems to assess defense allocation, quantitative measurement of specific defenses allow direct comparisons. In order to test the hypothesis that closely related species of plants may evolve contrasting defense strategies, we compare the degree of defense allocation in four coexisting species of Salix in the field. Sampling design included temporal and interindividual variation as well as damage made by herbivores and pathogens. A principal component analysis of five defenses analyzed showed two discrete clusters formed by two species; the other two species overlapped. This indicates that the Salix species studied had a distinct defense profile. However, none of the species was free of damage by either herbivores or pathogens. Each species showed a dominant damage by either chewing insects, pathogen fungus, rosette galls or stem galls. Results from this study show that 1) contrasting defense strategies may evolve in closely related species of plants and 2) that dominant damage between closely related species of plants may be caused by unrelated groups of organisms.

ALPHA-TOCOPHEROL ALTERATION OF TRICHOPLUSIA NI HERBIVORY IN GLYCINE MAX

Dale M. Norris and Fanindra P. Neupane, University of Wisconsin, Madison, WI 53706, U.S.A.

The antioxidant vitamin E, ∝-tocopherol, was tested through an application to the T3 leaf as a candidate elicitor of alterable anti-herbivory in soybean (Glycine max) plants against cabbage looper (Trichoplusia ni). Although a non-specific antioxidant, vitamin E proved elicitory to the involved sulfhydryl-dependent redox receptor-energy transducer protein in soybean plasma membrane. The observed elicited effects were systemic, and were all decreases in herbivory. The best detected phytochemical correlate with the bioassayed looper feeding was a negative regression (r=0.937) of the percentage of increased total resolved HPLC peak area of extractables from elicited as compared to non-elicited leaves. The overall results support the total resolved chemical profile as the evolved chemical basis for the observed anti-herbivory; thus, the leaves from elicited plants bear a "chemical fingerprint" which characterizes the observed anti-herbivory.

MIZUTANI, Junya

Department of Agricultural Chemistry, Hokkaido University, Sapporo 060, Japan.
Plant Ecochemicals Project, Research Development Corporation of Japan (JRDC), Eniwa-shi, Hokkaido 061-13, Japan.

Plant Ecochemicals and Their Roles in Plant-Insect Interactions.

Green plants produce hundreds of thousands of compounds that are not involved in primary metabolism. The specific functions of these so-called secondary metabolites are still largely unknown.
We have been interested in those metabolites which are produced by higher plants that may play important roles in complex interactions among living organisms in the natural environment. In this symposium some examples will be shown, and the roles of plant ecochemicals will be discussed from the viewpoints of plant-insect or plant-nematode interactions.
Silkworm larvae may use chlorogenic acid taken from mulberry leaves as an antibacterial substance after its transformation into caffeoquinone *via* caffeic acid against their pathogenic bacteria.
It is necessary to develop new appropriate bioassay in order to elucidate the role of an ecochemical in plant-insect/nematode interactions. In our project we have been developing new bioassay techniques. Some recent results will be shown.

Kirk Helen Margaret. **Chemical protection of eggs against cannibalism in the chrysomelid beetle, *Gastrophysa viridula*.** Laboratoire de Biologie Animale et Cellulaire. Université Libre de Bruxelles. Av. F.D. Roosevelt 50. B-1050 Bruxelles. Belgique.

The larvae of *Gastrophysa viridula* eat viable eggs from within their own and other clutches. Although within-clutch cannibalism is of limited extent, larvae proved to eat many more eggs when experimentally given an unlimited supply. This suggests that the interest of cannibalism in this species lies not so much in its extent as in the degree to which it is restricted.

Larvae feeding on young eggs and leaves gain fitness benefits in terms of developmental rate and survival compared with larvae feeding only on leaves. If it is advantageous to eat conspecifics, natural selection may have favoured mechanisms to avoid the loss of females' inclusive fitness through such predation. An observed limited extent of cannibalism would then be the result, even though the potential for intra-specific predation may superficially have seemed much greater.

Isoxazolinone glucosides, previously thought to have evolved in relation to interspecific predation, may play a part in protecting eggs against predation from within their own species. The susceptibility of eggs to cannibalism decreases with their age. Correspondingly, the more toxic dinitropropionate isoxazolinone glucosides are found to be increasingly prevalent in older eggs. This result suggests the possible implication of these substances in the defence of eggs against cannibalism.

Renwick, J.A.A., Celia D. Radke and Kusum Sachdev-Gupta. **Plant surface chemicals mediating oviposition by the cabbage butterfly, *Pieris rapae*.** **Boyce Thompson Institute, Ithaca, NY 14853. USA.**

Host-plant recognition and non-host rejection by ovipositing cabbage butterflies depends on contact reception of chemical stimuli at the leaf surface. Oviposition stimulants from cabbage and other hosts, as well as deterrents from a non-host crucifer, *Erysimum cheiranthoides*, have now been identified. The most active stimulants are aromatic glucosinolates, and the deterrents are specific cardenolides. The structural requirements for activity of both groups of glycosides have been at least partially determined.

Pure compounds are now being used to test how the balance of positive and negative cues might affect an insect's acceptance of a plant. However, leaf surface washes indicate that chemicals within the leaves may not be equally available to the insect tarsal receptors at the leaf surface. This may be due to differential movement to the surface or different degrees of binding to the leaf cuticle.

Joulain Daniel. The odour of flowers. Research Laboratories, Robertet S.A., B.P. 100, F-06333 Grasse Cedex, France.

During a recent period, extensive research has been carried out on the odorants from flowers. On the one hand, this work has been motivated by the need to acquire an in-depth knowledge of the phenomena that regulate the relationship between some plants and insects, either pollinators or predators. On the other hand, it has been found particulary useful for the perfume industry to identify those substances that account for the pleasant odour of certain flowers.
Many flower species are still processed as raw materials in the perfume industry. However, one can observe frequently that the odour of the industrial extracts or essential oils from these flowers are not always true replicas of those from the living flowers.
The author reviews the analytical methodologies that have been developed during the past few years for the isolation and the identification of odoriferous substances from flowers, with emphasis on the use of "hyphenated" spectroscopic techniques such as GC/MS and GC/FTIR.
Based on his own experience, the author presents original results on the chemical composition of the fragrant emissions from many flowers, either local (European) or tropical : *Philadelphus coronarius* (seringat), *Sambucus nigra* (elder), *Polianthes tuberosa* (tuberose), *Osmanthus fragrans*, *Jasminum grandiflorum*, *J. officinale*, *J. sambac*, *Gardenia jasminoides*, *G. tahitensis*, etc.. Some of the constituents identified had never been previously reported in these flowers, neither in the extracts nor even in the headspaces ; some constituents may even be considered as new in the plant world. The identification of certain substances brings to light new stepping-stones for illustrating biogenetic or metabolic pathways between these compounds and their precursors.

FLAMENT Ivon. **CHRONO-CHROMATOGRAPHY, A THREE-DIMENSIONAL ANALYSIS OF THE VOLATILE CONSTITUENTS OF "LIVING" ODORS AND FLAVORS.** FIRMENICH SA, Scientific Research Division, P.O. Box 239, CH - 1211 Geneva 8 (Switzerland)

Important technological progress has been realised during the past decade and today it has become possible to isolate, separate and identify the volatile components of a flower or fruit without provoking the least degradation of the living matter. Whereas the technique is, in principle, simple, it becomes very sophisticated and much more complicated in practice: in fact, it is a matter of combining requirements such as efficiency, reproducibility and sensitivity in each of the following operations: sampling, injection, separation, detection and identification. Up to now, in the field of natural products, the analyst must solve an equation with two unknowns: which are the aromatic components present in the perfume or aroma and in what proportions are they present? Now it is possible for him to add to these quantitative notions a chronological dimension: when do they appear, how do they evolve, when do they disappear? New perspectives open up: how to measure the circadian rhythms of plants, to control the ripening of a fruit, or follow the decomposition of a perishable foodstuff. Headspace analysis, in contrast to the classical analysis of natural extracts or essential oils, is effected on a living specimen. Instead of undertaking an autopsy or something which is irreversibly inanimate one effects a sort of olfactive echography which may be repeated at will and without damage, from the formation right up the death of a fruit or flower. This possibility opens up perspectives to perfumers and flavourists because if offers them the opportunity, as in a film, to select, image by image, the optimum profile of their subject.

BERGSTRÖM, Gunnar. **Pollimones...**
University of Göteborg, Reutersgatan 2C, S - 41320

Flowering plants use volatile compounds to attract and excite pollinators. These substances may be called "pollimones" for short. Sometimes they signal the availlability of nectar; in other cases the olfactory substances are deceptive: they mimic food signals or chemical signals from the pollinators themselves.

The study of pollination attractants/excitants should throw some light over the adaptations between flowering plants and their pollinators. By chemical and biological analyses of flower volatiles, we want to identify the chemical substances involved, and to find out which compounds are the behaviourally active ones. The ultimate goal of these studies is to contribute to the understanding of the co-evolution between flowering plants and their pollinators.

We have analysed the volatile compounds given off by several species belonging to seven major plant families. The chemistry will be described, and some of the biological phenomena involved will be discussed.

Dobson, Heidi E.M. Effect of pollen odors on flower visitation by bees. Ecological Research Station of Uppsala University, Ölands Skogsby 6280, S-386 00 Färjestaden and Department of Chemical Ecology, University of Göteborg, Reutersgatan 2 C, S-413 20 Göteborg, Sweden.

Chemical studies of floral volatiles indicate that in some plant species the pollen has an odor that is chemically distinct from that of other flower parts. This suggests that pollen volatiles may be used as cues by flower-visiting insects searching for pollen.
Experimental behavioral studies were undertaken to evaluate whether pollen odor influences flower choice by bees. In one pollen-specialist solitary bee species, *Chelostoma florisomne* (Megachilidae), pollen volatiles were found to provide key stimuli that allowed the bees to recognize their host-flower species, *Ranunculus* spp. (Ranunculaceae). In the case of bumble bees foraging on flowers of *Rosa rugosa* (Rosaceae), which produce no nectar and offer only pollen as food reward, various experimental manipulations of pollen volatiles in the flowers had a significant effect on which flowers the bees visited; in particular, the presence of certain pollen volatiles increased the frequency of landings on the flowers and thus seemed to aid the bees in determining prior to alighting whether or not pollen was available. Results point to the olfactory stimuli from pollen as playing an important role in the flower selection of bees and provide evidence that pollen odor can allow bees to discriminate both between flower species as well as between individual flowers having differing amounts of pollen reward within a species.

White, Peter R. and Guy M. Poppy.
Evolution of male "pheromones" in moths for reproductive isolation: testing the hypothesis.
Department of Zoology, South Parks Rd., Oxford, U.K.

Many insects rely on chemical communication using pheromones to coordinate such behaviours as mate location and courtship. Amongst moths, whilst the role of female sex pheromones in mate location is well established, the evolution of many diverse structures to release male scent has remained an enigma. The distribution of such structures among species has been used to suggest that the male scents evolved as an adaptive response to the need for reproductive isolation, but no account has been taken of the chemicals present in the scents. By comparing the scent similarity of male noctuid moths of different degrees of relatedness and host plant overlap it was possible to show that male scents reflect moth phylogeny and also support this reproductive isolation hypothesis. It is suggested that male scents and their structures have evolved repeatedly to prevent mating mistakes during speciation events, whilst subsequently the scents may become redundant or take on a new function.

McNeil, Jeremy N. and Er-ning Han. Genetics of calling behaviour in the true armyworm, Pseudaletia unipuncta. Université Laval, Departement de biologie, Ste-Foy, P.Q., G1K 7P4, Canada.

There is considerable inter-individual variability in the age at which Pseudaletia unipuncta virgin females initiate calling for the first time following emergence at 20°C, 16L:8D. Research was therefore undertaken to obtain a better understanding of the genetics controlling this variability. Early and late calling lines were established within three generations of strong selection and the results of subsequent mating experiments with these lines indicate a strong paternal component. The calling behaviour of females from early and late isofemale lines was examined under a range of temperatures (15-25°C) and a significant gene-environment interaction was observed. The results of these experiments will be discussed within the context of the seasonal biology of this migrant species.

Schulz, Stefan[1], Søren Toft[2].

Identification of a sexual pheromone of *Linyphia* spiders.

[1]Institut für Organische Chemie, Universität Hamburg, Martin-Luther-King-Platz 6, W-2000 Hamburg 13, F. R. G.; [2]Institut for Zoologi og Zoofysiologi, Zoologisk Laboratorium, Universitetsparken, Bygning 135, DK-8000 Århus C, Danmark

Wandering males of several species of *Lyniphia* spiders (Araneae: Linyphidae) show a striking web reduction behavior before courtship when encountering a web of an unmated female, even when the female is absent. This behavior is not performed in a web of an already mated female. As has been shown in the literature, the male thus inhibits further evaporation of the sexual pheromone of the female. The male do not show this behavior in webs of unmated females which were washed with dichloromethane or methanol, or in webs of unmated females of a different species. In a web of a mated female sprayed with a dichloromethane extract of a web of an unmated female the typical web reduction behavior was performed by the male. The pheromone present in the dichloromethane extract could be identified using GC/MS and chiral GC. Synthetic samples were positively tested in a laboratory bioassay and found to be identical in several species. Species specificity may be introduced by the lipids, which are present in relatively large amounts as compared to other spider species. Different species show species specific patterns of branched and unbranched hydrocarbons and methyl alkyl ethers, which are previously unknown natural products and may be specific for spiders.

Albone, Eric S, Stephan E Natynczuk. Chemical Images and Chemical Information. Clifton College, Bristol BS8 3JH, UK.

In making semiochemical sense of mammalian scents, powerful analytical procedures are employed which are capable of generating large amounts of chemical information. The question which dominates mammalian semiochemistry is how this analytical chemical information relates to the biological message.

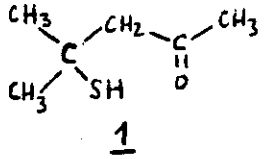
In this paper we examine approaches to this issue drawn from our own work on wild rats and on hares, and from the work of other investigators.

Kappeler, Peter M. **Chemical Signals and Lemur Behavior.** Department of Zoology and Primate Center, Duke University, Durham, NC 27706, USA.

Lemurs, as other prosimian primates, use chemical signals from several sources to communicate with their conspecifics. It is unknown, however, which factors influence signalling behavior and how signal transmission is accomplished in group-living species. To address these questions, I investigated the use of chemical signals in a large group of semi-free ranging ring-tailed lemurs (*Lemur catta*). Several aspects of olfactory behavior were recorded over a three year period. Significant positive correlations between male social status and marking frequencies were found, but no correlation existed between female rank and female marking frequency. There was no significant sex difference in marking frequencies, but adult males engaged in significantly more tail-marking than subadult males. Marking with the antebrachial gland was the most frequently observed form of male scent deposition (71%; n=392), followed by tail- (18.9%), and anogenital-marking (10.2%). Sixty-nine percent of both male and female scent marks were investigated olfactorily and/or overmarked by conspecifics within 10 minutes after their deposition. Fourty-five percent of all responses occurred within the first minute of marking. Female anogenital marks were most attractive: on average, they received more responses and within shorter latency than either male marks. The sex of the scent donor and the responding individuals were not independent; both males and females showed disproportionately fewer responses to male than female scents. During one annual cycle, both signalling and investigation rates peaked just prior to the short annual breeding season. In conclusion, chemical signals are transmitted with high effectiveness within groups and may primarily serve to mediate reproductive synchronization and competition.

Joulain Daniel, Raymond Laurent. **The catty odour in black-currant extracts versus the black-currant odour in cat's urine ?.** Research Laboratories, Robertet S.A., B.P. 100, F-06333 Grasse Cedex, France.

With a view to explaining the origin of the frequently used association between the "catty" odour and the black-currant aroma, an in-depth investigation has been carried out in order to identify the volatile compounds that are responsible for the unpleasant but characteristic odour from the urine of cat *Felis catus*. Surprisingly, 4-mercapto-4-methylbutan-2-one *1*, already well-known for its powerful black-currant characteristic odour at high dilution, has been identified for the first time in traces in a tomcat's aged urine. However, the constituent mainly accounting for the strong odour from urine, has been found to be 4-mercapto-3-methylbutan-1-ol *2* (R^1=R^2=H, n=1). A number of di- and trisulfides *2* (R^4=H, R^2=CH_3, n=*2* or *3*) and *3* (R^4=Hn=*2* or *3*) have also been identified, together with several sulfur- and nitrogen-containing minor elements. Spectroscopic and synthetic studies have been carried out in order to complete the identification of the new compounds.
The presence of 4-methoxy-2-methylbutan-2-thiol *2* (R^4=CH_3, R^2=H, n=1) previously identified in an extract from black-currant buds by Rigaud *et al.* (1985), has been further confirmed by us in berry and leaf extracts. An industrial black-currant bud absolute has been found to contain disulfide *3* (R^4=CH_3, n=2).
Hypotheses concerning the formation of the newly identified substances have been formulated.



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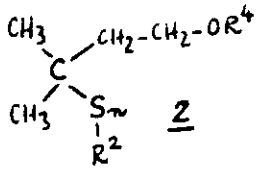

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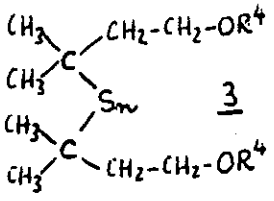

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EVANS CS : Contact Olfaction in the Ring-tailed Lemur . Biosciences, Glasgow Polytechnic, Ecosse G40BA, UK

Bioassay of genital scent-mark-constituents presented standardised quantities on sterile swabs in free-approach 2-choice trials .These produced a preference scale of :
Labial > Scrotal=Vaginal > Urine=Water for both sexes.
Bacterial populations detected in the skin-gland exudate overlapped in content but contained sex-specific species ;the samples yielded anaerobic & aerobic types .
Labial scent marks elicit prolonged close-range investigation & male overmarking for up to 10 days.Deposited scent does not convey estrous status to captive males. Proceptive behaviour by the female allows direct licking + Flehmen at the genital zone, suggesting an involvement of *accessory* olfaction. Replicate bioassay scores with labial secretion masked to prevent direct nose/tongue contact , support this contention : male|female discrimination was impaired & compensatory investigation induced.
Extracts of labial surface scrapes taken with acid-washed frosted glass provided further evidence of low- &/or non-volatile signal content in genital scent . Water extracts were (i) sonicated, spun & filtered ; (ii) distilled @ ambient & under vacuum. Both the bacteria-free supernatant from (i) and the residue from (ii) were taken up on sterile swabs or placed in glass wells sunk in test rods. These extracts retained between 50- 70% of the intact secretion's activity. Uptake of labial scent to Jacobson's Organ seems a likely mechanism for *male chemosignal analysis*. Further exploration of vomerolfaction is indicated .

INVESTIGATIONS ON REPELLENTS IN UNGULATES.

Cécile ARNOULD and J. P. SIGNORET
INRA/CNRS URA 1291 Comportement Animal F- 37380 NOUZILLY.

In a first experimental series, the effectiveness of repellents has been tested under laboratory conditions in the domestic sheep. Ovariectomized ewes were individually tested in a food choice situation to measure the repulsive effect of various odours: a synthetic mixture designed to reproduce the odour of lion's faeces, dog's faeces, and the odour of various products in decomposition. Repulsion was observed at first presentation in each case. After several tests, habituation rapidly took place. The only exception concerns the odour of dog's faeces that was the more efficient in food choice tests and remained active after repeated presentations.

Furthermore, the effect of this repellent was not overcome by social facilitation when control ewes were associated in group tests with anosmic females.

A first step of the study of volatile compounds of dog's faeces suggests the presence of some components (mostly fatty acids) acting as specific repellents.

The effect of dog's faeces as food repellent has been tested under field conditions in sheep and in cervidae (roe Deer and red Deer).

PASTEELS, Jacques M., ROWELL-RAHIER, Martine, DALOZE, Désiré.
Use and non-use of plant toxins for defence in leaf beetles. Lab. Biol. Anim. Cell., Université Libre de Bruxelles, 50 av. F.D. Roosevelt, B-1050, Bruxelles.

We review chemical defence in 4 subtribes of Chrysomelini. The adults of 7 genera (10 species) of Chrysomelina, 1 genus (3 species) of Phratorina, 2 genera (24 species) of Chrysomelini and 4 genera (8 species) of Doryphorina produce autogenous compounds, including isoxazolinone and nitropropanoic acid glucosides, cardenolids and polyoxygenated sterols, amino acid derivatives. Paradoxically, within the Doryphorina, *Labidomera divicollis* feeding on *Asclepias syriaca* synthesizes amino acid derivatives, whereas *Calligrapha* spp. feeding on *Cornus* and *Salix* synthesize cardenolides. Only 2 *Oxeina* species (Chrysolinina) derive PAs from host plant. It is concluded that the utilization of plant toxins is a rare, secondary evolutionary event in leaf beetles and that chemical defence appears more as a prerequisite for, than as a consequence of, specialization on toxic plants. Similar conclusions were already reached with the larvae of the Chrysomelina: most species produce *de novo* iridoid monoterpenes, whereas only a few derive salicylaldehyde or juglone from host plant precursors. Life cycle characteristics of leaf beetles are discussed in this context and compared to those of Lepidoptera in which sequestration could be the primitive status.

Hartmann, Thomas. **Physiology of Pyrrolizidine Alkaloids in Plants and Insects.** Institut für Pharmazeutische Biologie der Technischen Universität, D-3300 Braunschweig (Germany)

In a brief overview the role of pyrrolizidine alkaloids (PAs) as potential defensive compound of plants is discussed in relation to their physiological properties. The plant derived knowledge is applied to follow the fate of PAs in specialized PA-sequestering insects.
In *Senecio* ssp. (Asteraceae) PAs are synthesized in the roots, translocated into the shoots by phloem transport and finally are chanelled to the preferred sites of storage i.e. inflorescences, epidermal tissues. Within cells PAs are stored in the vacuoles. PAs are synthesized, translocated and stored as alkaloid N-oxides. In *Senecio* PAs do not show significant turnover or degradation but are slowly transformed into "secondary PAs" which constitute the species specific PA pattern. Thus plant PAs are dynamic in terms of transformation and translocation but stable in terms of turnover and degradation. The mechanisms involved in PA synthesis, transformation, translocation, and cellular storage are highly specific for PA-plants.
A number of specialized insects do not only sequester PAs from plants, but also use the same biochemical means to "handle" these compounds. Most of them store PAs exclusively as N-oxides and are able to N-oxidize tertiary PAs specifically. Arctiids (e.g. *Creatonotos and Tyria*) are even able to synthesize their own PAs. Thus the long known callimorphine and the recently identified creatonotines are formed by insect specific partial synthesis, i.e. a necine base (retronecine) derived from sequestered plant PAs is esterified with a necic acid formed by the insect from isoleucine.

Speiser, Bernhard and Rowell-Rahier, Martine. **Effects of alkaloids, food availability and nutritional value on food choice in the generalist herbivorous snail *Arianta arbustorum*.** Zoologisches Institut der Universität Basel, Rheinsprung 9, CH-4051 Basel, Switzerland.

Generalist herbivores, such as the snail *Arianta arbustorum* along with other herbivores, could provide a selection pressure on the plant *Adenostyles alliariae* (Asteraceae) favouring the production of pyrrolizidine alkaloids (PA). To test this hypothesis, the diet of *A. arbustorum* in the field was determined by examining microscopically the faeces of field-collected snails. The snails' diet is very broad and it includes arthropods, wilted flowers, fresh and decayed plant material, leaf litter, and soil. The most important food items were leaves of *Adenostyles alliariae, Rubus sp., Festuca altissima, Stachys silvatica* and leaf litter.

The proportion of *Adenostyles* in the snails' diet rises from 3% in April to over 60% in August, and the proportion of *Adenostyles* leaves suffering high herbivore damage rises from 1% in April to over 80% in September. At the same time, PA in *Adenostyles* leaves decrease from over 15000 ppm in April to 1500 ppm in September. This strongly suggests that *Adenostyles* is avoided by the snails when it contains high PA concentrations. This is also confirmed by preliminary results of laboratory tests in which snails were fed leaf discs treated with retrorsine N-oxide (another PA).

We also tested whether the snail consumption of the herbaceous plant species was related to their availibility per unit area in the field or their nutritional value (water and nitrogen content). Availability of the different food items is significantly correlated with the amounts eaten. Water and nitrogen content are correlated with each other, but not with the amounts of a plant eaten by the snails.

Grégoire[1] Jean-Claude, Marianne Baisier[1], Daniel Couillien[1], Alain Drumont[1], Holger Meyer[2] & Wittko Francke[2]. **Semantic drifts in chemical signals through three trophic levels in conifer forests. An example from the *Picea excelsa/Dendroctonus micans/Rhizophagus grandis* system.** [1]Laboratoire de Biologie animale et cellulaire CP 160, Université libre de Bruxelles, Belgium; [2]Institut für Organische Chemie, Universität Hamburg, Federal Republic of Germany.

Monoterpenes are important components of spruce defense against generalist herbivores. Many monoterpenes are lethal to primary bark beetle species such as *Ips typographus* L., which need to kill the trees before they can establish. Another primary species, *Dendroctonus micans* (Kug.), is tolerant to these toxins. It even uses them for producing larval aggregation pheromones which are probably responsible for larval survival in the live tissues of the host by allowing them to outrun the induced hypersensitive reaction of the tree. One level further, the specific predator, *Rhizophagus grandis* Gyll. is also tolerant to the tree defenses of which it takes full advantage: either pure or transformed by the prey, they are used as long- and short-range attractants and as oviposition stimuli for the adults, as attractants and as aggregation pheromones for the larvae.

Induction of indirect defense of plants: recruitment of bodyguards.

Marcel Dicke[1], Junji Takabayashi[2] & Maarten A. Posthumus[3]

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[3] Department of Organic Chemistry, Agricultural University, Dreijenplein 8, 6703 HB Wageningen, The Netherlands

Plants may defend themselves against herbivores by promoting effectiveness of natural enemies, which may include attracting natural enemies by synomones. This *indirect* defence may be induced upon herbivore damage. Induction may occur at the site of damage but synomones may also be produced in undamaged leaves of damaged plants or in detached uninfested leaves.
Behavioral observations show that the response of the natural enemies to the synomones is affected by the plant species, plant cultivar, herbivore species and natural enemy experience. Chemical data show that the composition of the volatile blends that attract natural enemies also differs between different plant-herbivore combinations.
We will present data for a tritrophic system consisting of predatory mites, spider mites and their host plants. The main topics will be (1) different aspects of induction of indirect defence, and (2) the effect of plant and herbivore on (a) the composition of the volatile blend emitted by plants and on (b) the response by natural enemies.

Muller-Schwarze, Dietland. Mammalian Pheromones: New Results on the Chemical Composition and Behavioral Role of the Castoreum of Beaver (Castor canadensis). College of Environmental Science and Forestry, State University of New York, Syracuse, New York 13210, U.S.A.

The beaver is one of the few mammalian species whose semiochemicals can be rigorously bioassayed by direct observation of freely moving animals of intact family units in their natural habitat. Beaver scent mark their territory by applying castoreum from their castor sacs to scent mounds built from mud. Recent and ongoing chemical and behavioral work will be reviewed. **Chemistry:** Castoreum is a complex mixture of phenolics, acids and neutral. Ten phenolic compounds are described as castoreum constituents for the first time. Castoreum samples vary widely in composition. Presence and relative amounts of neutrals vary more than phenols. Many constituents are known to occur in the beaver's diet. **Behavior:** The number of scent mounds per colony varies with beaver population density. Experimental castoreum marks discourage beaver from settling in a potential colony site. The level of response to whole castoreum and single compounds varies between beaver populations. Several single components release territorial responses, but mixtures are more active than single compounds. **Acknowledgments:** This review is based on work by biologists Robert G. Welsh, Peter Houlihan, and Bruce Schulte, and chemists Ron Tong, Dr. Francis X. Webster, and Dr. Robert M. Silverstein.

Rozenfeld, Francine. Olfactory assessing in rodents. Laboratoire de biologie animale et cellulaire. Université libre de Bruxelles. avenue Roosevelt 50 - B 1050 Bruxelles (Belgique).

Rodents are socially organized in various ways : solitary life, single-family female kin clusters, female kin clusters with male territoriality, polygynous harems with male dominance..., permanent or seasonal. The mechanisms that determine the pattern of territoriality, who has to emigrate and who can stay, and who ranks where in the hierarchy rely, at least partly, on aggression between the members of the population. The importance of body odours, scent marks and olfactory perception in the social integration of species is widely recognized. For many species, much of the available information is limited to the description of aggressive behaviour of two individuals confronted in a neutral arena, to the description of various scent glands and scent-marking activities and to experiments on odours discrimination in isolated individuals. Most discussions of the functional significance of this behaviour may be regarded as highly speculative.

Recent studies, however, on wild house mice (*Mus domesticus*) and to some extent on bank voles (*Clethrionomys glareolus*), attempted to investigate into olfactory communication through scent marking in a more social environment. A functional model of scent marking in Rodents can be proposed.

Lepri, John J., Clare E. Strittmatter and Rhonda R. Gardner. **The Development and Function of the Vomeronasal System in Prairie Voles: A Model for Reproductive Coordination.** University of North Carolina at Greensboro, Department of Biology, Greensboro, NC 27412 USA.

The reproductive biology of prairie voles, *Microtus ochrogaster*, presents a wide variety of research problems related to the behavioral and physiological responses of rodents to social odors. In particular, adult female voles remain reproductively quiescent when isolated from males, in contrast to the predictable ovarian cycles of other lab rodents like house mice. Does this system of reproductive activation in female voles help them to conserve metabolic energy? Yes– we found increased rates of oxygen consumption in females that had been placed in physical contact with males. Notably, exposure to male odors in the absence of physical contact did not increase metabolic rates. In previous work, we found that the vomeronasal organ of female voles can mediate the male-induced activation of reproduction. The chemosensory vomeronasal-system displays immunoreactivity for gonadotropin-releasing hormone (GnRH), even in the nasal cavity, although its functional role in the periphery is unknown. In 1989, two independent reports showed that the hypothalamic GnRH-neurons of house mice originate in the embryonic nasal cavity and then migrate into the brain during development. In embryonic voles, we found that the earliest GnRH cells appeared in the anlage of the vomeronasal organ, raising some interesting questions on the relationships of this system to the hypothalamus. A brief model of these relationships will be presented for discussion.

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VERNET-MAURY Evelyne and BROUETTE-LAHLOU Isabelle.
The regulating factor from pup's preputial glands secretion as a cyberomone. Lab. Physiologie neurosensorielle - CNRS - Université Claude Bernard/Lyon, F-69622 Villeurbanne cedex.

The anogenital area of Wistar rat pups was shown to be very attractive to the dam. Recently, Brouette-Lahlou et al. have demonstrated that this attraction is a result of preputial gland secretion in pups; it regulates anogenital licking (AGL) a fundamental pattern of maternal care, crucial to pup survival. The active part of pups preputial gland secretion was isolated and identified as dodecyl propionate (DP). After the ablation of the pups preputial glands, the dam's AGL is disorganized : licking time is increased, and some pups are never licked and die. These results lead us to conclude that (DP) responds to the criteria taken into account to identify it as a pheromone. Therefore, it cannot truly be classified as a signalling pheromone. Without DP, the dam's AGL is anarchical, as noted before, and DP actually function is to regulate AGL behavior. To emphasize this distinction, we suggest the term "cyberomone", coined after kairomone and allomone. From recent results, ultrasonic calls from pups were postulated as the inductor of MAGL behavior and DP was confirmed as the regulating factor. The evolution of concepts such as the regulating pheromones of mammals, allows a better understanding of the behavior of more complexe species. This concept of cyberomone may led to a new unstanding of mammal olfactory behavior.

Beauchamp, Gary K. **Genetic Determination of Olfactory Individuality.** Monell Chemical Senses Center, 3500 Market Street, Philadelphia, Pennsylvania 19104-3308 USA

Chemical signals are of critical importance in communication systems of many mammals. These signals may influence reproductive physiology as well as behavior. One message of paramount importance in social animals is that of individual identity. Our studies have revealed that the same set of genes involved in regulating various immune responses in all vertebrates , the major histocompatibility complex (MHC) also plays a central (but not exclusive) role in conferring olfactory individuality or odortype. This presentation will describe some of our recent research focusing on the genetics of odortypes, the source(s) of the odors distinguishing individual animals, the development of an individual's olfactory identity and the role of MHC-regulated odortype in modifying reproductive behavior and physiology.

Prestwich, Glenn D. MOLECULAR STUDIES OF PHEROMONE PERCEPTION AND TRANSDUCTION. Department of Chemistry, State University of New York, Stony Brook, New York 11794-3400, USA

In the current molecular models for insect olfaction developed and elaborated by K.-E. Kaissling, R.G. Vogt and H. Breer, pheromones are transported through the sensory lymph by pheromone binding proteins (PBPs) and ultimately degraded by sensillar enzymes. In the dendritic membrane, pheromone molecules are recognized in a minimum-energy conformation by specific receptor protein. Binding to the receptor protein then triggers a G-protein mediated phospholipase C, which releases a short pulse of the second messenger Ins(1,4,5)P_3. IP_3 is presumed to act via its receptor to mobilize Ca^{2+} ions, eventually leading to a transmembrane ion current.

To understand the ligand-molecule interactions, we have synthesized photoaffinity labels for the pheromone receptor sites and for the IP_3 receptor binding site. We are working toward analysis of PBP-pheromone interaction using x-ray crystallography and 2-D and 3-D NMR spectroscopy of the protein-pheromone complexes using overexpressed, cloned cDNAs for specific PBPs. In other studies, we have prepared fluorine-substituted pheromone analogs as probes of receptor site hydrophobicity. Through these methods, we seek to examine the chemical ecology of pheromone perception through the evolution of molecular interactions.

THE EFFECT OF SEXUAL PHEROMONES AND SOCIO-SEXUAL INTERACTIONS ON REPRODUCTIVE PHYSIOLOGY OF THE DOMESTIC SHEEP.

J. P. SIGNORET
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The socio-sexual interactions influence the endocrine secretions and the reproductive processes in male and female sheep: The presentation of anoestrous ewes to rams induces a rapid release of gonadotropins resulting in ovulation whereas the presence of oestrous females increases the rhythm of pulsatile release of LH and the production of testosterone by the male.

In the female, the odour of male's fleece, and its extracts induce in a matter of minutes the release of LH. Male goat's hair or its extract is similarly active, indicating an interspecific pheromonal action. Acid fractions of both extracts are efficient. It has not been possible to induce changes in endocrine secretions of the male by isolated odours of oestrous females.

The sense of smell is not the only one involved in the endocrine consequences of socio-sexual interactions in the domestic sheep: In females as well as in males, anosmia does not modifies the response to the actual presence of the partner.

Tømmerås, Bjørn Åge, Atle Wibe and Arne Nilssen[1].

The olfactory system of the reindeer parasite, the nose bot fly Cephenemyia trompe, is sensitive to components both from reindeer interdigital pheromone gland and host urine.

Department of Zoology, University of Trondheim, N-7055 Dragvoll, Norway. [1]Department of Zoology, Tromsø Museum, University of Tromsø, N-9000 Tromsø, Norway.

By the use of linked gaschromatographical/electroantennogram (GC/EAG) technique it was discovered that the parasitic reindeer nose bot fly is specifically able to sense components produced by the interdigital pheromone gland of reindeer. Also one component in urine was found to be a potent stimulus for the sensory neurons of the fly. To trap the components head-space extraction technique with Porapak Q as collecting polymer was used for both pheromone glands and urine. The chemical structure of the compounds are under analysis so possible behavioural effects of the compounds from the ruminant host on the parasitic insect are to be studied later in field tests.

Steullet, Pascal, Patrick, Guerin. Perception of vertebrate breath components by the tropical bont tick *Amblyomma variegatum.* Institute of Zoology, University of Neuchâtel, Chantemerle 22, 2007 Neuchâtel, Switzerland

Breath is an important cue for the arousal and host finding behaviour of ticks. Activated ticks sample the surrounding air by raising their forelegs in the air, just as many insects do with their antennae. Olfactory wall-pore sensilla on the tarsus of the foreleg in *Amblyomma variegatum* respond to breath and concentrates thereof collected on porous polymers. The stimulatory effect of individual breath components was tested as they eluted from a capillary column in combined gas chromatography-single sensilla analysis of the concentrates. Sensilla located in an olfactory pit respond to the more volatile components of breath, carbon dioxide and sulfides. Both excitatory and inhibitory CO_2 receptors have been identified on separate sensilla. The inhibitory receptor acts as an on-off switch in response to stimulation with CO_2. This, and the complementarity between it and the excitatory receptor, suggests that CO_2 perception in this tick species is based on the convergent integration of input from these two receptors in the brain via a central suppression system. Receptors which are exquisitely sensitive to sulfides have also been characterized on separate sensilla, and hydrogen sulfide has been identified as the most active component of human breath for these olfactory cells. Both CO_2 and H_2S serve to activate ticks, but CO_2 is a better locomotion stimulant.

Cork, Steven J., and Braithwaite, L. Wayne Resource-availability, plant chemical defense, and the utilization of *Eucalyptus* by folivorous marsupials. CSIRO, Division of Wildlife & Ecology, PO Box 84, Lyneham, Canberra, Australia 2602.

Several arboreal Australian marsupials (koalas, greater gliders and some possums) are browsers of *Eucalyptus* trees but utilize only the eucalypt communities growing on the most nutrient-rich soils (although Australian soils generally are nutrient-poor compared with European or American soils). Such communities also are sort after for farming and forestry. Phenolics, terpenoids and lignin in eucalypt foliage are potent anti-nutrients for these folivorous marsupials (Cork & Foley, 1991). These observations suggest that the "Resource-Availability" hypothesis (Coley *et al.*, 1985) might both explain the patchy distribution of folivorous marsupials and provide a model on which to base strategies for management of eucalypt forests. This hypothesis predicts that carbon-based defenses of plants (e.g., phenolics, terpenoids and lignin) should be high where availability of nutrient resources for growth is low. We have found significant negative correlations between concentrations of mineral nutrients and carbon-based defenses in foliage from a range of eucalypt species and communities in south-eastern Australia. Similarly, ratios of nutrients to carbon-based anti-nutrients in foliage from eucalypt communities where folivores are abundant are significantly higher than in communities where these animals are rare. Furthermore, there are indications that carbon-based defenses in eucalypts might be responsive to manipulation of carbon:nutrient ratios in the environment. We conclude that the Resource-Availability hypothesis is a good basis for future research on the chemical ecology of eucalypt-marsupial and forestry-farming-conservation interactions in Australia.

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Alonso, Miguel E., Margarita Pérez-Mena, María Pía Calcagno Quantitative determination and Dynamics of Ptaquiloside, the main carcinogen of Pteridium aquilinum var. caudatum, in a population of the tropical Andes. Laboratorio de Química Ecológica, Departamento de Química, Facultad de Ciencias, Universidad de Los Andes, Mérida 5101, Venezuela.

Bracken fern, Pteridium aquilinum has long been known to possess toxic components. Of major importance are thiaminase, an enzyme related to B1-avitaminosis in horses and laboratory rats, and Ptaquiloside. The latter has been proven to be the cause of cancerous lessions of the intestine, bone marrow and other tissue in farm animals, as well as bovine enzootic hematuria, which is the consequence of carcinomas in bladder. Ptaquiloside displays an illudane-type structure that is unstable to heat, acid, base, and long exposure to air. A new method has been devised to analyze quantitatively this compound, using a combination of controlled base decomposition to Pterosin-B, microcolumn prepurification, and quantitation by HPLC. This method has been applied to examine the chemodynamics of Ptaquiloside in a bracken population of the venezuelan Andes. Correlations of ptaquiloside amounts with frond development (age and or size) will be discussed.

Glendinning, John. Ingestive responses of five congeneric species of mouse to diets laced with cardiac glycosides that differ in toxicity. Department of Biological Science, Florida State University, Tallahassee, FL 32306 USA.

Several recent studies indicate that wild predators have difficulty distinguishing between harmful and harmless foods. One problem involves over-ingestion of harmful foods, while another involves rejection of nutritious foods because of innate taste aversions to harmless compounds contained within them. I examined this latter phenomenon by comparing the ingestive responses of five congeneric species of mouse (*Peromyscus aztecus*, *P. leucopus*, *P. maniculatus*, *P. melanotis* & *P. polionotus*) to diets laced with one of 3 types of bitter-tasting cardiac glycosides (CGs): ouabain, digoxin or digitoxin. These CGs differ greatly in potential toxicity (ouabain < digoxin < digitoxin). I predicted that if the mice could assess the potential toxicity of a diet using taste cues, their avoidance thresholds should correlate negatively with the diet's potential toxicity. Two-choice preference tests revealed the predicted ranking of avoidance thresholds for *aztecus* (ouabain > digoxin > digitoxin), but not for the other four species (ouabain > digoxin = digitoxin). Ranking the five mice species in terms of their respective median avoidance threshold to the three CGs produced the following relationship: *leucopus* = *maniculatus* > *melanotis* > *polionotus* > *aztecus*. The lowest and highest medians differed substantially--by a factor of 50. I conclude that avoidance thresholds to a CG-laced diet in *Peromyscus* are not directly related to the diet's potential toxicity, with the exception of *aztecus*. Further, the low median avoidance thresholds for *aztecus* and *polionotus* suggest that these two species are more likely than the others to taste-reject harmless, CG-laced foods (e.g., monarch butterflies).

TAKAHASHI, Shozo, Masao FUKUI and Hisashi TAKEGAWA.
A Comparative Study of Semicchemicals in the Blattaria.
Pesticide Research Institute, Faculty of Agriculture, Kyoto University, Kyoto 606, Japan.

Although characteristics of present-day cockroaches have changed little from those of fossil cockroaches, we find diversity and similarity in behavir of Blattaria today mostly in response to semiochemicals. Our research on 14 species of cockroaches covered the following three subjects.
(i) Chemotaxonomical studies of cuticular wax composition. Hydrocarbons are the major components of cuticular waxes of cockroaches. The compositions were mostly species-specific.
(ii) Allomonal secretions in the genera Periplaneta and Blatta. An allomonal secretion is discharged from a pair of ventral glands. Three out of 6 related species produced phenolic compounds and the other 3 species produced an unsaturated alcohol.
(iii) Function of sex pheromone in mating behavior. Males of the families Blattidae, Blattellidae and Blaberidae showed a common behavioral characteristic of wing-raising at sex recognition. Stimulants eliciting this behavior come from a variety of compounds.
The results will be discussed to trace the likely evolution of diversity and similarity in cockroach behavior.

FARINE, J.P.: **Sexual behavior and semiochemicals in cockroaches: an evolutionary approach.**

Universtité de Bourgogne, Laboratoire de Zoologie, C.N.R.S., U.A. 674, 6 Bd Gabriel, 21100, DIJON, France.

The 4000 described species of cockroaches are distributed in two large superfamilies, the Blaberoidea and the Blattoidea. With a few examples, we emphasized the complexity of the sexual behavior of these insects. In *Blattella germanica* (Blattellinae), *Blaberus craniifer* (Blaberidae) and *Periplaneta americana* (Blattidae), the female attracts the conspecific males using a long-range sex pheromone. In *Nauphoeta cinerea* and *Leucophaea maderae* (Oxyhaloinae), it is the male which emits the sex pheromone. A more intricated behavior is examplified with *Blatta orientalis* and *Eurycotis floridana* (Blattidae) in which males and females play an active role in the sexual attraction of conspecifics.

BAUTISTA E.*, JULLIEN R.*, MORENO E**., BIEMONT J.C***., POUZAT J.***: Cuticular Lipids from the Coffee Weevil , Araecerus fasciculatus : Important specificities.

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**Laboratorio de Investigaciones sobre la quimica del cafe de la Federacion Nal. de Cafeteros de Colombia, Calle 26A 37-28 BOGOTA
***Institut de Biocénotique Expérimentale des Agrosystèmes I.B.A.S. Parc Grandmont 37200 TOURS France.

Cuticular lipids from Araecerus fasciculatus (Anthribidae), improperly called "Coffee weevil" are interesting for more than one good reason. They are constituted of hydrocarbons and esters of lipidic alcohols, most of them ethylenic compounds. The determination of their structures has showed a sex specificity of the esters of ethylenic alcohols, which could be related to the different biosynthetic mechanisms for the males and the females
Particularly, the presence of esters of primary alcohols, not described in insects until now, allows us to suggest a possible biosynthetic hypothesis for these compounds.
Preliminary results on the biological role of this compounds will be presented.

Boppré, Michael & R.I. Vane-Wright

Some chemoecological aspects of mimicry in Lepidoptera

Forstzoologisches Institut der Universität Freiburg i.Br., Fohrenbühl 27, D-7801 Stegen-Wittental, FRG, and Biodiversity Programme, Entomology Department, The Natural History Museum, Cromwell Road, GB-London SW7 5BD, United Kingdom

This paper discusses the chemoecology of insect defence by emphasising both variability and individuality of chemical protection with special reference to the evolution of mimicry and chemical communication in butterflies and moths.

Plant chemicals have long been seen as the ecological basis of chemical defence, aposematism and mimicry in adult Lepidoptera. According to this idea, larvae feeding on chemically defended plants can sequester noxious or distasteful compounds and pass them on, through the pupal stage, to the adult insects. Selective predation then results in the evolution of warning coloration which, in turn, drives the formation of Batesian and Müllerian mimicry rings.

Such a simple view ignores the extraordinary range of variation now known to exist within and between species of aposematic Lepidoptera, particularly with respect to their chemoecology. For example, allelochemics of widely differing chemical natures are employed by different Lepidoptera, involving a corresponding variety of sensory and physiological effects on predators. Multicomponent defences occur, incorporating self-made compounds together with modified plant substances. Variation at individual level is caused by both qualitative and quantitative differences in host plant chemistry, as well as by differences in the sequestering and synthetic capacities of the insects themselves. Additionally, many species are known to gather and accumulate defensive metabolites actively, as adults, not just passively as larvae. This can cause drastic intraspecific differences, and even temporal variation within the lifespan of individuals. We are thus prompted to ask the question - are the chemical defences of Lepidoptera individual traits rather than species characters?

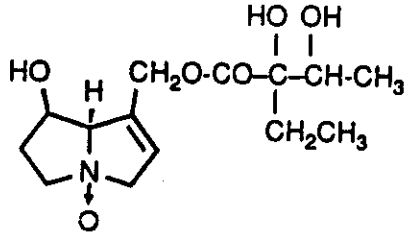
A further complication arises from the use of colour patterns as warning signals. In butterflies mate-location is generally based on visual signalling, and mimicry poses problems for mate-recognition. These problems can be overcome by pheromone communication. However, complex interplay of defensive signalling and chemical communication is not limited to mimetic butterflies. A better understanding of these phenomena will enable us to develop richer theories about how such systems have evolved and, in turn, these theories will help us to ask more precise questions about the chemoecology of mimicry amongst the Lepidoptera.

Nishida, Ritsuo, Chul-Sa Kim and Hiroshi Fukami

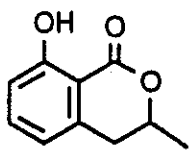
Novel Association of a Danaine Butterfly, *Idea leuconoe*, with Non-Pyrrolizidine Aromatic Substances

Pesticide Research Institute, Kyoto University, Kyoto, 606 Japan

Idea leuconoe Erichson is a giant danaine butterfly whose larvae feed exclusively on a pyrrolizdine alkaloid (PA)-containing plant, *Parsonsia laevigata* Alston (Apocynaceae). The adults (both males and females) were found to store a series of the host-originating PAs (ideamines A and B, lycopsamine and parsonsine) as the *N*-oxide forms (1) in extraordinarily large quantities (>3 mg/butterfly). Portions of the *N*-oxides were also transferred to the eggs, suggesting their primary role as the defense substances. Unlike most of other danaine butterflies, however, *I. leuconoe* males (both wild and captivity) did not store any one of the PA fragments (e.g. danaidone, hydroxydanaidal and danaidal) in the hairpencils in significant quantities. Instead, the males were found to incorporate some artificial aromatic compounds such as methyl *p*-hydroxybenzoate which strongly attracted the males in an indoor experiment. Analysis of hairpencil volatiles from the wild males revealed a selective accumulation of mellein (2). The males attracted to mellein salivated and reimbibed the solution as though other danaines did on the PA sources, which suggested a pharmacophagous interaction between *I. leuconoe* and some unknown aromatic attractant sources.



Ideamine A *N*-oxide (1)



Mellein (2)

Nishida et al., *Chem. Express*, **5**, 497 (1990); Nishida et al., *Agric. Biol. Chem.*, **56** (7) in press (1991).

Hilker, Monika ANTHRAQUINONES IN DIFFERENT DEVELOPMENTAL STAGES OF *GALERUCA TANACETI* AND OTHER GALERUCINAE (COLEOPTERA, CHRYSOMELIDAE)

Universität Bayreuth, Lehrstuhl f. Tieroekologie II, Postfach 101251, 8580 Bayreuth, FR Germany

The overwintering eggs and the larvae of the leaf beetle *Galeruca tanaceti* (L.) contain hydroxylated anthraquinones. In both developmental stages, 1,8-dihydroxy-3-methylanthraquinone (=chrysophanol) and 1,8-dihydroxyanthraquinone (=chrysazin) were detected by GC-MS and GC-FTIR analyses. In the eggs, chrysazin was found only in traces. Anthraquinones are also present in the ovaries and hemolymph of gravid females, which were investigated in order to examine the incorporation of these substances into the eggs. Neither in acidified nor in nonacidified extracts of the hostplants *Tanacetum vulgare* L. and *Achillea millefolium* L. anthraquinones were found. The activity of these anthraquinones as chemical defense substances was proved in bioassays with the ant *Myrmica ruginodis* NYL. Furthermore, GC-MS analyses of six other galerucine species revealed the presence of chrysophanol and chrysazin in eggs and larvae. In some species, additionally 1,8,9 trihydroxyanthracene was detected.

New C_{26} δ-lactones from the Dufour's gland of the ant *Tetramorium aculeatum*

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Tetramorium aculeatum is an aggressive ant which is well known for causing skin irritation by stinging and biting, being named in Zaire the "urticating ant".Dissection of ant workers has shown that they possess an hypertrophied Dufour's gland reaching the front of the gaster. We have studied the composition of the Dufour's gland secretion of this ant and identified the major component as (6R*)-[(2S*)-2-hydroxyheneicos-12-enyl]-5,6-dihydro-2H-pyran-2-one (**1**),mainly on the basis of its spectral properties. It is accompanied by a minor component whose structure was established as (1S*,5R*,7S*)-7-(nonadec-10-enyl)-2,6-dioxabicyclo(3,3,1)nonan-3-one (**2**). In solution, **1** was slowly transformed into **2**, by an intramolecular reaction. This result indicates that **1** is the compound biosynthesized by the ant. Closely related unsaturated δ-lactones, e.g. massoilactone from the bark oil of *Cryptocaria massoia* and from the mandibular gland of the ant *Camponotus* sp., are known to be powerful skin irritants, thus suggesting that **1** could be responsible, at least in part, for the irritating properties of this ant.

DEFENSIVE CHEMISTRY OF SOME CARABID BEETLES

Athula B. Attygalle, Jerrold Meinwald, Thomas Eisner

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Defensive secretions of several species of Carabidae were investigated. We observed a high degree of sexual dimorphism in Oodes americanus; male and female secretions show qualitative differences, suggestive of a sex-related pheromonal function, secondary to the defensive role. In contrast, the differences in male and female secretions of Scarites subterraneus are not dramatic. In this beetle, we showed that methacrylic acid is biosynthesized from L-valine via isobutyric acid. The defensive spray of Helluomorphoides grouvellei consists of formic and acetic acid, together with a complex mixture of over twenty lipophilic constituents.

Dettner, Konrad and Beran, Helmut

ARE DEFENSIVE GLANDS OF HERBIVOROUS *GONIOCTENA*- LEAF BEETLE LARVAE ALSO EXCRETORY ORGANS ?

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Leaf beetle larvae of the genus *Gonioctena* (Col.: Chrysomelidae) possess abdominal glands which are in many species everted on molestation and emit a defensive secretion. Depending from species a gradual reduction of this gland system is observed within larvae of this genus. The secretion of various *Salix*- and *Populus*-feeding species was analysed by GC-MS. It contained several volatiles such as 6-methyl-5-hepten-2-one or 2-phenylethanol with a species specific pattern. In addition, larvae feeding on *Populus*-leafs which contain high titers of phenol glycosides also secrete several lower volatile aromatics which are probably biogenetically derived from food plant glycosides. The defensive secretion of *G. viminalis* even varies intraspecifically depending from the offered food plant in the laboratory: Only *Populus*-feeding populations secrete aromatics which are absent within secretions from *Salix*-fed individuals.
These results favour the idea that defensive glands of *Gonioctena*-larvae to some extent may represent excretory organs in order to detoxify food plant phenol glycosides. A detoxification of xenobiotics via defensive glands was also observed in other defensive glands of beetles.

CLEMENT, Jean-Luc. The chemical signature in social insects: role, identification, production and regulation. CNRS-LNB - Communication Chimique, 31, chemin. Joseph. Aiguier F-13402 MARSEILLE cedex 09.

In social insect, nestmate recognition is essentially achieved by contact. Ethological experiences shown that members of a colony are generally able to discriminate nestmates and alien individuals of the same species, but some examples described inquilines able to integrate themselves into the life of a colony without aggression. Cuticular hydrocarbons have been postulated to be the major chemical class involved in Ants and Termites nest signature. In some cases both behavioral and chemical analyses demonstrated that the hydrocarbon mixture acts as a chemical signal and variations of relative proportions characterize signatures in different colonies or species. Myrmecophilus or Termitophilus beetles contain the same hydrocarbon components than their hosts. Slave and slave making ants have similar cuticular hydrocarbons patterns. These chemical mixtures are not totally under genetical control and the signature can vary according to the social environment or experimental modifications. The production and regulation of the nest chemical signature constitute complex systems and hydrocarbon synthesis can be modulated by hormones.

BAGNERES, ANNE G.*, Jean-Luc CLEMENT*, Murray BLUM**, Catherine LANGE***. Intracolonial polymorphism of cuticular hydrocarbons in Termites of the genus *Reticulitermes* : a possible role in caste differenciation ? *CNRS-LNB.8, 31, ch.J.Aiguier,F-13402 MARSEILLE cedex 09. **University of Georgia, 30602 ATHENS Ga,USA. *** Université P.M.Curie, 4, Pl.Jussieu, F-75005 PARIS.

Cuticular hydrocarbons of *Reticulitermes* species from U.S. and Europe were identified by GC/MS, quantified by GC and their relative proportions and quantities analysed by multivariate analysis. The hydrocarbons permitted discrimination of 6 phenotypes (three in *R. flavipes*, one in *R. santonensis*, and two in the superspecies *R. lucifigus*). Inside each phenotype, cuticular hydrocarbon proportions allowed discrimination of various castes : workers, soldiers, nymphs and sexuals. A plot of the major axis of the principal components and of the component weights separates the soldier caste from the other castes in the same phenotype. For example in one phenotype of *R. flavipes*, soldiers are distinguished from workers by the compounds 5-Me C24, nC23, 9C25:1, 9C24:1. On the other hand, worker cuticular hydrocarbons are characterized by the following compounds : 4/2MeC24, 9C23:1, 4/2MeC23 and 3MeC23. Nymphs, white soldiers, neotenics and imagos are very close to workers but small variations in cuticular hydrocarbon proportions readily allowed their discrimination. The mathematical distance between each caste is greater than the mathematical distance between nests in each caste of the same phenotype.

In lower termites, caste differenciation occurs during moulting in the first stage. We hypothesize that caste variations can determine larval caste differentiation because of the small numbers of chemical contacts between castes with different chemical signatures, especially the soldiers, during the great number of antennal contacts between members of the same society.

J.-M. JALLON, J.-F. FERVEUR, M. PENNANEC'H, M. ARIENTI and R. VENARD

THE MELANOGASTER SUBGROUP PHEROMONAL SYSTEM.

Laboratoire de Biologie et de Génétique Evolutives, CNRS, 91198 Gif-sur-Yvette, France.

The group of species related to Drosophila melanogaster -melanogaster subgroup- represents a very good model system to study chemical signals in an evolutionary perspective. Two are cosmopolitan with racial variations while six are endemic to Africa with overlapping ecological niches. In this latter group, two are restricted to islands of the Indian ocean. The pheromonal system of mature flies of all these species is complex, consisting in a common aggregation pheromone and a set of cuticular long chain hydrocarbons which control short distance and/or contact interactions. In five of these species, both sexes share aphrodisiac monoenes while three of them display a marked sexual dimorphism, with mature female specific pheromonal dienes.

All these molecules are structurally related with usually a w 7 double bond. Thus they have to share part of their biosynthetic pathway which has been
studied with radiolabeled precursors, such studies suggest that they are all derived from medium size acids as many other pheromones, using only a small number of enzymatic transformations, mainly desaturations, elongations and decarboxylations.

Among the cosmopolitan species, a marked polymorphism was found which characterizes chemical races. These races are usually not sexually isolated but display strong dissymetrical interactions. Such a situation is very favorable to initiate genetic studies. They evidenced one autosomal major gene ngbo, which controls in a dose dependent manner, the hydrocarbon polymorphism of D.simulans (II :65). In D. melanogaster the female polymorphism depends on a third chromosomal locus.

Finally two of the species are linked to host-plants.

Löfstedt, Christer. **Species specificity and population variation in moth sex pheromones.**

Department of Ecology, Lund University, S-223 62 Lund, Sweden.

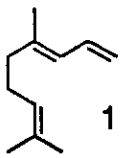
The adaptive value of species-specific sex pheromones in terms of reproductive isolation has traditionally been taken for granted. However, the identification of specific pheromones is not enough to assign pheromones a definite role in this respect. Pheromone specificity may play no role in reproductive isolation between species which are already reproductively isolated by other means. For divergence in reproductive characters to evolve by *reinforcement* (i.e. selection against the formation of inferior hybrids), there must be large initial differences in reproductive characters and considerable heritable variation. Reproductive *character displacement* may take place as a result of interference in pheromone communication between populations which do not hybridise. However, convincing empirical examples are missing for both processes. Phylogenetic reconstruction of selected moth genera is necessary to allow meaningful interpretation of the observed specificity in pheromone composition. Instead of routinely invoking "the ghost of competition past" to explain sex pheromone specificity, new research efforts should focus on selective processes in *currently* polymorphic communication systems. I will illustrate these points using studies on the noctuid moths *Agrotis segetum* and *Diachrysia chrysitis* s.l., the European corn borer *Ostrinia nubilalis*, and the European small ermine moths *Yponomeuta* spp. as examples. The usefulness of different species concepts in the evolutionary interpretation of specificity and population variation in sex pheromone communication will also be discussed.

Wilhelm Boland

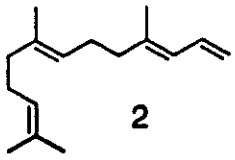
Institut für Organische Chemie der Universität, Richard-Willstätter-Alle 2, D-7500 Karlsruhe

From Flowers, Leaves and Spider Mites; Biosynthesis of Homoterpenes.

The two homoterpenes **1** and **2** are widespread flower fragrances or leave volatiles of higher plants. They are also important semiochemicals between herbivore-damaged plants and the third trophic level of insect parasitoids and predators.



1



2

1 and **2** are biosynthesized from the two regular terpene alcohols nerolidol and geranyllinalool, respectively. Biosynthetic studies with enantiospecifically labelled precursors revealed, that the process of the oxidative cleaveage of e.g. nerolidol is widespread in nature and proceeds with the same site specificity in all hitherto examined plant species (gymnosperms and anglosperms). The geometry of the transition state of the reaction was found to be *syn*-periplanar. The cleavage proceeds *via* geranylacetone as an intermediate and resembles the well known cytochrome P-450 catalyzed dealkylation of steroids.
The release of **1** or **2** from plants infested by herbivores (spider mites) probably requires a chemoenzymatic interaction beteen both partners which is assumed to be an hydrolytic cleavage of a nerolidolglycoside prior to the oxidative cleavage.

Frenzel, Mark, Dettner, Konrad, Boland, Wilhelm: ATTRACTANCY OF CANTHARIDIN AND FEW ANALOGUES TO THE CERATOPOGONID MIDGE *ATRICHOPOGON OEDEMERARUM* (DIPTERA, CERATOPOGONIDAE)

Universität Bayreuth, Tierökologie II, Postfach 101251, 8580 Bayreuth, FR Germany

Some species of the ceratopogonid *Atrichopogon* are attracted by the terpenoid cantharidin which is an effective insecticide against many arthropods. This phenomenon occurs too in regions where the only known producers, meloid and oedemerid beetles, are absent or rarely distributed. During our research for the meaning of cantharidin in ceratopogonids, the phenology and sex ratio of cantharidphilous *Atrichopogon* - species at cantharidin baits was studied. Since *Atrichopogon* seems to be associated with umbelliferous plants, we investigated whether attractancy was restricted to cantharidin or if the flies would react to cantharidin analogues which could serve as a linkage to plant derived compounds. Response to the analogues was always considerably lower than to cantharidin, but attractancy was present especially in case of *A. oedemerarum* Storå if the exo,exo-7-oxabicyclo[2.2.1]heptane-skeleton of cantharidin was associated with a 2,3-γ-lactone instead of the original 2,3-dicarboxylic anhydride.

Malcolm, Stephen. *Cardenolides and molecular parsimony of plant chemical defences.*
Imperial College, Department of Biology, Silwood Park, Ascot, Berks., SL5 7PY, U.K.

It was suggested recently that plants maintain a high diversity of potential chemical defences against natural enemies because of the low probability that new chemicals will be biologically active. Instead I argue that this low probability will select for plants to exploit single metabolic pathways that have a high probability of producing biologically active chemical defences. Since both taxonomically similar and dissimilar groups of plants commonly use similar kinds of chemical defences this argues for such "molecular parsimony" and not for evolutionarily expensive diversity to counteract low probabilities. Thus diversity of chemical defences can often be covered by a single molecular type. For example, the toxic cardenolides of foxgloves, oleander and milkweeds, in 3 different families, are steroids with the same kind of basic toxic activity. However, variation within this single molecular pattern appears to account for most of the defensive needs of the plants. These include the full range of toxic/digestibility reducing and mobile/immobile defences suggested by apparency and resource availability hypotheses. A possible reason for the effectiveness of this single molecular pattern, covering a wide range of defensive needs, is that cardenolide are targeted at disrupting a fundamental physiological attribute of all herbivores - sodium/potassium ATPases. The use of coumarins by umbellifers, alkaloids by Solanaceae, glucosinolates by Cruciferae, and cardenolides by Asclepiadaceae argues for molecular parsimony and selection to increase the probability that new molecules will be biologically active.

Jones, David A., Scott Zona. **Chemical defence by cyanogenesis: cyanogenesis in some Florida plants.** Department of Botany, University of Florida, Gainesville, FL 32611-2009 USA.

We have been examining some Florida plants for cyanogenesis and found some interesting patterns both in the time of expression of cyanogenesis and in the herbivory of these plants. While this work is at a very early stage we have evidence that one plant at least, *Piriqueta carolliniana* is profligate with its nitrogen, strongly suggesting that the metabolic costs of synthesizing cyanogenic compounds are not particularly important to some plants.

ESCOUBAS P., FUKUSHI K., LAJIDE L., MIZUTANI J., A novel bioassay for rapid isolation of insect antifeedant compounds.
Japan Research and Development Corporation (JRDC), Eniwa RBP, Eniwa-shi Megumino Kita 3-1-1, Hokkaido 061-13, Japan.

The isolation of bioactive natural substances, requires monitoring of all fractionation and purification steps using a bioassay system. This is often a long and tedious process, especially with insect bioassays. We propose here a new method, based on the principle of bioautography, for a quick isolation of insect antifeedant compounds.
TLC plates after migration, are coated with a thin layer of artificial diet, and fed to *Spodoptera litura* larvae. The location of uneaten areas is then compared with the Rf values of the TLC spots, in order to rapidly determine the active fractions. This method allows for a very fast determination of the most active antifeedant compounds in a complex mixture and considerably speeds up the isolation process.
This new method was successfully applied to the identification and isolation of insect antifeedant constituents in the japanese plant *Skimmia japonica* (Rutaceae).

Ramachandran, R., D.M. Norris. Volatiles mediating plant-herbivore-natural enemy interactions. Department of Entomology, Univ. of Wisconsin, Madison.

Electroantennogram responses of a herbivore, Pseudoplusia includens (Noctuidae: Lepidoptera), and a natural enemy, Micropelitis demolitor (Braconidae: Hymenoptera), exposed to aliphatic hydrocarbons, aldehydes, alcohols and ketones of 5 through 12 carbons were compared. Excluding alcohols, responses of the herbivore to hydrocarbons, aldehydes and ketones peaked at 6- and 7-carbons while those of the natural enemy peaked at 7- and 8-carbons. Differences in the response profile between the herbivore and the natural enemy suggested that the chemoreceptors of the natural enemy are tuned to perceive volatiles from other sources besides plants. Tenax trapped volatiles from the frass of P. includens fed on soybean leaves were attractive to the female parasitoid, M. demolitor, in olfactometer assays. Such volatiles from larvae fed on artificial diet did not affect the behavior of the parasitoids. Linalool, 3-octanone, 2-methoxy phenol and 2-methyl-propionic acid, 1-(1,1-dimethylethyl)-2-methyl-1,3-propane were identified by GC-MS as the components of the attractive frass volatiles. These chemicals were not detected in the frass from artificial diet fed larvae. Volatiles from the frass of soybean looper fed lima bean, (Phaseolus vulgaris), also contained these compounds. 3-Octanone and 2-methoxy phenol were attractants for M. demolitor in olfactometer bioassays. 3-octanone was detected in trace amounts in volatiles trapped from leaves of soybeans. Linalool and 2-methoxy phenol were not detected. The origin of these chemicals and its significance to plant-herbivore-parasitoid interactions is discussed.

Le Quéré, J.L. (1), Brossut, R. (2)

Identification and stereochemistry of 4,6,8-trimethyl-7,9-undecadien-5-ol, a female specific compound of the woodroach *Cryptocercus punctulatus*.

(1) INRA, Laboratoire de Recherches sur les Arômes, Dijon, France.
(2) Université de Bourgogne, Laboratoire de Zoologie, Dijon, France.

The chemical analysis of the tergal gland secretions of males and females of the primitive woodroach *Cryptocercus punctulatus* showed the presence of a compound which was abundant only in females under reproductive conditions. The compound was purified by preparative GC and subsequantly analyzed by spectrometric methods.

GC-MS (EI and CI modes), on-line catalytic hydrogenation GC-MS, GC-FTIR and finally ^{1}H-NMR in one and two dimensions established the structure 4,6,8-trimethyl-7,9-undecadien-5-ol. The configuration was determined by GC-FTIR to be either (7Z,9E) or (7E,9E).

The four diastereoisomers of each were synthesized [1]. The natural product possessed the same retention time as that of one (7E,9E) diastereoisomer, and a coinjection experiment proved this identity. The natural product was subsequantly identified as one of the antipode of (4R*,5R*,6R*,7E,9E)-4,6,8-trimethyl-7,9-undecadien-5-ol. A study in bi-dimensional GC with a chiral column in the second oven of the gas chromatograph revealed that the natural product is the (-) isomer.

[1]. K. Mori, M. Itou and R. Brossut, *Liebigs Ann. Chem.* **1990**, 1249-1255.

Junwei Zhu, Håkan Ljungberg, Bill S. Hansson, Nils Ryrholm, and Christer Löfstedt.

Chemical identification and electrophysiological analysis of sex pheromone components of two geometrid moths *Idaea aversata* and *I. straminata*

Department of Ecology, Lund University, S-223 62 Lund, Sweden

Pheromone compounds identified so far from geometrid moths consist of all-cis diene, triene, or tetraene hydrocarbons with chain lengths of C17 to C21. We now report the identification of three pheromone components from the female gland extracts of the geometrid moth *Idaea aversata* (Lepidoptera: Geometridae) using combined gas chromatography - electroantennography (GC-EAD). Two of them have been identified as (*Z*,*Z*)-9,11-tetradecadienyl acetate (Z,Z-9,11-14:OAc) and (*Z*,*E*)-9,11-tetradecadienyl acetate (Z,E-9,11-14:OAc) by gas chromatographic and mass spectrometric characteristics. The third component could, based on its retention time, be a 7,9-dodecadienyl acetate (7,9-12:OAc). In an electrophysiological study, single sensillum recordings from male *I. aversata* showed that there were three types of sensilla: The first type contained two cells and one of these responded with a large spike amplitude to Z,Z-9,11-14:OAc, whereas another responded with a small spike amplitude to Z,E-9,11-14:OAc. The second type contained one cell which responded strongly to Z,Z-9,11-14:OAc, and weakly to Z,E-9,11-14:OAc. The third type showed a large response to what could be a 7,9-12:OAc according to its retention time when testing the female extracts in GC-single sensillum recordings. Only few insects of *I. straminata* were available but some sensilla responded with a large amplitude cell to Z,E-7,9-12:OAc and with a small amplitude cell to Z,Z-9,11-14:OAc. Our study confirms the occurence of olefinic acetates as pheromone components within the Sterrhinae subfamily of Geometridae. Analyses of pheromone precursors and labelling experiment are underway to test hypothesis about the biosynthetic routes to the doubly unsaturated acetates.

Pickett[a], John A, Colin A.M. Campbell[b], Glenn W. Dawson[a], Jim Hardie[c], Steve Nottingham[c], Jan Pettersson[d], Wilf Powell[a], Lester J. Wadhams[a] and Christine M. Woodcock[a]

New evidence for the importance of volatile semiochemicals in aphid ecology

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[b] Horticultural Research International, East Malling, West Malling, Kent, ME19 6BJ, U.K.

[c] AFRC Linked Research Group in Aphid Biology, Department of Biology, Imperial College at Silwood Park, Ascot, Berks., SL5 7PY, U.K.

[d] Department of Plant and Forest Protection, Swedish University of Agricultural Sciences, P.O. Box 7044, S-750 07, Uppsala, Sweden

Volatile plant semiochemicals influence aphid ecology by mediating interactions through at least three trophic levels. Recently identified sex pheromones can show dramatic activity in attracting males in the field, but this behaviour can be influenced by winter host plant components. Coupled GC-SCR studies have identified summer host components that attract spring migrants and antennal receptors have been found for non-host compounds that interfere with host attraction in the field. Host plant components influence the foraging behaviour of aphid parasitoids and there is now evidence of parasitoids employing the aphid sex pheromone as an attractant kairomone.

BORDEREAU Christian[1], ROBERT Alain[1], BONNARD Odile[1], LE QUERE Jean-Luc[2]

Dispersal flights and sex pheromones in two species of fungus-growing termites, *Pseudacanthotermes spiniger* and *P. militaris*

1. Université de Bourgogne, Zoologie, URA-CNRS 674, 21000 DIJON, FRANCE
2. I.N.R.A., Laboratoire de Recherches sur les Arômes, 21000 DIJON, FRANCE

Pseudacanthotermes spiniger and *P. militaris* coexist in sugar cane plantations of many countries of tropical Africa. During these last years, the colonies of *P. spiniger* become more and more numerous . In both species, the colonies reproduce by seasonal dispersal flights of winged males and females. The sex pheromone of *P. spiniger* was identified as the cis-3, cis-6, trans-8- dodecatrien-1-ol. This compound was also found in *P. militaris* , but in much smaller quantities (in the ratio 10 : 1). The males of *P. militaris* are attracted by female sternal glands extracts from both species, but if given a choice, they preferentially choose extracts from *P. spiniger* containing more dodecatrienol. This unsaturated alcohol is probably also the major component of the sex pheromone in *P. militaris* . The respective times of the dispersal flights (in April between 2 and 6 p.m. for *P. militaris* ; in May between 6 and 7 p.m. for *P. spiniger*) are the major factor of the reproductive isolation of these two species of fungus growing termites.

Schlyter, Fredrik*, Byers, John*, Göran Birgersson°, Wittko Francke*, Alf Bakke*. **THE PHEROMONE OF *Ips duplicatus*; INTERACTING WITH THE COMPETITOR *I. typographus*.**
*) Dept. Ecol., Lund Univ., Ecology bldg., S-223 62 Lund, Sweden, ○) Dept. Chem. Ecol., Göteborg Univ., Sweden, ★) Dept. Org. Chem., Hamburg Univ., BRD, ⁕) Dept. Forest Entomol., Norw. For. Res. Inst., Norway

I. duplicatus co-inhabiting with the larger *I. typographus* on Norway spruce (*Picea abies*) faces an asymmetric competition for breeding substrates, suggesting that *I. duplicatus* would benefit by having a pheromone system distinct from that of the larger competitor. [redacted]

GC-MS analysis showed that *I. duplicatus* males feeding in the host produced racemic ipsdienol (Id), *cis*-(cV), *trans*-verbenol (tV), myrtenol (Mt), and *E*-myrcenol (EM), while *I. typographus* males produces only cV, tV, Mt, and large amounts of 2-methyl-3-buten-2-ol (MB). Exposure of *I. duplicatus* males to myrcene and α-pinene resulted in the production of small amounts of Id, cV, tV, Mt, and *trans*-pinocarveol, but not EM, while *I. typographus* males produced large amounts of cV, tV, and Mt but little MB. [redacted]

Id was unattractive by itself, while EM, which was inactive by itself, when added to Id caused a synergistic response in walking bioassays. Addition of EM to the pheromone of *I. typographus* did not reduce the attraction of females of this species in the laboratory. A combination of EM and Id at a rate corresponding to 100 -200 males was more attractive in the field than 70 un-mated males in a spruce log. Subtracting EM from a blend of Id, EM, cV and MB drastically reduced trap catches, while subtraction of cV or MB or both from the blend had no significant effect on *I. duplicatus*. A pheromone interaction field test with three decadic steps of release of *I. typographus* pheromone (10 -1000 synthetic male equivalents (ME)) and four steps of *I. duplicatus* components (0 -1000 ME) in all possible combinations, showed both positive intraspecific dose-response effects and interspecific interactions indicating inhibition, as well as cross-attraction. [redacted]

The pheromone systems of the two species allow effective discrimination with some cross-attraction. Whether the two pheromone systems have in fact evolved in response to present ecological conditions, or if the discrimination is an incidental effect of the phylogeny of these two distantly related *Ips* species remains to be shown. [redacted]

Dunkelblum, Ezra and Michal, Mazor. **Sex pheromone components of Cornutiplusia circumflexa; The role of Z7-12:OH in the pheromone complex of Plusiinae moths.** Institute of Plant Protection, Volcani Center, Bet Dagan 50250, Israel

Plusiinae moths abound in Israel. Some are sympatric, such as the very common Autographa gamma and the fewer Cornutiplusia circumflexa. In view of their morphological similarity, it was important to identify the sex pheromone of the C. circumflexa moth. Capillary GC, MS and DMDS derivatization confirmed the presence of Z7-12:OH and Z7-12:Ac as the two main components in the pheromone gland extracts. Flight tunnel and field tests indicated that Z7-12:OH is the major component eliciting medium response from the males. Addition of 20-50% of Z7-12:Ac to the alcohol resulted in a lure which evoked the complete courtship behaviour form 75% of the males. The responses of the males to this lure and to a virgin female were similar. This is the first case of a Plusiinae species utilizing Z7-12:OH as the major pheromone component. In A. gamma the alcohol is a minor pheromone component whereas in Chrysodeixis chalcites and Trichoplusia ni it is an inhibitor. The pheromone composition in A. gamma and C. circumflexa is particularly interesting because both species utilize the same components but in an almost inverse ratio. Considering that Z7-12:OH is the precursor of Z7-12:Ac, the ratio of these two components is probably regulated by a mechanism which controls either the acetylation of the alcohol or the hydrolysis of the acetate.

Gabel B.(1), Thiéry D.(1), Suchy V.(2), Marion-Poll F.(1), Hradsky, P.(3), Farkas P.(3).

Tansy semiochemicals detected by females of *Lobesia botrana* Den. et Schiff. (Lepidoptera, Tortricidae).

(1) INRA-CNRS (UA 1190), BP 23, Bures sur Yvette, F-91440.
(2) Pharmaceutical Faculty, Bratislava, CS-83232.
(3) Food Research Institute, Bratislava, CS 82509.

The European grape vine moth (*Lobesia botrana*) is a major pest of vine grapes in Europe. Females are well attracted towards a non-host plant (tansy, *Tanacetum vulgare* L.) which are a part of the weed comunity in the slovakian vineyards. In order to identify the volatile components responsible of such an attraction, we screened out the constituents from a steam distilate of tansy flowers which are detected by the antennal olfactory receptors of that insects. We have recorded the antennal responses of 20 females by a direct GC-EAG technique. 24 molecules released EAG responses in more than 25% of the recorded females and 5 of them were deteced by more than 85 % of the females. The 5 active compounds which have been identified by GC-MS analysis are monoterpenes. The attractiveness of a synthetic blend made out of these active compounds is in progress.

POPPY, Guy and Martin BIRCH

The function of hair-pencils in Mamestra brassicae - the difference between an "inbred" and a "wild" strain.

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Previous studies on hair-pencils (HP's) using "inbred" moths, have suggested that the HP's are redundant (Birch et al., 1990). Recent work with a newly established "wild" strain has shown that the HP's are used to increased female acceptance of the male during courtship.

Behavioural experiments in closed containers and wind tunnels have provided evidence of a correlation between eversion of HP's and courtship success and removal of HP's and courtship failure. Further experiments, in which only the volatiles from the HP's are added to the courtship arena of ablated males and females, show that the volatiles alone can increase success and thus constitute a pheromone.

Comparisons between "inbred" and "wild" moths are described including an experiment in which the strains were cross courted. This cross-strain courtship experiment showed that both male "quality" and female choice were lower in the "inbred" strain. The importance of the difference between the strains will be discussed.

Gabel B., Thiéry D.

Biological evidence of an oviposition-deterring pheromone in *Lobesia botrana* Den. et Schiff. (*Lepidoptera, Tortricidae*).

INRA-CNRS (URA 1190), BP 23, Bures sur Yvette, F-91440.

At low population density females of European grapevine moth (*Lobesia botrana* Den et Schiff.) usually deposit single eggs on the flowers and berries of grapevine (*Vitis vinifera* L.). We have investigated wether the occurence of an epideictic pheromone present on the egg surface explain such a behaviour in that species. Twenty one thousands eggs of *L. botrana* have been washed in cold purified methanol. Different dilutions of the extract have been obtained by evaporation with a purified nitrogen flow. The biological activity have been tested in a bioassay which afford a two choice situation between treated and non treated areas. Methanol, used as a control, was not found to deter the oviposition which is consistent with observations made on other species. At the dose of 4 eggs equivalent per cm^2, the number of eggs laid by the females of *L. botrana* was reduced up to 57% on the treated areas as compared to non-treated areas. There might be a long term lasting reduction in the oviposition (at least 24 hours) following an exposure to the extract. Our results strongly suggests the occurence of an oviposition-deterring pheromone on the eggs of *L. botrana*. The identification of the pheromone constituants is actually in progress.

Blackwell, Allson, A.J. Mordue, L.J. Wadhams* & W. Mordue.

OLFACTORY SENSILLA OF BITING MIDGES OF THE GENUS *CULICOIDES*

Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen, Scotland, AB9 2TN.
*** Rothamsted Experimental Station, Harpenden, Herts, England, AL5 2JQ.**

Morphological and ultrastructural studies have been carried out to characterise the olfactory sensilla on the antennae of two species of biting midge: *Culicoides nubeculosus* and *Culicoides impunctatus*. Both species are endemic to the UK. *C. nubeculosus* has a wide geographical distribution, being found around farmland biting cattle, whereas *C. impunctatus* occurs in greatest numbers in the Scottish Highlands, where it is the major biter of man.

The two species have different life styles and mating strategies. *C. nubeculosus* mates readily and is one of only two species of biting midge in which pheromone-mediated sexual behaviour has been identified. A female-produced pheromone has been shown to attract male *C. nubeculosus* midges and increase their mating attempts (Kremer *et. al.* 1979, Blackwell, unpublished)). Mating of *C. impunctatus* is initiated within special 'mating swarms' of male midges. The relative importance of sound and possible pheromone involvement have not yet been characterised in this species.

The antennal sensilla of *C. nubeculosus* and *C. impunctatus* are similar. The ratio of mechanoreceptors to olfactory receptors on the antennae of the blood-seeking female is 1 : 5 and in males is 1 : 1.4. Olfactory sensilla are identified by the extension of the sensory dendrites to the tip of the hair shaft, branching of the dendrites and pores in the hair side walls allowing communication with odour molecules. Trichoid-, basiconic- and coeloconic sensilla are present in both *Culicoides spp.* and are candidates for pheromone perception. The appearance and distribution of each of these will be described.

Current and future investigations will be concerned with the chemical nature of the pheromone produced by *C. nubeculosus* and the possible involvement of pheromones in the behaviour of *C. impunctatus*.

References

Kremer M, M T Ismail & C Rebholtz 1979. *Mosquito News 39(3)*: 627 - 631.

Ljungberg, Håkan[1,2], Hansson, Bill S.[2], Hallberg, Eric[1], Löfstedt, Christer[2]

Cobalt filling of physiologically identified pheromone receptor neurons in the male turnip moth *Agrotis segetum* (Lepidoptera: Noctuidae)

[1]Department of Structural Zoology, Lund University, Helgonavägen 3, S-223 62 Lund, Sweden.
[2]Department of Animal Ecology, Lund University, Helgonavägen 5, S-223 62 Lund, Sweden.

The sex pheromone of *Agrotis segetum* consists of a mixture of (*Z*)-5-decenyl acetate(Z5-10:OAc), (*Z*)-7-dodecenyl acetate(Z7-12:OAc) and (*Z*)-9-tetradecenyl acetate(Z9-14:OAc). On the male antenna, sensilla trichodea containing receptor cells specific for Z5-10:OAc or Z7-12:OAc are present in the ratio 65:35, with the Z5-10:OAc-sensilla dominating on the tips of the antennal branches. Sensilla containing cells specific for Z9-14:OAc make up less than one percent of the sensillum population. The sensilla containing the Z5-10:OAc-specific cell, also house a cell sensitive to Z5-10:OH. By using the tip-recording technique, but replacing the Ringer in the recording electrode with a solution of a cobalt-lysine complex, it is possible to backfill the sensory neurons immediately after identifying their physiological type. In spite of the unconventional electrolyte, the cells often maintained a good response to stimulus for several hours. During the filling, we applied pulses (200ms duration, 0.5 Hz) of the pheromone component stimulating the cell we wished to fill, whereby action potentials were generated in the cell. The action potentials seemed to facilitate the uptake of cobalt by the cell, making it possible to distinguish between cells in the same sensillum, since in most cases only the cell stimulated would fill. After precipitation and intensification of the cobalt stain, the arborizations of the different cell types within the male specific macroglomerular complex (MGC) in the antennal lobes could be studied from wholemounts and serial sections. Histological studies show that the MGC in *A.segetum* is subdivided into four compartments, and our results indicate that the arborizations of different receptors are restricted to different subdivisions.

Hansson, Bill S.[1], Van der Pers, Jan N. C.[1,2], Högberg, Hans-Erik[3], Hedenström, Erik[3], Anderbrant, O.[1] & Löfqvist, Jan[1]

Sex pheromone perception in male pine sawflies, *Neodiprion sertifer* (Hymenoptera ; Diprionidae)

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Electroantennographic and single sensillum recordings were performed on male pine sawfly, *Neodiprion sertifer,* antennae. Responses to the sex pheromone component (2S,3S,7S)- 3,7-dimethyl-2-pentadecenyl (diprionyl) acetate (SSS:OAc), to the behavioral inhibitor (2S,3R,7R)- diprionyl acetate (SRR:OAc), to the six other enantiomers of diprionyl acetate, and to the biosynthetic precursor diprionol were recorded. Responses to *trans*-perillenal, a monoterpene identified in female gland extracts and to (2S,3S,7S)-diprionyl propionate (SSS:OPr), a field attractant for *N. sertifer* and some related sawfly species were also recorded.
EAG recordings demonstrated a high antennal sensitivity to SSS:OAc and to SSS:OPr. A somewhat lower response was elicited by SRR:OAc.
Single sensillum recordings revealed 8-12 different cells firing in each sensillum, corresponding to the number of cells observed in earlier morphological investigations. Out of these cells *all*, except one, responded to SSS:OAc and to SSS:OPr. No differences in the response to the two components could be observed. The largest amplitude cell in each sensillum was specifically tuned to the behavioral antagonist, SRR:OAc. The pheromone perception system encountered in male pine sawflies thus differs clearly from that observed in moths.

Schmidt, Justin O. Pheromonal Mediation of Nest Site Location by Honey Bees. Carl Hayden Bee Research Center, USDA-ARS, 2000 E. Allen Road, Tucson, AZ 85719, USA.

Honey bee reproduction is achieved by a coordinated movement of a queen and a large portion of the colony to a new nest site. This complicated process is almost entirely directed by pheromonal communication, with the major pheromone being a blend of at least seven monoterpenes collectively called the Nasonov pheromone. The purpose of this presentation is to determine the subtle importance of individual components of the Nasonov blend by field bioassays using unmanipulated natural honey bee swarms. The results reveal that the pheromones mediating nest site location operate more like alarm pheromones than sex pheromones; that is, the exact natural blend need not be closely approximated to obtain activity. In fact, use of a blend consisting of citral, geraniol, and nerolic + geranic acids (the thermodynamic equilibrium formed during synthesis) result in complete control of the nest location process. If, however, the nerolic + geranic acid is omitted, significant loss in activity is observed. The role, specificity, and modus operandi of the nest site locating pheromone and its current economic uses will be discussed.

TROUILLER Jérôme, Gérard ARNOLD, Yves LE CONTE, Bertrand CHAPPE and Claudine MASSON. **Secretion of capping pheromones as a function of age in the honey-bee larvae.** Laboratoire de Neurobiologie comparée des Invertébrés. INRA-CNRS F-91440 Bures-sur-Yvette.

In the honey-bee society, brood care is ensured by adult worker bees. They incubate and feed larvae of different sexes and castes differently. When worker larvae are 9 days old, adult bees realize the capping behavior by closing the top of the brood cell with a wax cap. During the same day of development of the larva, the parasitic mite *Varroa jacobsoni* enters the cell before the capping to reproduce on brood.

We showed that among the 10 methyl and ethyl aliphatic esters secreted by the anterior part of the larva, four of them (methyl palmitate, methyl oleate, methyl linoleate and methyl linolenate) elicit the capping behavior of worker adult bees. Three esters (methyl palmitate, ethyl palmitate and methyl linolenate) are attractive to *Varroa* females. The secretion of esters is age dependant and these act as true temporal chemical signal. The esters are present as traces before the 9th day of development of the larva. During this day, the amount of esters strongly increases, up to 15 times. After capping, the amount of esters decreases and the level is lower than the 8th day. In drone larvae, the same esters are also present. The amount of esters increases up to 3 times during the day of the capping. In drone larvae the maximum level of esters is 3.5 times higher than in worker larvae. This can be an explanation of the preference of *Varroa* for drone brood.

Valeur, Peter and Christer Löfstedt. **Behaviour of male *Grapholita molesta* in overlapping pheromone plumes in a wind tunnel.** Lund University, Department of Ecology, Helgonavägen 5, S-223 62 LUND, Sweden

The behaviour of male *Grapholita molesta* was studied in overlapping pheromone plumes in a laboratory wind tunnel. Two baits were placed after each other in the wind tunnel, with 75 cm distance between the baits, making the plumes overlap as much as possible. We varied the total concentration of pheromone and the proportions of different components in the two baits and observed the number of males approaching the different sources. The ratio of components is shown to be more important for a baits ability to attract insects in competition with another bait than the concentration of pheromone. The distant bait (from the males point of view) is shown to have a small competitive advantage when the two baits are identical. A weak bait (0.3 µg) with an optimal pheromone blend gave a significant response (>15 %), even when competing with a strong bait (30.0 µg). The experiments demonstrate a very high discriminatory ability of male moths choosing between different pheromone blends. The males easily find the complete blend in mixtures with various incomplete blends. The results are discussed in the context of mating disruption.

Bolter Caroline, George Lazarovits, Roni Cohen. Relationship between glutathione concentration and resistance to Fusarium wilt in melons and tomatoes. Agriculture Canada, 1400 Western Rd., London, Ontario, N6G 2V4. CANADA.

Dinitroanaline herbicides have been shown to enhance plant tolerance to various pathogenic organisms. The mechanism by which they act is not known, but it is likely that they effect the plant's biochemistry directly. Many herbicides are detoxified by conjugation with glutathione, and since glutathione is also a known activator of host defence, we investigated the possibility that there might be a relationship between induced resistance and glutathione concentration in herbicide-treated plants. Three dinitroanaline herbicides, dinitramine, treflan and surflan and the chloroacetamide, acetochlor were tested in soil pretreatments with tomatoes, against Fusarium oxysporum f. sp. lycopersici and with melons, against F. oxysporum f. sp. melonis.

The concentration of glutathione (GSH), as measured spectrofluorometrically using o-phthalaldehyde (OPT), was found to be significantly higher in both tomatoes and melons after treatment with herbicides that induced resistance. A linear relationship was observed between GSH and resistance in melons, while there appears to be a narrow window of GSH concentration, below which there is no protection and above which protection is complete, in tomatoes. This model system will be used to investigate the potential of other chemicals to induce resistance.

DEJEAN, Alain, NONEGUBU, Paul, and DJUIKWO, Félicité.

Dominant and non-dominant arboreal ants of African rain forest: Comparison of alimentary behaviour. Lab. of Zool., P.O. Box 812, Yaounde, Cameroon.

Dominant arboreal ant species are distributed in a tridimentional mosaic in consequence of their intra- and interspecific territoriality, but, tolerate non dominant species. *Oecophylla longinoda* and *Polyrhachis laboriosa* construct their nests with the leaves of the trees thanks to the silk of their larvae while *Tetramorium aculeatum* utilise a carton. *Crematogaster clariventris* construct large carton nests with vegetal materials of intense defoliation. *Atopomyrmex mocquerisii* is a carpoenter ant while *Plathyrea conradti* and *Camponotus brutus* nest in dead branches of under epiphytes. These species exploit sugary substances supplied by the trees (nectar, fruits) and tend different hemipterans. The Ponerine *Platythyrea conradti* devoid of crop present a behavioural adaptation for the transport of nectar and honeydew. Dominant and co-dominant species hunt in groups. Prey are strocod by several workers, even if the prey is very small. In *Oecophylla longinoda* stretching is sufficient to kill the prey, while in other species there is also biting and stinging. Workers of non-dominant species hunt alone and are first number by venom then carved right on the spot after recruitment of nestmates.

ABSTRACTS:

Posters

ABED Dehbia and FRANÇOIS Jean. **Composition of the tergal and cercal proteinaceous secretion of *Blatta orientalis* (Dictyoptera; Blattidae).**

Laboratoire de Zoologie, C.N.R.S. U.A. 674, Université de Bourgogne, 6 boulevard Gabriel, 21100 Dijon.

Females and nymphs of both sexes of the oriental cockroach, *Blatta orientalis*, accumulate a greyish viscous secretion on their terminal abdominal segments. This material is secreted by glandular cells from the cerci and tergites 6 and 7.
When the cockroaches are isolated or kept in small number, the secretion is more rapidly accumulated.
This secretion, insoluble in organic solvents but soluble in water, is mainly proteinaceous. Its composition in amino acids was investigated by H.P.L.C after HCl hydrolysis.
All the common amino acids are represented but we found that glutamic and aspartic acids were present in unusual amount (respectively, 20 % and 10 % of the secretion).
In *Eurycotis floridana*, another species of Blattidae, only nymphs of both sexes present this type of secretion; the aspartic acid is the more abundant amino acid.
Because of it viscous nature, a defensive function was attributed to these secretions. Not only we failed to prove any defensive activity but we observed that these secretions were eaten by conspecifics. The real function of this secretion will be discussed.

Anaya-Lang, A. L.[1], B.E. Hernández-Bautista[1], M.Jiménez-Estrada[1],L.Velasc Ibarra. [2]. Phenylacetic acid as a main phytotoxic compound of corr pollen.[1] Instituto de Fisiología Celular, and [2] Instituto de Química. U.N.A.M. Apartado Postal 70-600. México, 04510, D.F. Ciudad Universitaria.

Growth regulators and secondary metabolites of pollen can be involved in allelopathic interactions. Peasants of the Valley of Mexico, Tabasco and Yucatan, assert that fruiting of squash, bottle gourd, and watermelon are reduced, and also some leaves of beans are "burned", when corn pollen falls over them. Jiménez-Osornio et al. (1983), confirmed the strong inhibitory effect of corn pollen on the radicle growth of Cassia jalapensis. Cruz Ortega et al. (1988) tested the effects of an ethanolic extract of corn pollen on growth, respiration, and cell division of watermelon. Various inorganic and organic compounds had been reported in corn pollen, also, growth regulators substances, mainly brassinosteroids which have stimulating effects. Any of these studies, except ours, made reference to the inhibitory effects of corn pollen. In this paper, we report the identification of one of the main phytotoxic compound in corn pollen: phenylacetic acid (PAA). The isolation started with a CH_2Cl_2 extract that had an inhibitory effect similar to an ethanolic extract. The compound was identified with GC/ME techniques and compared with pure comercial samples of PAA. Bioassays was carried out testing extracts and pure compounds on germination and radicle growth of Amaranthus leucocarpus and Echinochloa crusgalli. The effect of corn pollen was compared with that of Zea mexicana (Teosinte) one of the wild closest relative of cultivated maize.

Anderson, Peter, Löfqvist Jan. Ovipositional deterrents from larval frass and artificial diet in the turnip moth, *Agrotis segetum* (Lepidoptera: Noctuidae). Department of Ecology, Lund University, S-223 62 Lund, Sweden.

In the turnip moth, *Agrotis segetum,* methanol extracts from larval frass and artificial diet act as very active oviposition deterrents on egglaying females. In a bioassay, where the female has a choice between a substrate treated with a methanol extract and a control substrate treated with the solvent only, less than 10% of the eggs were laid on the extract substrate. The methanol extract was equally active on wild caught females as on laboratory reared. No significant differences could be found between extracts from larval frass and artificial diet.
Chloroform and water extracts were also active, but to a lower extent. When a chloroform extract is applied approximately 20% of the eggs were laid on the extract substrate, while 30% of the eggs were laid on the extract substrate when a water extract was used.
Fractioning of the crude extract on a silica gel column, resulted in two well separated active fractions identified by the behavioural bioassay. One of these active fractions was split on another silica gel column into three new fractions. None of the three was acitive by itself in the behavioural bioassay. When the last two fractions were combined the deterring effect was regained. In conclution at least three fractions in the larval frass and the artificial food are active as deterrents for egglaying females. At least two of the fractions have a synergistic effect.
GC-EAD recordings of crude frass extracts on female antenna did not give any response. In order to further establish where the deterring compounds are perceived, manipulated females were used in two-choice bioassays. Cutting of the antenna off the female did not effect their ability to respond to the deterring extracts. When all six tarsi of the female were treated with 5 M hydrochloric acid, the females ability to respond on the extract was reduced, indicating that sensilla on the tarsi are involved in the perception of the deterring compounds. Contact chemoreceptors on the fore-tarsi of females react to the crude extract of frass with a complex response. At least three of the four receptor cells in the sensilla are activated.

J. AUGER, E. THIBOUT and N. MANDON

HPLC ANALYSIS IN *ALLIUM* LEAVES OF SULFUR AMINO-ACIDS PARTLY RESPONSIBLE OF *ACROLEPIOPSIS ASSECTELLA* OVIPOSITION.

I.B.E.A.S., University F. Rabelais, URA CNRS 1298, Avenue Monge, Parc Grandmont, F 37200 TOURS

An extract of *Allium porrum* leaves induces oviposition by females of *Acrolepiopsis assectella*, an *Allium* specialist phytophage.

Chemical factors responsible for egg-laying are present in numerous fractions obtained by solvent extraction and liquid chromatography. The biological activity of the most active fractions is markedly enhanced by adding different other fractions.

In polar compounds fractions, specific sulfur amino-acids and peptides are identified by HPLC.

Among them only synthetic (+)S-propylcysteine sulfoxide is a weak stimulant. Apolar compounds, probably inactive by themselves synergize this activity.

BAGNERES, Anne G.*, Eric PROVOST*, Jean-Luc CLEMENT*, Luc PLATEAUX**, David MORGAN***. Chemosystematics in Leptothoracine ants. *CNRS-LNB.8, 31, ch.J.Aiguier, F-13402 MARSEILLE cedex 09. **Univ. de Nancy I,Bd des Aiguillettes,B.P.239, F-54506 VANDOEUVRE LES NANCY CEDEX.***Univ. of Keele, Dept of Chemistry,KEELE, STAFFORDSHIRE ST5 5BG U.K.

A comparative analysis has been made of the chemical compounds presents in the cuticle of six species of *Leptothorax*. Five of these species (*lichtensteini, nylanderi, parvulus, unifasciatus* and *racovitzai*) belong to the sub-genus *Myrafant* and the other (*recedens*) belongs to the sub-genus *Temnothorax*.

The mandibular glands of these species contain either an alkylpyrazine or a compound of as yet unknown structure (probably an alkylphenol) or no volatile substance detectable by GC-MS. The Dufour glands contain either pentadecene and pentadecane or no material detectable by GC-MS. In addition, the five major hydrocarbons from the cuticle, other than those which are common to all the species, have been included in the comparisons.

A hierarchical cluster analysis was produced from a matrix constructed by using the criteria of presence (1) or absence (0) of each substance, in such a manner that the sums of each row, corresponding to each of the species, were equal. This grouped the species *L. lichtensteini* and *L. nylanderi* as the two most closely related species, and to a smaller extent, *L. parvulus* and *L. recedens* , species all of which are isolated both geographically and by time of swarm production. *L. unifasciatus* is intermediate between these two groups. *L. racovitzai* is the most distant chemically. It is interesting to compare this classification with that obtained by an enzymological study by Douwes and Stille (1987). In our study, *L. lichtensteini* and *L. parvulus* , although morphologically very similar, were even more different than in the enzymological analysis of Douwes and Stille. The proximity of *L. recedens* to the species of the sub-genus *Myrafant* has been confirmed.

Bellerose, Sylvie, Charles Vincent* and Jean-Guy Pilon. **Effects of Azadirachtin on the biology of the Oblique-banded leafroller, *Choristoneura rosaceana* Harris (Lepidoptera:Tortricidae).** Département de sciences biologiques de l'Université de Montréal, C. P. 6128 Montréal (Québec) H3C 3J7 Canada. *Station de recherche Agriculture Canada, 430 boul. Gouin, Saint-Jean-sur-Richelieu (Québec) J3B 3E6 Canada.

The Oblique-banded leafroller (OBLR), *Choristoneura rosaceana* Harris, is a polyphagous insect that feeds on Rosaceous plants. In Quebec this insect is bivoltine and seriously damages the apple production if orchards are untreated with insecticides. It has recently been demonstrated by Reissig *et al.* (1986) and Bellerose *et al.* (unpublished data) that OBLR is resistant to organophosphate insecticides in North Eastern America. The neem tree, *Azadirachta indica* A. Juss (Meliaceae) is a plant widely distributed in the tropics. Neem seeds contain several secondary chemicals including azadirachtin (AZA) which may exert insecticidal effects among a wide range of insect species. Our objectives were to measure the effects of azadirachtin on 1) developmental parameters and, 2) mortality of OBLR. Larvae were reared individually on a pinto bean diet having the following azadirachtin concentrations: 0, 0.1, 1, 10 ppm. Thirty larvae per treatment were reared from first instar to completion of oviposition. In the first 22 days, larval weight increased more rapidly in untreated (0 ppm AZA) diet than in diets containing azadirachtin. Larval mortality were 17%, 3%, 100% and 100% for respectively 0, 0.1, 1, 10 ppm AZA. Pupal mortality were 0% and 37% for 0, 0.1 ppm AZA. Developmental time (from first larval instar to adult emergence) were 46 and 53 days for 0, 0.1 ppm AZA. From the individuals that developed as pupae, 91% (0 ppm AZA) and 45% (0.1 ppm AZA) of treated pupae emerged as phenotypically normal adults. From these adults egg production was 2.7 (0 ppm AZA) and 0.6 (0.1 ppm AZA) masses per female. Therefore the overall fitness of the Oblique-banded leafroller was diminished when developing on diet containing at least 0.1 ppm of azadirachtin.

Bengtsson, Marie[1] and Liljefors, Tommy[2]. **SEMIOCHEMICAL RELEASE FROM FILTER PAPER SOURCES IN ELECTROPHYSIOLOGICAL ACTIVITY MEASUREMENTS.** [1]**Dept. of Animal Ecology, Ecology Building, Lund University, Helgonavägen 5, S-223 62 Lund, Sweden.** [2]**Dept. of Organic Chemistry 3, Chemical Center, P.O. Box 124, S-221 00, Lund, Sweden.**

The biological activity of pheromone components and analogs can be measured by electrophysiological methods. With these techniques, olfactory responses from an insect antenna are recorded when the antenna is exposed to a test compound via an air stream. Usually, a substance applied on a piece of filter paper is used as an odor source and the dose-response curve obtained is based on amount of stimulus applied on the filter paper.

We have studied the relative amounts of different compounds released from filter paper by gas chromatographic analysis of head space samples. The measurements allow an estimation of the substance amount actually reaching the antenna. The study includes 30 aliphatic compounds, with a chain length varying between 8-16 carbon atoms, saturated or (Z)-mono-unsaturated, and from four functional classes (acetates, aldehydes, alkanes and alcohols). All of them are pheromone components or pheromone analogs.

Our results demonstrate the necessity to take differences of volatility into account when comparing electrophysiological data for compounds of different chain length and/or functional group. We conlude that relative, saturated vapor pressures can be used to estimate relative amounts released from filter paper sources.

Biller, Andreas and Thomas Hartmann. **Are Pyrrolizidine Alkaloids Toxic for Insects?** Institut für Pharmazeutische Biologie der Technischen Universität, D-3300 Braunschweig (Germany).

The effect of pyrrolizidine alkaloids (PAs), such as monocrotaline and senecionine and their corresponding N-oxides on 3 different species of insect herbivores was tested.

The generalist *Spodoptera littoralis* which easily feeds on PA-plants (e.g. *Senecio* spec.) was not at all affected by PAs included in an artificial diet at conc. as high as 50 mM. Oral feeding or injection into the hemolymph of ^{14}C-labelled senecionine and its N-oxide indicated a efficient elimination mechanism. Most of the radioactivity is voided with the frass within 4 to 8 hours.

Epilachna varivestis the mexican bean beetle is a specialist on beans. Under natural circumstances adults and larveas never get in contact with PAs. When fed on bean leaves treated with senecionine a strong repellent effect was observed at PA concentrations >0.25 mM (fresh weight basis). This is well in the range of PA concentrations known from PA plants (e.g. *Senecio vulgaris* 0.3 mM [leaves] and 1.25 mM [flower heads]). The tracer feeding experiments showed that *Epilachna* is less efficient in eliminating PAs from the body. Aprox. 16 to 19% of the PAs fed remained in the insect body. However, neither acute nor long-term toxification could be observed.

The grasshoper *Locusta migratoria* prefers to feed on Poaceae but under conditions of shortage *Locusta* accepts feeding on other plant sources. Leaves treated with PAs were rejected at PA concentrations >12.5 mM. Ingested PAs were efficiently eliminated, <3% of total PAs fed were detectable in animal extracts 48 hours after tracer application.

Biller, Andreas, Adelheid Ehmke, Ludger Witte, Claudine Theuring, and Thomas Hartmann. **Sequestration and Partial Biosynthesis of Pyrrolizidine Alkaloids by the Arctiid Moth *Tyria jacobaeae* L.** Institut für Pharmazeutische Biologie der Technischen Universität, D-3300 Braunschweig (Germany)

Larvae of the cinnabar moth *Tyria jabobaeae* sequester pyrrolizidine alkaloids (PAs) from their host plant *Senecio jacobaea.* Like plants, the larvae store PAs exclusively as N-oxides. Tertiary PAs are taken up as efficient as the respective N-oxides and are rapidly N-oxidized. Both larvae and pupae are able to N-oxidize tertiary PAs. The individual PAs of two chemotypes of *S. jacobaea* are taken up without preference, except the O-acetylseneciphylline and O-acetylerucifoline which are hydrolyzed in the gut and are taken up exclusively as deacetyleated PAs. The insect-PA callimorphine, well known from several arctiids could be identified from pupae and imagines of *Tyria.* Tracer experiments with ^{14}C-labelled retronecine and isoleucine revealed the formation of labelled callimorphine. Hydrolysis of the [^{14}C]callimorphine showed that, as expected, the labelled retronecine is localized in the retronecine moiety whereas the isoleucine is selectively incorporated into the necic acid moiety. The formation of callimorphine is restricted to the very early phase of pupation. Neither larvae nor pupae are able to transform orally fed or injected retronecine into callimorphine. Retronecine fed during early larvae stages is efficiently taken up and stored in the bodies until transformation during pupation. The question is risen whether the synthesis of callimorphine is a physiological need or of ecological significance.

BONAVITA-COUGOURDAN, Annie*, Catherine HABERSETZER**, Anne-Geneviève BAGNERES*, David MORGAN***, Jean-Luc CLEMENT*. **Comparison of cuticular hydrocarbons in slave and slave making ants : *Formica rufibarbis* and *Polyergus rufescens.*** *CNRS-LNB8, 31,ch.J.Aiguier,F-13402 MARSEILLE cedex 09, **CNRS-UPR38, 31, ch.J.Aiguier,F-13402 MARSEILLE cedex 09, ***Univ. of Keele, Dept of Chemistry, KEELE, ST5 5BG U.K.

It has been demonstrated in several experimental studies that in Ants, the species-specific and colony-specific signatures, which take the form of cuticular hydrocarbon mixtures, are liable to vary depending on the social environment. It seemed worth investigating this question in naturally mixed Ant colonies consisting of slave-making Ants (*Polyergus rufescens*) and their slaves (here, *Formica rufibarbis*), which are usually transported to the mixed nest as pupae by the slave-makers after raiding the former's colony.

Analysis of the two species' cuticular hydrocarbon mixtures showed that the constituents were mostly the same : branched and linear alkanes ; the proportions of which differed between the two species. The eight major constituents identified were the same in both species : two alkanes (nC25 and nC27), several monomethylalcanes (5-MeC25, 13-MeC27+11-MeC27,5-MeC27, 15-MeC29+13-MeC29+11-MeC29), two dimethylalcanes (5,13-DimeC27, 13,17-Dime C31). Some unsaturated constituents (alkenes) were found to be present only in *Polyergus*, however, two of them in relatively large proportions (xC23: 1 and xC25: 1).

Comparison between the cuticular spectra (factor analysis of correspondences) of *Polyergus* workers from various colonies, *Formica* workers living in mixed colonies and workers from the original *Formica* colonies from which the latter stemmed showed that the *Formica* workers living in mixed colonies kept the cuticular spectrum of their original colony, apart from some slight variations in the proportions of the constituents.

The natural change of social environment undergone by the *Formica* slaves (involving cohabitation with Ants of a different species) does not seem to bring about any change in their cuticular characteristics.

BONAVITA-COUGOURDAN, Annie*, Guy THERAULAZ**, David MORGAN***, Anne-Geneviève BAGNERES*. Polyethism and cuticular hydrocarbons in *Polistes gallicus*. *CNRS-LNB8, 31, ch. J.Aiguier,F-13409 MARSEILLE cedex 09. ** CNRS-UPR38, 31, ch. J.Aiguier, F-13409 MARSEILLE cedex 09. *** Univ. of Keele, Dept of Chemistry, KEELE ST5 5BG U.K.

The cuticular hydrocarbons of the *Polistes dominulus* Wasp are branched, linear saturated alkanes. Monomethylalcanes were in high proportions (54,4 %) and n-alcanes and dimethylalcanes were present in roughly equal amounts (22,2 and 21,7 % respectively) ; trimethylalcanes amounted to only 1 % of the total compounds.

The foundress can be distinguished from its offspring by differences in the relative proportions of some alcanes (nC31 and nC33) and monomethylalcanes (17-MeC33+15-MeC33+13-MeC33, 7-MeC33, 16-MeC34+14-MeC34, 17-MeC35+13-MeC35) which were the same in all the foundresses studied here and were not major constituents of the cuticular mixture. The ovarian state is linked to the cuticular spectrum since these constituents were present in similar proportions in a foundress and in a descendant with comparably developed ovaries.

In some, but not all cases, it was possible to discriminate between descendants originating from different foundresses on the basis of other hydrocarbons belonging to all the chemical families present. Within a population there existed a gradient among cuticular mixtures through which it was possible to move from a colony to another.

No correlation was observed between the descendants' behavioural profiles and the cuticular hydrocarbon spectra.

BROSSUT, Rémy, P. CHEVIET, D. ABED, O. BONNARD, J.P. FARINE.

Periplanone, the female sex pheromone of Periplaneta americana: but where does it come from?

Laboratoire de Zoologie, U.R.A. 674, 6 Bd. Gabriel 21100 Dijon.

While the chemistry of Periplanone A, Periplanone B and their analogues was exhaustively studied, and their activity evaluated by electroantennography, we still know very few about their biological activity and their origin remains rather ambiguous.

A close observation of calling females, urged us to investigate the function of paired glands, nomally hidden in the genital atrium, which are everted only during this specific behavior.

The activity of gland extracts was compared to those of other parts of the body, especially the gut, involved by several authors in the production of Periplanone, and to pure Periplanone B (graciously supplied by Lehn & Fink, Mont Vale, N.J., USA)

Glands extracts are as attractive as virgin females, while other part of the body are inactive. They were the only tissues in which the Periplanone was found.

Periplanone B alone, triggers a great sexual excitation in males with paroxismic wing raising and wing fluttering, but fails to attract them at a distance. Our current hypothesis is that Periplanone B is only one component of the pheromonal blend and that other compounds (Periplanone A and/or analogues) are necessary to attract the males at a distance.

Brown Jr., Keith S., Clécio Klitzke, C. Berlingeri & P.E. Rubbo dos Santos

CHEMICAL ECOLOGY OF LARVAL HOSTPLANTS OF NEOTROPICAL SWALLOWTAILS

(Laboratório de Ecologia Química, Zoologia/Biologia-UNICAMP, Campinas-SP, Brasil)

To investigate the rôles of secondary chemicals in the mediation of host plant use by sympatric herbivores, we have initiated a broad study of the principal active compounds in leaves of individual plants regularly used by Neotropical swallowtail populations (Lepidoptera: Papilionidae). Included are 15 species of Aristolochia (fed on by Troidini), 3 species of Annonaceae (Graphiini), 3 of Lauraceae and 2 of Magnoliaceae (Graphiini and Papilionini), 4 species of Rutaceae and 2 of Piperaceae (Papilionini), and one of Leguminosae (Baroniinae). A standardized fractionation, initiated with MeOH-H_2O-HCl-$CHCl_3$-hexane maceration of fresh leaves, led to apolar, acidic, phenolic, alkaloidal, glycosidic and other fractions whose principal chemical components were identified and tested, along with mixtures and crude fractions, for effects on divided single cohorts of larvae; storage of plant-derived compounds was also examined. Leaves of almost all swallowtail host plants contain mixtures of sesquiterpene hydrocarbons, phenolic glycosides, benzylisoquinoline alkaloids, and characteristic acids and phenylpropane derivatives; many of the substances in these latter three classes are present in large quantities (up to 15% of dry weight of leaves), ecologically active, and stored. Special attention was given to activities of phenanthrenic and diterpene acids, prenylated phenols, coumarins in general, and quaternary alkaloids in relation to swallowtail larval behavior and adult defensive strategies. Some active compounds known from roots or stems of the plants were present in leaves; they may be actively sought by swallowtail larvae through stem-chewing. In general, the chemical characters of these plants are more helpful than their taxonomic families, in explaining the behavior of larvae and evolutionary aspects of hostplant use. (Aided by the CNPq, CAPES, FAPESP and FAP/UNICAMP)

Phillips, Thomas W., Wendell E. Burkholder, Xiao-Long Jiang, Joel K. Phillips, Hieu Tran-Quoc. **Food Odor Attractants and Pheromone Synergists for Stored-Product Coleoptera.** USDA ARS, Stored-Product Insect Research Unit, Dept. of Entomology, University of Wisconsin, Madison, WI 53706.

Evidence suggests that responses of phytophagous insects to pheromones are typically affected by volatile semiochemicals from host plants. Coleoptera that infest stored grain and other food products use pheromones and also display attraction to food odors. Earlier work from this laboratory demonstrated a synergistic effect from the combination of synthetic pheromone and cracked wheat odors on the response of the maize weevil, *Sitophilus zeamais*. We examined the responses of three species of stored-product beetles to their pheromones and to candidate volatile attractants derived from grain. The beetle species differ in their habits and food preferences: *Tribolium castaneum* is a secondary insect that infests damaged grain and fine material; *Rhyzopertha dominica*, an internal grain feeder, oviposits externally in fine material; *Sitophilus oryzae* infests sound grain and deposits eggs within host kernels. Laboratory responses to a series of grain oils, containing fatty acids and triglycerides, varied among the species. None of the three species were attracted to rice or sesame oils, and *S. oryzae* was markedly repelled by the latter. *T. castaneum* was highly attracted to corn oil while *R. dominica* showed highest responses to soybean oil. The grain-derived flavor volatiles valeraldehyde, vanillin, and maltol elicited attractive responses from *S. oryzae*, but were not highly attractive to *T. castaneum*. A commercial food product, "WGN", made from soybeans and containing volatile flavorings, was highly attractive to *T. castaneum* but displayed no or little activity for *S. oryzae* and *R. dominica*. Low molecular weight volatiles were critical for synergising the response of *S. oryzae* to the synthetic pheromone sitophinone, while the soy-based WGN synergistically enhanced the synthetic pheromone of *T. castaneum*. The importance of grain volatiles for stored-product insects is likely a function of the insect's ecology (primary vs secondary feeder) and the condition of the grain (fresh vs old) from which they are derived.

Camps, F[a]., S. Hospital[a], A. Guerrero[a], A. Delgado[b], M. Ruiz[b]. **Synthesis of potential biosynthetic inhibitors of the sex pheromone of the Egyptian armyworm *Spodoptera littoralis* .** [a]Dept. Biological Organic Chemistry, CID-CSIC, Jordi Girona 18. 08034-Barcelona, [b]Dept. Pharmaceutical Chemistry, Faculty of Pharmacy, Diagonal, s/n. 08028-Barcelona.

In the last few years much attention has been paid to the biosynthesis of insect sex pheromones. Generally, the precursors are common fatty acids which, by specific biosynthetic pathways, can lead to the pheromonal components present in the gland. The development of inhibitors of these processes appears to us as a new and attractive approach to insect control, although to our knowledge very limited efforts along this line have been so far reported.

In the Egyptian armyworm *Spodoptera littoralis* the chain shortening step has been postulated to be the first process involved in the biosynthesis of (Z,E)-9,11-tetradecadienyl acetate, the main component found in the pheromone gland. In this communication, we present the synthesis of new fluorinated, acetylenic and cyclopropanic fatty acids, structurally related to palmitic acid, as putative inhibitors of the chain shortening step. The compounds have been rationally designed either as potential suicide inhibitors, capable of an irreversible alkylation reaction with an active residue of the enzyme, or by blocking the enzymatic oxidation process at 2 and/ or 3 position of the parent palmitic acid through introduction of a fluorine atom, a triple bond or a cyclopropane function.

Cardoso, M. Z. & Brown Jr., K.S. Chemical defense, warning coloration and learning in the system pyrrolizidine alkaloids - vertebrate predator. Depto de Zoologia, IB, C.P. 6109, UNICAMP, Campinas, SP, CEP 13081, Brazil.

Pyrrolizidine alkaloids (PAs) are commonly found in several groups within the Lepidoptera and may provide protection against predators and act as precursors for pheromone biosynthesis. The palatability of the PAs have not been tested systematically against vertebrate predators though they have been shown to protect lepidopterans against a spider predator. In an experimental bioassay, four caged bird predators (Coryphospingus pileatus) were offered mealworm larvae where the PA monocrotaline was applied. The birds were also offered blue-painted larvae with and without the alkaloid, to test for its capacity to elicit a learning process in the predators. After attacking and ingesting some of the PA-treated larvae, all birds subsequently refused to eat them. Blue-painted larvae were rejected by the birds. Prior to this offering, blue painted larvae were readily accepted by the predators. Following this test, blue larvae without PA were rejected by three birds and moderately eaten by one. The results clearly indicate the unpalatability of the PA for predators. Moreover birds were also demonstrated to associate the bad experience with PA with the prey color pattern. The generalization process was not homogeneous, emphasizing the importance of behavioral flexibility among predators in the learning process leading to aposematic coloration and mimicry among unpalatable prey.

Carlson, David
"Human Produced Kairomones for Mosquitoes"
USDA, ARS
1600 SW 23rd Drive, Gainesville, FL. 32608

Studies of animal-produced kairomones that attract blood-feeding arthropods have shown sucess recently with tsetse fly attractants from cattle. Human-produced volatiles have been described for hair, sebum and oral, axial and vaginal cavities using modern analytical methods. Bioassays of the organic compounds described show little effect on hungry mosquitoes in offactometers, particularly the aliphatic acids or adorous aliphatic or heterocyclic amines such as cadanorine, indole or skatol. However, short-chain substituted aliphatic acids such as lactic acid do show offactometer activity, particularly when combined with pharmacological quantities of CO^2. Separation of human-skin produced compounds by HPLC (followed by MS) indicated the presence of lactic acid and other compounds that were active without the addition of excess CO^2 to room air. We describe bioassays and GCMS analysis of low molecular weight acids collected from human skin and derivatized .

The chemical defence of Doryphorina beetles (Coleoptera:Chrysomelidae)

Daloze, D.[+], Braekman, J.C.[+], Randoux, T.[+], Timmermans, M.[+], Pasteels, J.M.[*], and LeSage,L.[++]

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Many leaf beetles (Chrysomelidae) possess chemical defence mechanisms. We have lately shown that representatives of the sub family Chrysomelinae are able to produce *de novo* defensive compounds that are stored in specialized glands. Beetles belonging to the sub tribe Chrysolinina generally produce cardiac glycosides or polyoxygenated steroid glycosides, whereas those belonging to the Chrysomelina and Phyllodectina biosynthesize isoxazolin-5-one glucosides bearing one or two nitropropanoate moieties.

We have now investigated the chemical defence of several representatives of yet another chrysomelid sub tribe, the D oryphorina. The genus *Leptinotarsa* is characterized, whatever the food plant, by the production of amino acid derivatives, with γ-L-glutamyl-L-2-amino-(3Z),5-hexadienoic acid being widely distributed in this genus. One species of the genus *Labidomera*, *L. clivicollis* lives on a cardenolide-producing plant, but its defensive secretion only contained amino acid derivatives. In the genus *Zygogramma*, cardiac glycosides considered till now to be characteristic of the Chrysolinina were unexpectedly found in admixture with amino acid derivatives. In two species of the genus *Calligrapha*, only cardiac glycosides are present, accompanied by ethanolamine. In the latter two genera, the cardenolides must be biosynthesized by the beetles themselves, since they live on plants (*Ambrosia*, *Salix*, *Cornus*) which are devoid of such compounds. This discovery lends support to the hypothesis that the Chrysolinina and Doryphorina are closely related.

DEJEAN, Alain, NONEGUBU, Paul, and DJUIKWO, Félicité.
Dominant and non-dominant arboreal ants of African rain forest: Comparison of alimentary behaviour. Lab. of Zool., P.O. Box 812, Yaounde, Cameroon.

Dominant arboreal ant species are distributed in a tridimentional mosaic in consequence of their intra- and interspecific territoriality, but, tolerate non dominant species. *Oecophylla longinoda* and *Polyrhachis laboriosa* construct their nests with the leaves of the trees thanks to the silk of their larvae while *Tetramorium aculeatum* utilise a carton. *Crematogaster clariventris* construct large carton nests with vegetal materials of intense defoliation. *Atopomyrmex mocquerisii* is a carpoenter ant while *Plathyrea conradti* and *Camponotus brutus* nest in dead branches of under epiphytes. These species exploit sugary substances supplied by the trees (nectar, fruits) and tend different hemipterans. The Ponerine *Platythyrea conradti* devoid of crop present a behavioural adaptation for the transport of nectar and honeydew. Dominant and co-dominant species hunt in groups. Prey are strocod by several workers, even if the prey is very small. In *Oecophylla longinoda* stretching is sufficient to kill the prey, while in other species there is also biting and stinging. Workers of non-dominant species hunt alone and are first number by venom then carved right on the spot after recruitment of nestmates.

Eiras, A.E. & Jepson, P.C. **Behavioural responses of Aedes aegypti (L.) (Diptera: Culicidae) to human odour stimuli.**
Department of Biology, University of Southampton, SO9 3TU, England

In mosquitoes, chemicals signals are the most important cue for the location of hosts for blood meals. The olfactory kairomone system in mosquitoes remains however essentially unknown. Of the range of chemical signals released by vertebrate hosts, there is evidence that carbon dioxide (CO_2), lactic acid and unknown host odours (eg. from sweat) have a role. Precise knowledge of the role of host-related odours is essential to understand the mechanism of host location behaviour by mosquitoes.

Using a wind tunnel bioassay and a video techniques, we have investigated the behavioural responses of female *A. aegypti* to host-related odours. The analysis determined the nature of the response to different stimuli and the concentration ranges within which specific behaviours occurred. We also discriminated between those chemicals or combinations of chemicals which activated host location behaviour and those which acted at a later stage in the sequence.

Carbon dioxide elicited the complete sequence of behaviours from activation to landing and the behavioural thresholds for these responses were determined. Lactic acid was active only when combined with CO_2 and it appears to have a role in early stages of host location behaviour. Unknown host odours elicited later sequence behaviour in the host location, indicating the presence of chemical stimuli, other than lactic acid, active in the short range.

ESCOUBAS P., FUKUSHI K., LAJIDE L., MIZUTANI J., A novel bioassay for rapid isolation of insect antifeedant compounds.
Japan Research and Development Corporation (JRDC), Eniwa RBP, Eniwa-shi Megumino Kita 3-1-1, Hokkaido 061-13, Japan.

The isolation of bioactive natural substances, requires monitoring of all fractionation and purification steps using a bioassay system. This is often a long and tedious process, especially with insect bioassays. We propose here a new method, based on the principle of bioautography, for a quick isolation of insect antifeedant compounds.
TLC plates after migration, are coated with a thin layer of artificial diet, and fed to *Spodoptera litura* larvae. The location of uneaten areas is then compared with the Rf values of the TLC spots, in order to rapidly determine the active fractions. This method allows for a very fast determination of the most active antifeedant compounds in a complex mixture and considerably speeds up the isolation process.
This new method was successfully applied to the identification and isolation of insect antifeedant constituents in the japanese plant *Skimmia japonica* (Rutaceae).

EVERAERTS, C & BONNARD, O.

***Microcerotermes - Megaxenus* relationships: chemical resemblances and differences between the termitophile and its host.**

Université de Bourgogne, Laboratoire de Zoologie, C.N.R.S., U.R.A. 674, 6 Bd Gabriel, 21100, DIJON, France.

The genus *Megaxenus* is the first described termitophiles of the family Aderidae (Coleoptera), living associated to *Microcerotermes* (Termitidae). While early *Megaxenus* instars living at the center of the nest are well adapted to the social system of *Microcerotermes* (trophallaxis exists between the larvae and the termites), pupae and adults are fiercely attacked by *Microcerotermes*. To avoid that, prior to pupation the late instar larvae migrate to the outer part of the nest where they construct web-like cocoons which protects the pupae from the termites.

Extracts of the various castes of *Microcerotermes* and of different *Megaxenus* stages are compared by GC. While the extracts of termites and *Megaxenus* larvae are similar, the extract of *Megaxenus* pupae exhibits a different pattern.

FILIATRE Jean-Claude. **OLFACTORY EXPLORATION MECHANISMS OF THE DOG IN RELATION TO HUMAN.** Laboratoire de Psychophysiologie, UFR Sciences et Techniques, Université de Franche-Comté, Route de Gray, 25030-Besançon, FRANCE.

Recent ethological studies on the interactions between man and his pet dog, have shown different analogies between the behavioural mechanisms developped during intra and interspecific proximal relationships. Two complementary studies allow a better understanding of these mechanisms. The first study mainly characterizes new analogies between exploratory and contact behaviours of familiar dogs, directed towards their environment, their conspecific and their master. The second study mainly shows that the exploratory olfactory behavioural mechanisms of the pet dog in relation to the human adult differ according to whether the adult is known to the dog or not. It also confirms the previous hypothesis concerning the functions of chemical substances emitted by man in the man/animal relational systems (i.e. human's identity and/or emotionnal states determination). Different hypothesis are presented concerning the functions of these behaviours developped by dogs during their social interactions and their importance in Human-animal relationships.

Foster[1], Stephen P., Marion O. Harris[2] and Jocelyn G. Millar[3]. IDENTIFICATION OF THE SEX PHEROMONE OF THE HESSIAN FLY, *Mayetiola destructor* (Say).

[1]D.S.I.R. Plant Protection, Private Bag, Auckland, New Zealand; [2]Dept. of Entomology, Kansas State Univ., Manhattan, KS 66506 USA; [3]Dept. of Entomology, Univ. of California, Riverside, CA 92521 USA.

Wheat is the most widely cultivated plant in the world. The Hessian fly is one of the most destructive pests of wheat and other small grains. Annual yield losses in the United States alone are estimated at $100 million.

Female Hessian flies produce a highly attractive sex pheromone (Mackay and Hatchett, 1984). This pheromone could be of great utility in Hessian fly control programs, both as a tool for monitoring and predicting outbreaks, and potentially for mating disruption of fly populations. We report here the isolation, identification, and synthesis of the major component of the Hessian fly pheromone.

González-Coloma[1], Azucena, Raimundo Cabrera[2], and Braulio Manuel Fraga.
Seasonal variations in diterpene content of Persea indica. Within and between populations considerations.[1] Instituto de Productos Naturales y Agro biología de Canarias, CSIC, Avda. Astrofísico F. Sánchez, 2, 38206 La Laguna Tenerife, Spain. [2]UDI Fitopatología, Departamento de Biología Vegetal, Universidad de La Laguna, Tenerife, Canary Islands, Spain

ABSTRACT.- We have been studying the chemical defences of the tree species Persea indica (Lauraceae). This is an endemic species of the evergreen forest of the Canary Islands, and dates from the Tertiary Period. Our previous studies have demonstrated that extracts of this plant are active against a specialist insect, the endemic Macaronesia fortunata (Lepidoptera: Lymantriidae) and a generalist insect, Heliotis armigera (Lepidoptera: noctuidae). From a bioassay-guided fractionation of these extracts we have purified and characterized two toxic diterpenes: ryanodol and cinnceylanol.

Because of the potential of this plant for use as a natural pesticide, and also due to its evolutionary importance, we have recently developed an HPLC method to quantify both products in P. indica extracts. We have selected two populations located in the island of Gomera (Garajonay National Park, Canary Islands) consisting of twenty mature trees per population, terminal twigs of which were seasonally collected during 1989-90 from marked branches. Three twigs per tree were oven-dried (60°C) and pooled to give the extracts. Total phenol content, total nitrogen and the ryanodol and cinnceylanol content of these extracts have been determined along with the water content of a second set of twigs collected simultaneously.

The results obtained from this experiment will be discussed in the light of resource allocation to plant defences in this tree species.

Harmatha, Juraj (1), Jan Nawrot (2) and Václav Rupeš (3).
Antifeeding and synergistiç effect of lignans with insecticides towards insect pests. (1) Institute of Organic Chemistry and Biochemistry, 16610 Prague, Czechoslovakia, (2) Institute of Plant Protection, 60-318 Poznań, Poland, (3) Institute of Hygieny and Epidemiology, 10042 Prague, Czechoslovakia.

A series of more than 20 lignans and monomeric phenylpropanoids selected to represent the main types and forms, were tested for feeding deterrent activity againt three species of insect storage pests: Sitophilus granarius, Tribolium confusum and Trogoderma granarium by a standard method /1,2/. The relation between their structure and activity was investigated. The most effective were yatein, hinokinin and cubebin, lignans, containing the methylenedioxyphenyl (piperonyl) unit. Some of the lignans were tested also on the terrestrial termites Coptotermes formosanus with good results. There was tested also the synergistic activity of some lignans with Permethrin on housefly, Musca domestica. One of the cubebin derivatives has been as active as piperonyl butoxide.
1. J.Nawrot et al.: Acta Entomol.Bohemoslov. 83, 327 (1986)
2. J.Harmatha et al.: Biochem. Syst. Ecol. 12, 95 (1984).

Harmatha, Juraj (1), Jan Nawrot (2) and Václav Rupeš (3). **Antifeeding and synergistic effect of lignans with insecticides towards insect pests.** (1) Institute of Organic Chemistry and Biochemistry, 16610 Prague, Czechoslovakia, (2) Institute of Plant Protection, 60-318 Poznań, Poland, (3) Institute of Hygieny and Epidemiology, 10042 Prague, Czechoslovakia.

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2. J.Harmatha et al.: Biochem. Syst. Ecol. 12, 95 (1984).

Hobson, Kenneth, David Wood, Isao Kubo, Toshikazu Ohtsuka, Peter White, Laurence Cool, Eugene Zavarin. Stereospecific Attraction of the Red Turpentine Beetle *Dendroctonus valens* Leconte to Host Volatiles of Ponderosa Pine *Pinus ponderosa* Lawson. Dept. Entomological Sciences, University of California, Berkeley CA. 94720 USA.

D. valens is attracted in the field to resin monoterpenes of ponderosa pine. Using a field behavioral assay β-pinene was found to be the most attractive single compound in oleoresin. Strong stereospecific attraction was discovered to the *R* enantiomer of α-pinene while the dominant *S* enantiomer interrupted attraction. There was no consistent evidence of synergistic interactions among the monoterpene attractants. No differences were found in the response of the two sexes. Electroantennogram analysis of resin fractions and pure compounds paralleled the field responses with the significantly anomalous reversal of the response to the two enantiomers of α-pinene. Beetles at the study site appear to be most attracted to the principal components of the resin of their two local host species i.e. β-pinene in *P. ponderosa* and *R*-α-pinene in *P. lambertiana*. The relative preference of *D. valens* for the monoterpenes of its host's resin may serve as the basis for host selection.

Klitzke, C.F. and K.S. Brown Jr. CHEMICAL ASPECTS OF NEOTROPICAL TROIDINI/*ARISTOLOCHIA* RELATIONSHIPS. Departamento de Zoologia, UNICAMP, CP 6109, 13081, Campinas, SP, Brazil.

Chemical analysis of adults of eight species of neotropical Troidini (Lep., Papilionidae) showed the presence of aristolochic acids (AAs) (10 - 120µg/individual) as well as in leaves of five foodplant species (*Aristolochia*). Leaves of other four *Aristolochia* species showed no AAs but had large amounts of labdanoic acids (LAs). Laboratory cultures of *B. polydamas* larvae on two foodplants showed best development on *A. arcuata*, and reduced feeding, slow growth and death of fifth instar larvae on *A. galeata*. Cultures of *B. polystichtus* on various foodplants also showed best development on *A. arcuata*; larvae died in the first instar on *A. macroura* and *A. galeata*. Addition of LAs to *A. arcuata* leaves deterred feeding in *B. polystichtus*, but not in *B. polydamas*. AA-I added to *A. galeata* leaves showed phagostimulatory effects for *B. polydamas*, but not for *B. polystichtus*. In the field, fifth instar larvae of *B. polydamas* are often observed feeding on *A. galeata* stems or flowers. Chemical analysis indicated AAs in these tissues as well as in roots. Addition of AA-I to *A. galeata* leaves (400µg/g) aided complete development of *B. polydamas* fifth instar larvae. This suggests that AA-I is necessary for complete development of immature stages. Chemical analysis of *B. polydamas* larvae reared on *A. galeata* leaves showed AAs (15 - 40µg/individual) indicating possible endogenous synthesis, since these compounds are not present in the leaves. Benzylisoquinoline alkaloids, the presumed precursors of AAs, were found in leaves of all *Aristolochia* species and were stored by all Troidini examined.

L. Legal, J.M. Pechine and J.M. Jallon

CUTICULAR HYDROCARBONS AND SEXUAL STIMULATION IN THE SPECIES *D. MERCATORUM*

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Among the communication signals of *Drosophila mercatorum*, only the acoustic signals have been studied but extensively; two types of pulse songs -A and B- are performed by males at different times of courtship, with racial variation.

As for other Drosophila species, the female sex-appeal consists in a shape /size component and a chemical component which has been extracted and is linked to cuticular compounds.

Gas-chromatography coupled to mass-spectometry shows a marked sexual dimorphism among cuticular long chain hydrocarbons. Major hydrocarbons have 29 and 31 carbons for males and 33-37 carbons for females in the Oahu strain. Both sexes have abundant dienes together with branched alkanes. While either sex dienes have double bonds on both sides -a marked difference with those of *D. melanogaster* mature females but a similarity with these of young *D. melanogaster* flies- female dienes show a more complex mixture of position isomers with more internal position.

Ljungberg, Håkan[1], Hansson, Bill S.[2]

Cobalt filling of physiologically identified pheromone receptor neurons in the male moth *Agrotis segetum* (Lepidoptera: Noctuidae)

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The sex pheromone of Swedish *Agrotis segetum* consists of a mixture of (*Z*)-5-decenyl acetate(Z5-10:OAc), (*Z*)-7-dodecenyl acetate(Z7-12:OAc) and (*Z*)-9-tetradecenyl acetate(Z9-14:OAc). On the male antenna, sensilla trichodea containing receptor cells specific for Z5-10:OAc or Z7-12:OAc are present in the ratio 65:35, with the Z5-10-sensilla dominating on the tips of the antennal branches. Sensilla containing cells specific for Z9-14:OAc make up considerably less than one percent of the sensillum population. The sensilla containing the Z5-10:OAc-specific cell, also house a cell sensitive to Z5-10:OH. By using the tip-recording technique, but replacing the ringer in the recording electrode with a solution of a cobalt-lysine complex, it is possible to backfill the sensory neurons immediately after identifying their physiological type. Earlier, pulses of depolarizing current have been used to enhance the migration of cobalt ions into the neuron. In this study we applied pulses (200ms duration, 0.5 Hz) of the pheromone component stimulating the cell we wished to fill, whereby action potentials were generated in the cell. In spite of the cobalt, the cells often maintained a good response to stimulus for several hours. The action potentials facilitate the diffusion of cobalt along the nerve, making it possible to distinguish between cells in the same sensillum, since in most cases only the cell stimulated will fill. After precipitation and intensification of the cobalt stain, the arborizations of the different cell types within the male specific macroglomerular complex (MGC) in the antennal lobes could be studied from wholemounts and serial sections. Histological studies show that the MGC in *A.segetum* is subdivided into four compartments, and our results indicate that the arborizations of different receptors are restricted to different subdivisions.

CUTICULAR HYDROCARBON PATTERNS OF THE TENEBRIONID BEETLE GENUS BLAPS AS A CHEMOTAXONOMICAL TOOL.

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The pattern of cuticular hydrocarbons of several species of the tenebrionid genus Blaps has been examined for its applicatbility as a chemotaxonomical tool. By means of cluster analysis we compared the hydrocarbon pattern of totally 70 individuals of 11 different species. Our results show that it is possible to differentiate between species by means of hydrocarbon patterns. The "chemical" determination of previously unidentified specimen was confirmed by a specialist. Also individuals from museum collections can be identified comparing them with freshly killed beetles of the same species.
However, it is very difficult to interprete our data from a phylogenetic point of view. The systematical relationship proposed by SEIDLITZ (1898) in the only revision on Blaps are not reflected in the clustering scheme. In a about half of all Blaps species the males are endowed with an abdominal sternal gland. The possession of this gland does not agree with the clustering scheme of cuticular hydrocarbons. So our findings suggest that the hydrocarbon pattern is not an appropiate feature concerning phylogenetic questions in Blaps.

Millar, Jocelyn G.[1], Michael Giblin[2], Dennis Barton[2], John W. Wong[2], and Edward W. Underhill[2]. SEX ATTRACTANTS AND SEX PHEROMONE COMPONENTS OF THE NOCTUID MOTHS *Euclidea cuspidea*, *Caenurgina distincta*, AND THE GEOMETRID MOTH *Eupithecia annulata*.

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3*Z*,6*Z*,9*Z*-Heneicosatriene (3*Z*,6*Z*,9*Z*-21:H) and 3*Z*,6*Z*-*cis*-9,10-epoxyheneicosadiene (3*Z*,6*Z*-*cis*-9,10-epoxy-21:H) have been identified in pheromone gland extracts from female *Euclidea cuspidea* and *Eupithecia annulata*. Several analogous compounds were also tentatively identified from *E. cuspidea* extracts. Male *E. cuspidea* were attracted to a 45:1 blend of the triene and the 9*S*-10*R* enantiomer of the epoxide, while *E. annulata* males were attracted to 3*Z*,6*Z*-9*S*,10*R*-epoxy-21:H or to the C_{20} analog. Male *Caenurgina distincta* moths were attracted by 8:1 blends of 3*Z*,6*Z*,9*Z*-20:H with 3*Z*,6*Z*-9*S*,10*R*-epoxy-20:H.

The chemical nature and origin of the abdominal substance of the social wasp *Liostenogaster flavolineata*.

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One of the most peculiar traits of Stenogastrinae wasps is the secretion of a viscid, milky secretion which they place on their eggs and young larvae. Examination of the secretion on the eggs of *Liostenogaster flavolineata* (Hymenoptera: Vespidae: Stenogastrinae) by gas chromatography-mass spectrometry and micro-intrared spectrometry showed that it consists of an emulsion of the Dufour gland contents, water and fructose. The Dufour gland contents in turn, consist of a mixture of long chain linear hydrocarbons (chiefly heneicosane, tricosane and 9-tricosene) and two homologous alkoxyethanols (eicosanyloxyethanol and docosanyloxyethanol). The alkoxyethanols are found in nature for the first time. They are well known in industrial chemistry as emulsifying agents and surface-active agents inhibiting evaporation. The fructose solution presumably comes from the crop and is emulsified with the Dufour gland contents by the adult wasp.

This provides a unique example of the use of the Dufour gland secretion in Vespidae and the alkoxyethanols are a unique application of emulsifying substances in nature.

Do Ca^{++} and Mg^{++} ions regulate the activity of the ß-glucosidase involved in the cyanogenic system of the larvae of *Zygaena trifolii* (Insecta : Lepidoptera)?

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The cyanogenic glucosides linamarin and lotaustralin and a linamarin/lotaustralin specific ß-glucosidase (linamarase) are both present in the serum of the haemolymph of the larvae of the five spot burnet moth. Nevertheless, no liberation of hydrogen cyanide occurs from the freshly prepared haemolymph. Addition of chelating agents, however, causes a rapid and effective cyanogenesis. Ca^{++} (c.10 mM) and Mg^{++} (c. 20 mM) are the predominant ions present in the serum. The crude haemolymph, crude enzyme preparations and the purified linamarase were employed for experiments. Using the haemolymph a dose dependend activation was observed upon incubation with EDTA and citrate buffer; this effect was nearly totally antagonized by addition of Ca^{++} and Mg^{++}. Using the purified linamarase a 75% inhibition occurred upon incubation with 10 mM Ca++/Mg++ in a 1:2 molar ratio at the pH of 6.2 of the haemolymph. These results present evidence that Mg^{++} and Ca^{++} ions are involved in the control of cyanogenesis in *Zygaena trifolii*.

Naya Yoko, John Wetzel, Mayumi Ohnishi, and Hiroaki Noda *

A KEY STEROL PRODUCED BY INTRACELLULAR SYMBIOTES IN PLANTHOPPERS

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In general, insects cannot synthesize sterols and have to obtain them for their development through the dietary sources. According to our working hypothesis, homopterous insects, the brown planthopper (*Nilaparvata lugens* Stal) and the smaller brown planthopper (*Laodelphax striatellus* Fallen) were evolved to utilize a C_{28} sterol provided by their intracellular yeastlike symbiotes. Our recent study revealed that the major sterol (>85%) present in the symbiotes, which were separated by Percoll density gradient centrifugation from both insect species, was ergosta-5,7,24(28)-trien-3β-ol, (erroneously assigned to ergosterol by Eya *et al.*, 1989). The co-occurrence of minor biosynthetic precursors in the symbiotes indicated that the symbiotes synthesized C_{28} sterols from lanosterol and ergosta-5,7,24(28)-trien-3β-ol was the end product in the symbiotic environment. After removal of symbiotes, cholesterol, 24-methylene cholesterol, and ergosta-5,7,24(28)-trien-3β-ol were found in the insect lipid fraction (2:7:1). The later was the only sterol found in substantial quantities in both the symbiote and insect lipid fractions. This sterol was apparently supplied by the symbiote to the host insect, since removal of symbiotes by heat treatment experiments led to its disappearance, as well as to a 10-fold reduction in total sterol content in insects hosting symbiotes. Biotransformation of the various ^2H-labeled precursors by the insects was examined and will be discussed in detail.

Isaiah O. Ndiege[1], William J. Budenberg[1], Florence W. Karago[1], Wilber Lwande[1], Bill Hanson[2] and Ahmed Hassanali.

Host Location and Aggregation Mechanisms in the Banana Weevil (Cosmopolites Sordisus): A preliminary study.

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Banana Weevils are attracted to cut pieces of banana rhizome and pseudostem as well as to volatiles trapped from these parts in a susceptible cultivar. Female weevils were attracted to males but not females. Both sexes were attracted to volatiles trapped from males and gave large EAG responses to those volatiles. The results suggest the presence of a male-produced aggregation pheromone.

The trapped airborne volatiles from the pseudostem have been identified by GC-MS as mono- and sesquiterpenes. However, volatiles from the rhizome have been identified as consisting of predominantly aliphatic ketones and alcohols. The monoterpenes from the pseudostem elicit stronger EAG responses than the sesquiterpenes.

Chromotographic comparison of the airborne volatiles from the pseudostems of a susceptible and a resistant cultivars showed differences in the chemical compositions of both. However, behavioural bioassays of the two sets of volatiles revealed no significant differences in the response of the weevil. This suggests that factors other than volatiles are responsible for cultivar susceptibility.

Nishida, Ritsuo and Hiroshi Fukami

Oviposition Stimulant of a Zerynthiine Swallowtail Butterfly, *Luehdorfia japonica*

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Luehdorfia japonica Leech (tribe Zerynthiini, Papilionidae) is a swallowtail butterfly whose larvae feed exclusively on the plant genus *Heterotropa* (Aristolochiaceae). *L. japonica* females were strongly stimulated to lay eggs on filter paper treated with a methanolic extract of the host plant leaves (*H. aspera*). The oviposition stimulant factor appeared to be composed of a mixture of several components with highly polar nature. One of the oviposition stimulants was isolated as a crystalline solid from the aqueous layer. The compound was found to be a flavonol glycoside (an isorhamnetin triglycoside), the strucutural elucidation of which is now in progress. This compound was inactive alone but induced the specific oviposition response from *L. japonica* females when tested as a mixture with other unidentified polar components.

Flavonoid glycosides have been characterized as the key ingredients of oviposition stimulants for several papilionid species in the tribe Papilionini, while aristolochic acids have been identified as the less polar stimulant components for the Aristolochiaceae-feeders in the tribe Troidini. Utilization of a flavonoid glycosides as a host-finding cue by a 'primitive' Aristolochiaceae-feeder, *L. japonica*, is intriguing, since the tribe Zerynthiini might be closely associated with the ancestral host plants of the Papilionidae.

ORDONEZ-GIRALDO, A.I. and J.P., FARINE: **Sexual behavior and chemical signals in *Eurycotis floridana* (Dictyoptera, Polyzosteriinae).**

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In *Eurycotis floridana*, the male initiates the sexual behavior by emitting a volatile sex pheromone which attracts the female at a distance. It adopts a calling posture, exposing its 8th tergite. In response, the attracted female opens its genital atrium; this increases the excitation of the male which adopts a "parade" posture, exposing tergites 2, 7 and 8. The female climbs onto the male and licks aphrodisiacs on tergites 1 and 2. Then, both sexes are in a proper position for mating.

GC-MS analysis of extracts from male tergites 7 and 8 indicates that about 25 chemical compounds are specific to the male. (2R,3R)-butanediol and dodecanol are the major components in tergite 8, whereas the major compound produced by tergite 7 has a strong caramel odor; this last compound is not yet identified.

Our preliminary observations suggest that secretory products of tergite 8 are responsible for the long-range attraction of the mature females. The same results are obtained by using (2R,3R)-butanediol.

M. Pennanec'h, A. Trémolières, J.M. Pechine and J.M. Jallon

BIOSYNTHETIC STUDIES OF CONTACT PHEROMONES OF *DROSOPHILA MELANOGASTER* AND RELATED SPECIES

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Chemical cues -mainly contact pheromones- play a predominant role in initiating male courtship behavior in *D. melanogaster* and related species of the melanogaster subgroup. The pheromonal blend of mature flies consists of long chain hydrocarbons (23 to 29 C), including monoenes and dienes, with at least one double bond in position 7, are particularly important; and there are sex and species-differences.

To study the biosynthesis of these compounds, we used a number of labelled precursors which are topically applied to flies of different sexes, species and ages. We then followed the incorporation of radioactivity in separated lipid classes which are split later on depending on their level. Finally, all the fatty acids involved were studied by GC-MS.

Our studies suggest the involvement of a small number of enzymatic steps, some of which are common to all biosynthetic pathways, whilst a few are sex and species specific.

In vitro studies of desaturation and elongation have also been begin, using radio-chromatography (GC and HPLC).

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STUDY OF HONEYBEES-RAPESEED INTERACTIONS : BEHAVIORAL AND CHEMICAL APPROACHES

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Oilseed rape *Brassica napus* is partially autogamous, but its abundant nectar and pollen attract numerous insect pollinators. Studies of rapeseed pollinating agents have indicated that the plant benefits from insect visitation, despite the high efficiency of wind pollination. The recent development of plant breeding programs using cytoplasmic male sterility to create hybrid varieties, and the application of genetic engeneering to rapeseed, leading to the introduction of new properties such as disease and insect resistance, have focused interest on the role of pollinating insects, particularly honeybees, and factors affecting plant-insect relations. Therefore, we have carried out combined experiments under both natural and controlled conditions to study these interactions. Behavioral assays were conducted in a flight room on (i) fresh plants, to evaluate foragers preferences among different rapeseed genotypes, on (ii) an artificial flower feeder device, to discover bees' preferences among different sugar solutions mimicking floral nectar. Samples of nectar were collected from different genotypes, to measure the amounts produced and to analyze the sugar composition, by high performance liquid chromatography. A coupled gas chromatography-behavior method was developed, using the conditioned proboscis extension reflex in individual bees as a bioassay, to locate behaviorally active components in complex plant extracts. Using these combined approaches, it was possible to define plant constituents which may be involved in honeybees selective foraging behavior on rapeseed genotypes. Such data may provide a better understanding of plant factors affecting cross-pollination and lead to the establishment of reference experiments to evaluate the impact of genetically modified plants on beneficial insects.

Dang Ba PHO

ANTENNAL PROTEINS IN *DROSOPHILA MELANOGASTER*

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A biochemical study of *Drosophila melanogaster* antennal proteins has been undertaken in order to get informations about olfactive transduction.

The antennal sensilla involved in chemoreception are located on the third segments of the antennae. A technique for isolation and accumulation of these segments has been designed. Under certain conditions, it provides well preserved segments the various sensilla of which are intact. This allows the production of extracts enriched in the antennal proteins potentially implicated in olfaction.

Comparative electrophoresis has first been performed on extracts obtained from young and mature males and females (6h, 24h and 96h after emergence), sensitivity to sexual pheromones being the exclusive characteristic of adult ones.

In SDS-electrophoresis , at least two marked differences are observable.

The first one appears to be age-related. A 26 kDa polypeptide doublet present in 6h flies, almost disappears in 24h flies and is replaced by another polypeptide with a similar molecular mass, in both males and females.

The second one points out a sexual dimorphism in adults. A set of 45-46 kDa polypeptides absent at 6h, becomes apparent at 24h and markedly increases at 96h, but this is observable only in females.

Native electrophoresis also reveals differences which are reminiscent of the age- and sex-related differences observed in SDS-electrophoresis. Besides, it also detects other polypeptides which appear to be male specific.

With our isolation technique it is thus possible to initiate a comparative study capable of detecting differences in the antennal proteins obtained from flies differing in their olfactive abilities. This is being extended to mutants which exhibit specific anosmias. A tritiated pheromone, 3H-vaccenyl acetate, is also used to determine whether it interacts with any of the proteins detected by comparative electrophoresis.

Besides, preliminary results of ADP-ribosylation also show the presence of two *Pertussis* toxin substrates in the extracts of third antennal segments , the apparent molecular masses of which are 40 and 41 kDa.

EFFECTS ON TEN MEDITERRANEAN BOTANICALS AS PROTECTANTS OF KIDNEY BEAN (*PHASEOLUS VULGARIS* L.) AGAINST THE PULSE BORER *ACANTHOSCELIDES OBTECTUS* SAY.

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Acanthoscelides obtectus Say is one of the most damaging borer for Leguminosae ; its host plant is the kidney bean, *Phaseolus vulgaris* L., one of the first alimentary pulses. To protect their stored products, farmers of South-West of France use to put with the seeds scented plants commonly considered as condiments for cooking or herb tea.

To test the efficiency of these practices, the effects of ten mediterranean botanicals on physiological behaviour of *A. obtectus* have been evaluated: ovipositionnal activity, growth inhibition and adults mortality.

The results show that some of these botanicals, especially aromatic plants, present a non negligible activity . Further investigations, to identify the efficient compounds, are presently carried on in the laboratory.

New aggregation pheromone in a Curculionidae species: Rhynchophorus palmarum

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The American palm weevil (APW) *Rhynchophorus palmarum* (L.) is a major pest of cultivated palms in the neotropical region. This weevil belongs to the Rhynchophorinae subfamily as do the *Sitophilus* species.

Field trapping with caged APWs and laboratory bioassays with adsorbent-trapped volatiles from APWs proved APW males to produce an aggregation pheromone. The pheromone was identified as *E*(2)-hepten-4-hydroxy-6-methyl (Rhynchophorol) mainly through GC-MS, [H^1]-NMR spectrometry, authentic compound synthesis, GC-EAD, EAG and pitfall bioassay.

Volatile collections showed that APW males released their aggregation pheromone only when they were feeding on their host-plant. Then the releasing of Rhynchophorol by APW males acts as a signal for suitable food resource as suggested for other aggregation pheromones of Coleoptera. The carbon skeleton of this pheromone suggests also a biosynthetic pathway from host-plant terpenoid precursors.

The structure of Rhynchophorol appears to be closely related to Scolytid aggregation pheromones such as sulcatol and ipsenol whereas it differs from those of known aggregation pheromones of *Sitophilus* species that are taxonomically more closely related.

The identification of the APW aggregation pheromone is a new contribution to the knowledge of pheromone systems in the largest Insect family which remains one of the less investigated in the field of chemical ecology.

SCHAAL, B.*, ORGEUR, P.**, LECANUET, J.P.* and POINDRON, P.**, FIRST DATA ON NASAL CHEMORECEPTION IN THE FETAL SHEEP.

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In utero chemoreception having been firmly demonstrated in murine rodents, the generality of similar sensory competence was worth to be studied in fetuses of nonrodent placental mammals.

Two 144G-day sheep fetuses were externalized to be implanted with 3 intra-nasal catheters and heart-rate electrodes. The catheters served to inject contrastedly flavoured odorants: 1) isotonic saline (IS) as a control; 2) citral (CI; 1,7% in IS); methyl-2-thiazoline (MT; 10% in IS). A total of 6 and 10 successive 100µl stimulations were administered to each fetus, the left nare receiving CI and MT, the opposite nare receiving IS infusions. The order of infusion was CI-IS-MT in both fetuses. The dependent variable was fetal heart rate (FHR) variation, picked up by EKG.

The intranasal infusions of flavoured solutions induced differential FHR variations: 1) MT infusions induced reliable FHR decelerations in both fetuses; 2) CI induced a mean weak accelerative effect in one fetus, but not the other; 3) no significant FHR changes were obtained after IS injections, which allowed to exclude confounding somesthesic effects associated with the fluid injections.

The differential effects of both odorants is discussed in relation to their contrasted physico-chemical and hedonical properties. The present results represent the first demonstration of functional nasal chemoreception in the ovine fetus tested in utero. Nasal chemoreceptive function originally shown in murine rodents may thus be extended to the fetuses of other taxa of placental mammals.

IDENTIFICATION OF THE MALE SEX PHEROMONE OF THE COCKROACH *Leucophaea maderae F.*

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Abstract: In *Leucophaea maderae* , the male triggers the sexual behavior, it adopts a "calling posture" (abdomen raised and flexed upwards) while emitting a volatile sex pheromone which attract the receptive female at distance. The male sex pheromone was isolated from adult sternal glands (sternites 2-8) and identified by gas chromatography-mass spectrometry. In sternal glands extracts, there are more 20 compounds but only 5 are specific to the males: 3-hydroxy-2-butanone (acetoin), (2,3)-butanediol, 3-methyl-2-butenoic acid (senecioic acid), E-2-methyl-butenoic acid (tiglic acid) and (E)-2-octenoic acid. These 5 compounds represent more than 90% of the volatile secretion (14%, 2%, 72%, 1% and 3% respectively).
The bioassays show that the male pheromonal blend is a mixture of 3-hydroxy-2-butanone which attracts females at distance (attractivity<1ng), 3-methyl-2-butanoic acid and (E)-2-octenoic acid which act as arrestants keeping the females near the males. We failed to demonstrate any activity for (2,3)-butanediol and tiglic acid which however are specific to the males.

Key Words: 3-hydroxy-2-butanone, 3-methyl-2-butenoic acid, (E)-2-octenoic acid, sexual behavior, calling posture, cockroach, *Leucophaea maderae*, Blattaria, Dictyoptera.

AGGREGATION BEHAVIOR OF THE PINE ENGRAVER BEETLE, *IPS PINI* (SAY) IN RESPONSE TO ENANTIOMERICALLY PURE IPSDIENOL.

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The aggregation pheromone of the pine engraver beetle, *Ips pini*, was isolated by extraction of the frass and Porapak trapping of volatiles from male-infested logs and identified as ipsdienol (2-methyl-6-methylene-2,7-octadien-4-ol)(Birch *et al.* (1980) *J. Chem. Ecol.* 6(3): 703-717 and Lanier *et al.* (1980) *J. Chem. Ecol.* 6(3): 677-687). Using Porapak trapping of volatiles and normal phase HPLC, we have re-isolated ipsdienol and determined its enantiomeric composition from more than ten populations of *I. pini* collected throughout North America. After purifying gram quantities of (R)- and (S)-ipsdienol by preparative HPLC, we have conducted a behavioral dose-response study of *I. pini* to the pure enantiomers at a field site in California.

Smith, T.E. & D.H. Abbott. **The importance of non-volatile components in the circumgenital scent secretion of the common marmoset, *Callithrix jacchus jacchus*.** Institute of Zoology, Zoological Society of London, Regent's Park, London, NW1 4RY, U.K.

The common marmoset, *Callithrix jacchus*, an arboreal, group living primate from South America has a well developed olfactory communication system. Specialised scent glands together with specific behaviour patterns and morphological adaptations effect efficient deposition and reception of scent material. Marmosets investigate scent material with sniffing, licking and close contact 'muzzling' behaviours. The two latter behaviours possibly promote the sampling of non-volatile material mediated via taste or the vomeronasal organ. Behavioural discrimination tests employing scent material from a foreign donor group as an attractive odour source, show that water soluble, non-volatile components do contribute to the attractiveness of scent material. Polyacrylamide gel electrophoresis of a sterile aqueous scent mark extract reveals the presence of 3 major proteins irrespective of donor gender or hormonal status (approx. 80KD, 55KD and 16KD). Subsequent behaviour tests show that *Callithrix jacchus* make subtle discriminations between aqueous extracts in which the proteins have been digested and those in which they have not. We suggest that non-volatile material, in particular the proteins, are a biologically relevant component of the circumgenital scent secretion of *Callithrix jacchus*.

Soetens, Philippe. **Host plant suitability of willows and poplars for two Salicaceae specialists : *Phratora vitellinae* and *Ph.tibialis* (Coleoptera: Chrysomelidae).**

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Ph.vitellinae is oligophagous on different species of willows and poplars. The larvae of this species use salicin and salicortin as precursors of salicylic aldehyde which is used as a defensive secretion. *Ph.tibialis* is monophagous on *Salix purpurea* in nature. The larvae secrete methylcyclopentanic monoterpenes of autogenous origin.
10 different host plants were offered to the beetles; 5 willows (*S.alba, S.babylonica, S.caprea, S.fragilis, S.purpurea*) and 5 poplars (*P.deltoides, P.deltoides x nigra, P.nigra, P.trichocarpa* and *P.trichocarpa x deltoides*). Phenoglucoside, mono- and disaccharide and water content, as well as trichome density of the leaves were determined for each plant.
Feeding preference, growth rate, fecundity and survival on the different plants were assessed for the two *Phratora* species.
Plant characteristics and beetle performances were tentatively related using multivariate statistical methods.

Noureddine SOLTANI, Ecological study on codling moth in Annaba (Algeria): efficiency of traps, fluctuation of population and infestation of quince varieties. Departement de Biologie Animale, Université de Annaba BP.12. 23 000 - Annaba (Algérie).

Codling moth (*Cydia pomonella* L. : *Lepidoptera, Tortricidae*), is a major pest of many crops (Apple, Quince and Pear) in Algeria.This study was conducted in a quince orchard at Annaba and aimed at determining :

1) the efficiency of three types of traps,
2) the annual fluctuation of codling moth population, and
3) the infestation rate of two quince varieties.

Three traps with variable design (Pherocon CM A, Pherocon CM B : Zoecon Corporation, USA: Reamol GF: Reanal, Hungaria) were tested against adult males, during the main flight period. The traps were baited with a synthetic sex pheromone (codlemone : Zoecon Corporation, USA), Male captures showed that the Pherocon CM B trap was most effective, and was chosen for further studies and agricultural surveys.

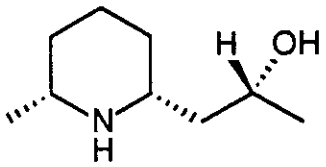
Field observations and male captures indicated that *C.pomonella* have four generations per year, the last one was partial. Infestation of two local and introduced varieties of quince by this pest was examined and the damages caused were also estimated. There was a significant difference among the infestation of these two varieties according to fruits traits (size, maturite...). Introduced variety was relativity more attractive to codling moth.

SRENG Leam. Male sex pheromone and calling or aggressive posture in the cockroach *Nauphoeta cinerea*. Lab de Neurobiologie; CNRS UPR 27; LNB 8 (Communication chimique); 31, chem. Joseph Aiguier 13402 Marseille cedex 09 France.

The male sex pheromone of the cockroach *N.cinerea* was isolated from developed sternal glands and identified by means of GC-Mass spectrometry. This pheromone attracts females from a distance, and is composed mainly of three compounds : 3-hydroxy-2-butanone, 2-methylthiazolidine and 4-ethyl-2 -methoxyphenol. Among the males in this species, systems of dominance through agonistic encounters often determine the access to females and mating success. After fighting (dominant-subordinate), only the dominant male (the winner of the combat) adopts the calling or aggressive posture : his abdomen is flexed upwards, exposing the sternal glands releasing sex pheromone; whereas the loser males adopt "subordinate posture" and do not expose their sternal glands. The dominant males attract receptive females more strongly and copulate more often than subordinate males. Preliminary GC analysis of individual glands of dominant and subordinate males did not show the existence of any differences in quality or quantity between pheromone extracts. In the mating system of *N. cinerea* , a relationship was found to exist between the dominance of a male, which involves aggressive or calling posture (releasing sex pheromone), and its mating success. In this context, the pheromone liberated by a dominant male serves as a sex pheromone attracting receptive females, and as a signal to other males to compete for dominance or in the case of the losers, to adopt the subordinate postures.

Stermitz, Frank R.; Jeanne N. Tawara and Marc D. Pomeroy. Alkaloids of Spruce (*Picea*) and Pine (*Pinus*) Species. Department of Chemistry, Colorado State University, Fort Collins, Colorado 80523.

The alkaloid pinidinol and a variety of related piperidine alkaloids have been isolated from *Picea abies* (Norway spruce) and *Pinus jeffreyi* (Jeffrey pine). The particular alkaloid spectrum varies depending upon plant part. Alkaloids are also found in a mistletoe, *Arceuthobium campylopodium*, which parasitizes Jeffrey pine. Mass spectrometry and NMR spectroscopy were used to determine the structures of the various alkaloids from these two conifers and an attempt is being made to assess the ecological importance of the alkaloids, especially as they relate to acid rain phenomena and insect predation.



pinidinol

Svensson, Mats & Jan Löfqvist

The attraction width of a three-component pheromone blend for the turnip moth *Agrotis segetum* (Lepidoptera: Noctuidae)

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The attraction width of male *Agrotis segetum* was studied in field experiments with a wind-oriented two-choice trap. One of the traps in the choice pair contained an otimized three-component blend, consisting of 5 µg (Z)-5-decenyl acetate, 100 µg (Z)-7-dodecenyl acetate and 275 µg (Z)-9-tetradecenyl acetate, applied on rubber septa. The other trap in the pair contained a blend with either an increased or a decreased amount of one or two of the three components, keeping at least one of them similar to the reference trap with the optimized blend. The results revealed differences between the three components. (Z)-5-decenyl acetate can vary within relatively broad limits without loosing the attractivity of the blend. Too high amounts result in a confusion situation, similar to a mating disruption effect. Any change in (Z)-7-dodecenyl acetate results in a drop of attractivity. (Z)-9-14:OAc can be varied within extensive limits without greater losses in attractivity. This method suggests a more direct way of optimizing pheromone blends, with direct comparison. The differential importance of different components is emphasized.

Trigo,J.R.[1,2,3], K.S.Brown Jr.[2], L.Witte[3], T.Hartmann[3], and L.S.Barata[1].
Pyrrolizidine Alkaloids (PAs) in the Primitive Ithomiinae (Lep.: Nymp.) and Chemical Defense Against the Spider *Nephila clavipes* (Araneidae).
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Butterflies of the subfamily Ithomiinae are aposematically coloured and chemically protecetd by PAs against the orb-giant spider *Nephila clavipes*. As larvae these species feed mainly on Solanaceae and in the case of the more primitive genera on Apocynaceae. Two primitive Apocynaceae-feeding species (i.e. *Aeria olena olena* and *Tithorea harmonia pseudretha*) from SE Brazil were studied in respect to host-plant acquired chemical protection. *T. harmonia* larvae feed on *Prestonia acutifolia* and sequester PAs such as lycopsamine and parsonsine; fresh emerged adults, however, are preyed by *Nephila*. *A. olena* feeds on *P. coalita*, which did not seem to contain detectable amounts of PAs as judged by GC-MS. Fresh emerged adults contain PAs (i.e. lycopsamine, sometimes only traces) and are liberated by *Nephila*. Wild caught adults of the two species contain PAs and are significantly liberated by the spider. Fresh emerged adults of *Mechanitis polymina* which as larvae fed on PA-free Solanaceae species are preyed by *Nephila*, whereas wild caught aldults which have had access to PA containing nectar sources (e.g. *Eupatorium*) were liberated. The idea is discussed that the protection against *Nephila* is a case of secondary adaptation (exaptation), since the spider is not visually oriented and not involved in any selection process associated with PA acquisition and warning colouration.

van Dam, Nicole M. **Inducible chemical defence in Cynoglossum officinale L. and Senecio jacobaea L.** State University of Leiden, Department of Population biology, Kaiserstraat 63, P.O. Box 9516, 2300 RA Leiden, The Netherlands.

Like most governments in the world, plants can spend only a fraction of their budget on defence. Therefore inducible defence may be more economical: the production of defence chemicals starts or increases at the moment the plant is attacked.
Cynoglossum officinale L. and Senecio jacobaea L. are common biennial plants in the dunes of North Western Europe. Both species are protected against generalist herbivores by pyrrolizidine alkaloids (PA's).
Plants of both species were artificially damaged. 3, 6, 12, 24 and 48 hours after damage, the PA-concentrations of the plants were measured.
In C. officinale a steady increase of PA's occurred, starting at 3 h and continuing until 48 h, after which PA's had doubled compared to the control. S. jacobaea plants did not show any increase.
The induction of PA's in C. officinale may be the reason for the typical pattern of damage (small, well-dispersed holes over the entire plant) caused by Ethmia bipunctella (Lepidoptera, Ethmiidae).

van Dijk, Marinke J. **Factors explaining within plant distribution of eggs and larval survival of** Liriomyza trifolii (diptera) **on the cut chrysanthemum (**Dendranthema grandiflora**).** State University of Leiden, Department of Population Biology, Kaiserstraat 63, P.O.Box 9516, 2300 RA Leiden, The Netherlands.

One of the most important insect pests on cut chrysanthemums in Dutch greenhouses is Liriomyza trifolii (serpentine leafminer). Susceptibility of chrysanthemums to leafminer damage varies not only between varieties but also between leaves within plants. Within plant distribution of eggs by female Liriomyza trifolii and subsequent survival of hatching larvae were compared to chemical composition and morphological traits of three cut chrysanthemum varieties: Dark Pink Pompon, Cassa and Fidessa. The distribution of eggs on the plant was partially explained by differences between leaves in toughness, number of hairs per cm^2 and nitrogen content. Subsequent survival of the larvae was clearly related to total phenol content in the leaves (Folin-Denis assay). The total amount of variance in survival explained by phenol content ranged from 45 to 58%.

Vrieling, Klaas & van der Meijden, Ed.
GENETIC VARIATION IN CHEMICAL DEFENCE IN RAGWORT.

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Genetic variation in pyrrolizidine alkaloids in ragwort (Senecio jacobaea) can not be explained by a balance between direct costs and benefits, as direct costs (expressed in reduction of growth) are small or absent.

A stable polymorphism in Pa concentration is possible by a tritrophic interaction (involving indirect costs) between aphids, ants and the cinnabar moth (Tyria jacobaeae). Plants with a high Pa concentration are defended against aphids, but not against the cinnabar moth. Plants with a low Pa concentration are vulnerable to aphids, but they are protected by ants against the cinnabar moth. These ants have a mutualistic relationship with the aphids.

SOCIAL SPATIO-TEMPORAL TRANSMISSION OF AN AVERSIVE EXPERIENCE IN THE DOMESTIC PIG.

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The process of spontaneous learning of the use of an automatic food dispenser by a group of domestic female pigs has been observed in two conditions: among naive animals, and in the presence of a previously trained pig.

No social facilitation of learning appeared in the presence of an animal already trained to use the food dispenser. The only observed consequence of the presence of a "demonstrator" animal was in some cases a considerable increase in the delay to the first contact with the food dispenser, especially when, during the process of training the demonstrator pig, this animal has been afraid of the dispenser.

In another experiment, the hypothesis of a delayed transmission of an unpleasant experience was tested. The food dispenser was sprayed with urine collected from either a control sow or from an animal undergoing an acute stress. In half of the cases, the presence of urine of a stressed animal resulted in long-lasting avoidance of the food dispenser, suggesting the existence of some kind of alarm pheromones produced in the urine of a sow during an aversive experience.

Hoskovec Michal, Kalinova Blanka, Koutek Bohumir, Vrkoc Jan

Sex Pheromone Components of the Synanthedon Species and their Analogs: Synthesis and Biological Tests.

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As a part of IPM program we have attempted to search for pheromone analogs with efficient competitive interaction with male antennal receptors. The pheromones of clearwinged moths (*Sessidae, Lepidoptera*) have been selected as a model for attractants with a nonconjugated diene system.

2,13- and 3,13-octadecadienyl acetates play an important role in the sexual communication of some *Synanthedon* species. (2E,13Z)-2,13-octadecadienyl acetate is, e.g., the major component of an attractant of *S. tipuliformis* and also *Zeuzera pyrina* (*Cossidae*). An alternative synthesis via corresponding enynes has afforded all geometrical isomers with high isomeric purity. Diyne and enyne analogs as well as pheromone isomers have been subject to EAG tests and preliminary field trials. Syntheses and biological tests of other analogs are in progress.

Walraven Vera, L. Van Elsacker, R. Verheyen, Scent marking behaviour in Golden-headed Lion Tamarins (Leontopithecus chrysomelas) (Primates, Callitricidae) in captivity. University of Antwerp, Universiteitsplein 1 B-2610 Wilrijk, Belgium.

Chemical communication seems to be important in the social and reproductive behaviour of New World monkeys. The secretions from sternal and circumgenital scent glands are the most important carriers of olfactory information and the animals use a variety of postures for distributing these scents in the environment. In order to gain clearer insight in its functions, several aspects of scent marking in captive families of Leontopithecus chrysomelas were analyzed. The results of our non-invasive observations showed a considerable inter- and intragroup variation in scent marking activity. It was also found that males scent marked more than females, and that both sexes exhibited significant preferences for particular marking sites, those often being situated on the cage boundaries. The use of the different glandular areas depended on the site being scent marked and the sexe of the performing animal. Finally, high scent marking frequencies were observed during intergroup vocalizations. The possible function of scent marking in territorial behaviour will be discussed.

Wu Wenqi [1], Marie Bengtsson [1], Bill S. Hansson [1], Tommy Liljefors [2], Christer Löfstedt [1], Glenn Prestwich [3], Wei-Chuan Sun [3], & Mats Svensson [1]. **The Behavioural and Electrophysiological Response Of Turnip Moth Males *Agrotis segetum* to Fluorinated Pheromone Analogues.** [1]Department of Ecology, Lund University, S-223 62 Lund, Sweden, [2] Deptartment of Organic Chemistry 3, Lund University, P.O. Box 124, S-221 00 Lund, Sweden, and [3] Department of Chemistry, State University of New York, Stony Brook, NY 11794-3400, USA.

Fluorinated pheromone analogues have been suggested to have a variety of biological activities, including attractancy, synergism and inhibition, depending on position and geometry of fluorination. In the present study we tested the response of male *Agrotis segetum* to fluorinated analogues of (*Z*)-5-decenyl acetate (Z5-10:OAc), comparing the behavioural activity with the electrophysiological activity of the respective compounds. A mixture of Z5-10:OAc, Z7-12:OAc, and Z9-14:OAc on filter paper dispensers was first tested in the flight tunnel in a natural 1:5:2.5 ratio. This mixture proved to be as attractive as female gland extracts, making approximately 70% of the males completing the behavioural sequence from taking flight to landing. When Z5-10:OAc was omitted, the two component mixture elicited a significantly lower male response, with 38% males contacting the source. Four analogues, 7,7-difluoro-(Z)-5-decenyl acetate (F2), 10,10,10-trifluoro-(Z)-5-decenyl acetate (F3), 7,7,8,8-tetrafluoro-(Z)-5-decenyl acetate (F4), and 7,7,8,8,9,9,10,10,10-nonafluoro-(Z)-5-decenyl acetate (F9), were added separately to the two component mixture in the same amount as Z5-10:OAc had been present. The responses elicited by the mixtures containing the F2, F3 and F4 analogues match the activity of the natural three component blend, whereas the response elicited by the F9-containing mixture was as low as the response to the two component blend. The single sensillum recordings show that the F2, F3 and F4 analogues are 100-fold and the F9 analogue approximately 10 000-fold less active than the natural Z5-10:OAc. Thus the F2, F3 and F4 analogues when added to a blend were behaviourally more active than could be expected from the electrophysiological recordings.

Semiochemicals emitted by pine weevils, Hylobius abietis, feeding on Scots pine

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The pine weevil, *Hylobius abietis* L., is known to be attracted by pine logs. We have investigated the volatiles emitted by insects feeding on host plant to determine the mechanism of the attraction (aggregation pheromone *versus* pine allelochemicals), which remains controversial. Chemical analyses of the collected volatiles showed no qualitative differences between Scots pine alone and Scots pine plus feeding weevils, but the insects feeding on pine released 2.5 times more pinenes than pine alone in our experimental design.

Electroantennograms (EAG) were recorded on male and female antennae stimulated by increasing doses of collected volatiles. The EAG responses to pine alone and pine plus weevils at the same concentration in (α+β) pinene gave superimposable curves. These results strongly suggest an attraction mediated by host plant allelochemicals.

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