THE 6TH ASIA-PACIFIC CONFERENCE ON CHEMICAL ECOLOGY

Chemical Ecology Future:

Green Chemoecology in 21st Century

Program & Abstracts

October 11-15, 2011

Beijing, China

Sponsors

Asia-Pacific Association of Chemical Ecologists (APACE)
National Natural Science Foundation of China (NSFC)
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Contents

Welcome Message

Dear APACE Friends and Members,

Eric Jang
APACE President

It gives me great pleasure to announce that our 6th Asia-Pacific Association of Chemical Ecologists (APACE) Conference with the theme "**Chemical Ecology Future: Green Chemoecology in 21st Century**" will be held in Beijing China (October 11-15, 2011). This conference marks the round trip of the Association in the Chinese philosophy (a 12 year one circle) since the first meeting of the APACE was initiated in Shanghai in 1999.

Welcome Friends

On behalf of President Eric Jang, the Executive committee, councilors and conference organizers of the Asia Pacific Association of Chemical Ecologists (APACE), I would like to welcome you to attend the sixth Conference of APACE, held in Beijing, China, October 11-15, 2011. This is the best season in Beijing, not hot and not cold. After the international Olympic games in 2008, Beijing has made great changes in all aspects. You will find the trip to Beijing and the meeting to be a pleasant and enjoyable one. The meeting will continue its rich history and future perspectives of chemical ecology, after our previous meetings held in Shanghai (China), Penang (Malaysia), Jeju (Korea), Tsukuba (Japan) and most recently Hawaii (USA), with the well-recognized value of being an proud APACE member. We would like to welcome friends whose researches are related to all aspects of chemical ecology to join us for a few days in Beijing, get together with old friends and meet new friends and colleagues who share a love of this fascinating and exciting area of research. We hope you will enjoy this meeting as much as the previous ones.

Yongping Huang, Vice President and co-chair,

Zhen Zhang, Co-chair

Committees

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Chairman

Eric Jang

Committee Member

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Keng-hong Tan	Kenji Mori	Kyung Saeng Boo	Ritsuo Nishida
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Secretary General

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Secretariat

Hongbin Wang	Xiangbo Kong	Qian Wang	Sufang Zhang

General Information

City Map

Meeting Venue

Building 1 (Guibin) (Multi-Function Hall)	Opening Ceremony, Plenary, Closing Ceremony
Building 2 (Jingbin)	Registration, Accommodation
Building 3 (Yingbin)	Accommodation
Building 7 (Ruibin)	Poster, Vendor Booth, Photo Salon
Building 8 (Jiabin)	Symposia
Friendship Palace	Lunch, Dinner

Program at Glance

Day / Time	11-Oct TUE	12-Oct WED	13-Oct THU	14-Oct FRI	15-Oct SAT
08:00-09:00	Registration (Bldg.2)	Registration(Bldg.1) **Opening Ceremony(9:00-9:40)** (Multi Function Hall, Bldg. 1)	Symp C (Bldg. 8 Room No.1) Symp D (Bldg.8 Room No.2+3) Symp J workshop (Bldg. 8 Room No.5)	Symp H (Bldg. 8 Room No.1) Symp F (Bldg. 8 Room No.2+3) Symp B (Bldg. 8 Room No.5)	Group Social Activities
09:30-09:50		Photo time and break(09:40-10:00)		Tea break	
10:00-10:20		Plenary-1(10:00-10:40)	Tea break	Tea break	
10:20-12:20		Plenary-2(10:40-11:20) Plenary-3(11:20-12:00) (Multi Function Hall, Bldg. 1)	Symp H (Bldg. 8 Room No.1) Symp D (Bldg. 8 Room No.2+3) Symp J Workshop (Bldg. 8 Room No.5)	Symp H (Bldg. 8 Room No.1) Symp F (Bldg. 8 Room No.2+3)	Symp I (Bldg. 8 Room No.5)
12:20-13:30		lunch	lunch	lunch	
13:30-15:00		Symp C (Bldg. 8 Room No.1) Symp A (Bldg. 8 Room No.2+3) Symp E (Bldg. 8 Room No.5)	Poster Vendor Booth Photo Salon Symp J workshop (Bldg. 8 Room No.5)	Plenary-4(13:30-14:10) Plenary-5(14:10-14:50) Plenary-6(14:50-15:30) (Multi Function Hall, Bldg. 1)	
15:30-15:50		Tea break	(Bldg. 7 Room No.1+2) With snacks Tea break	Tea break	
15:50-17:50		Symp C (Bldg. 8 Room No.1) Symp G (Bldg. 8 Room No.2+3) Symp E (Bldg. 8 Room No.5)	Symp J workshop (Bldg. 8 Room No.5 Lecture JCE	**Closing Ceremony** (Multi Function Hall, Bldg. 1)	
18:00		Welcome Reception	dinner	Conference Dinner	

OCT 12

09:00-09:30	**Opening Ceremony: Yongping Huang**	**Multi-Function Hall, Building 1**
09:30-10:00	Photo and Break	
10:00-12:00	**Plenary** **John G Hildebrand,** USA	
10:00-10:40	**P-A:** Honey bee queen pheromone: a recipe for success and survival	**Alison Mercer** University of Otago (New Zealand)
10:40-11:20	**P-B:** The Molecular Making of a Robust Insect's Olfactory System	**Walter Leal** University of California-Davis (USA)
11:20-12:00	**P-C:** Molecular basis of host-seeking behavior in Anopheles gambiae	**Guirong Wang** Chinese Academy of Agricultural Sciences (China)
12:00-13:30	**Lunch (APACE executive meeting)**	

13:30-15:30	**Symposium A: Aquatic Chemical Ecology** **Tilmann Harder**, Australia	**Bldg. 8 Room No.2+3**
13:30-13:50	**A-1**: Sensory ecology of seaweeds and microbes: linking molecular mechanisms with ecological outcomes	**Peter Steinberg** University of New South Wales (Australia)
13:50-14:10	**A-2:** Chemical signaling of coral larval settlement and metamorphosis	**Tilmann Harder** University of New South Wales Sydney (Australia)
14:10-14:30	**A-3**: Defensive strategies of tropical Pacific sponges against fish	**Peter J. Schupp** University of Guam (Germany)
14:30-14:45	**A-4**: Antifouling Metabolites from the South China Sea Invertebrates	**Yonghong Liu** Chinese Academy of Sciences (China)
14:45-15:00	**A-5**: Antifouling agents from sessile marine invertebrates and their symbiotic microorganisms	**Chang-Yun Wang** Ocean University of China (China)
15:00-15:15	**A-6:** Antifouling and antibacterial compounds from the South China Sea gorgonians and their associated microorganisms	**Shu-Hua Qi** Chinese Academy of Sciences (China)
15:15-15:30	**A-7:** Allelochemical induces growth and photosynthesis inhibition, oxidative damage in marine diatom Phaeodactylum tricornutum	**Cuiyun Yang** Chinese Academy of Sciences (China)
15:30-15:50	**Tea break**	

15:50-18:00	**Symposium G: Molecular Chemical Ecology** **Yokio Ishikawa**, Japan ; **Yongping Huang**, China	**Bldg. 8 Room No.2+3**
15:50-16:10	**G-1:** A sex pheromone desaturase functioning in a primitive Ostrinia moth is cryptically conserved in congeners' genomes	**Yokio Ishikawa** University of Tokyo Bunkyo-ku (Japan)
16:10-16:25	**G-2:** Molecular Cloning, Sequence Analysis and Tissue Expression of Two Putative Desaturase Genes from Spodoptera exigua (Hübner)	**Ya-Nan Zhang** Nanjing Agricultural University (China)
16:25-16:40	**G-3:** Genomics as a tool for chemical ecology	**Xie Ge** Chinese Academy of Sciences (China)
16:40-16:55	**G-4:** Os08g0167800 gene plays an important role in food chain of rice, striped stem borer and parasitic wasps	**Yang Sun** Chinese Academy of Agricultural Sciences (China)
16:55-17:10	**G-5:** Two WRKY transcription factors mediate herbivore-induced defense responses in rice	**Ran Li** Zhejiang University(China)
17:10-17:25	**G-6:** New Methodologies for the Asymmetric Synthesis of Pheromones and other Eco-Chemicals	**Pei-Qiang Huang** Xiamen University (China)
17:25-17:40	**G-7**: Mechanisms of age-dependent division of labor in a social aphid	**Harunobu Shibao** University of Tokyo (Japan)
17:40-18:00	**G-8:** Cotton aphid signal transduction genes derived from aphid genome sequences	**Yongping Huang** Chinese Academy of Sciences (China)
18:00	**Welcome reception: Eric Jang**	

13:30-17:55	**Symposium C: Chemical Ecology of Forest Pests** **Jacob Wickham,** USA **Jocelyn Millar,** USA; **Jianghua Sun**, China	**Bldg. 8 Room No.1**
13:30-14:00	**C-1:** Pheromones of Cerambycid Beetles	**Jocelyn Millar** University of California (USA)
14:00-14:20	**C-2:** A male-produced aggregation pheromone of Monochamus alternatus (Coleoptera: Cerambycidae), a major vector of pine wood nematode	**Jacob D. Wickham** Chinese Academy of Sciences (China)
14:20-14:40	**C-3:** cis-Vaccenyl Acetate, A Female-Produced Sex Pheromone Component of Ortholeptura valida, A Longhorned Beetle in the Subfamily Lepturinae	**Ann Ray** Xavier University (USA)
14:40-14:55	**C-4:** Chemical Communication in Asias halodendri (Pallas)	**Qiang Liu** Tianjin Normal University (China)

14:55-15:10	**C-5:** Mating behavior characteristics and its environmental influence factors of Apriona germari	**Guangli Wang** Jiangxi Agricultural University (China)
15:10-15:30	**C-6:** Insect Pheromone development and application in China	**Yinzhong Cui** Pherobio Technology Co., Ltd. (China)
15:30-15:55	**Tea break**	
15:50-16:10	**C-7:** Utilization of semiochemicals in forest ecosystems	**Kiyoshi Nakamuta** Chiba University (Japan)
16:10-16:25	**C-8:** Conifer resistance reduces aggregation pheromones of spruce bark beetle	**Tao Zhao** Royal Institute of Technology (Sweden)
16:25-16:40	**C-9:** Research and application on aggregation pheromone of Ips subelongatus and Ips typographus (Coleoptera: Curculionidae: Scolytinae) in N.E. China	**Liwen Song** Jilin Provincial Academy of Forestry Sciences (China)
16:40-16:55	**C-10:** Female sex pheromone of the dermestid beetle, Thaumaglossa rufocapillata (Coleoptera: Dermestidae)-II.	**Shigeru Matsuyama** University of Tsukuba (Japan)
16:55-17:10	**C-11**: Analysis and Evaluation of the Volatile Compounds In The Neem Trees	**Chen Naizhong** Chinese academy of inspection and quarantine (China)
17:10-17:25	**C-12:** Incubation enhances the attractiveness of the yellow-spined bamboo locust, Ceracris kiangsu feeding on human urine	**Jin-Ping Shu** Chinese Academy of Forestry (China)
17:25-17:40	**C-13:** Identification of volatiles of ophiostomatoid fungi associated with the red turpentine beetle in China	**Christian Salcedo** Chinese Academy of Sciences (China)
17:40-17:55	**C-14:** The sex pheromone of the stink bug Edessa meditabunda (Hemiptera, Pentatomidae)	**Paulo Zarbin** Universidade Federal do Paraná (Brazil)
18:00	**Welcome reception: Eric Jang**	

13:30-17:55	**Symposium E: Microbio-Chemoecology of Insects and Their Environments** **Junwei Jerry Zhu, USA;** **Xiaopeng Zeng, China**	**Bldg. 8 Room No.5**
13:30-14:00	**E-1:** Bacterial volatiles	**Stefan Schulz** TU Braunschweig (Germany)
14:00-14:30	**E-2:** Bacteria are ecosystem engineers in the container habitats of Aedes (Stegomyia) mosquitoes	**Coby Schal** North Carolina State University (USA)
14:30-15:00	**E-3:** Infochemical interactions between microbial community and pest flies: Oviposition selection	**Junwei Zhu** USDA-ARS, AMRU (USA)

15:00-15:30	**E-4:** House fly eggs, Musca domestica (Diptera: Muscidae), are associated with bacterial symbionts that act as ovipositional cues, anti-fungal agents, and larval food, and are vertically transmitted by house flies.	**Kevin Lam** Simon Fraser University (Canada)
15:30-15:50	**Tea break**	
15:50-16:15	**E-5:** The origin of the pine weevil repellent compounds	**Anna-Karin Karlsson** KTH, Stockholm (Sweden)
16:15-16:40	**E-6:** Chemical Analyses of Wasp-Associated Streptomyces Bacteria Reveal a Prolific Potential for Natural Products Discovery	**Michael Poulsen** University of Copenhagen (Denmark)
16:40-17:05	**E-7:** Olfactory receptor neurons for pheromone and plant volatile compounds in Sitona weevils	**Kye Chung Park** Plant and Food Research (New Zealand)
17:05-17:25	**E-8:** Analysis of the Secondary Compounds among Various Host Plants of Huanglongbing	**Huilin Lu(Yijing Cen)** South China Agricultural University (China)
17:25-17:50	**E-9:** Sustainable linkage between Hylobius abietis, Rahnella and conifer trees	**Kazuhrio Nagahama** Sojo University (Japan)
17:50-17:55	Summary	
18:00	**Welcome reception: Eric Jang**	

OCT 13

08:00-10:00	**Symposium C: Chemical ecology of Forest Pests** **Jacob Wickham,** USA **Jocelyn Millar,** USA; **Jianghua Sun**, China	**Bldg. 8 Room No.1**
08:00-08:20	**C-15**: Body wax hydrocarbons (Z)-9-heptacosene and (Z3, Z6, Z9)-tricosatriene as synergists of the sex pheromone in the yellow peach moth Conogethes punctiferalis (Guenée) (Lepidoptera: Crambidae)	**Wei Xiao** Southwest University (China)
08:20-08:40	**C-16:** Non-bombykal family pheromones of the Sphingidae moth, Dolbia tancrei	**Hiroshi Honda** University of Tsukuba (Japan)
08:40-08:55	**C-17:** Δ11 desaturation is involved in the biosynthesis of wing-produced esters in males of the African butterfly, Bicyclus martius	**Hong-Lei Wang** Lund University (Sweden)
08:55-09:10	**C-18:** A novel sex pheromone component produced by a female lichen moth, Miltochrista calamina, in the family Arctiidae	**Rei Yamakawa** Tokyo University of Agriculture and Technology (Japan)
09:10-09:30	**C-19**: Mate signaling specificity and redundancy in sympatric species Dendrolimus kikuchii and Dendrolimus houi	**Xiang Bo Kong** Chinese Academy of Forestry (China)
09:30-09:45	**C-20:** Corymbia species and hybrids: chemical and physical foliar attributes and implications for herbivory	**R. Andrew Hayes** AgriScience Queensland, DEEDI (Australia)
09:45-10:00	**C-21:** Pheromone System and Reproductive Isolation of Synanthedon bicingulata and Synanthedon haitangvora (Lepidoptera: Sesiidae)	**Chang Yeol Yang** National Institute of Horticultural and Herbal Science (Republic of Korea)
10:00-10:20	**Tea break**	

10:20-12:20	**Symposium H: Insect Plant Interactions and Plant Allelopathy** **Yonggen Lou,** China **Kotaro Konno,** Japan	**Bldg. 8 Room No.1**
10:20-10:40	**H-1:** Phenylpropanoid bouquets of Bulbophyllum orchids act as floral synomones to attract Bactrocera fruit flies	**Ritsuo Nishida** Kyoto University (Japan)
10:40-11:00	**H-2:** Co-evolution of piercing-sucking insects and plants	**Fengming Yan** Henan Agricultural University (China)
11:00-11:15	**H-3:** Nepenthes rafflesiana, a carnivorous pitcher plant smells like a flower to attract insect prey	**Bruno Di Giusto** Ming Chuan University (Taiwan, China)

11:15-11:30	**H-4**: Feeding deterrence of Zanthoxylum bungeanum and Piper nigrum extracts to Helicoverpa armigera larvae	**Wei-Zheng Li** Henan Agricultural University (China)
11:30-11:45	**H-5:** Insect-feeding and jasmonate inducible phenylalanine is a precursor for nitrile biosynthesis via decarboxylation in the giant knotweed, Fallopia sachalinensis	**Koji Noge** Akita Prefectural University (Japan)
11:45-12:00	**H-6**: Effects of Ferula assafoetida essential oil on some biological traits of Trichogramma embryophagum (Hym.:Trichogrammatidae), egg parasitoid of carob moth.	**Goldansaz Seyed H** University of Tehran (Islamic Republic of)
12:00-12:15	**H-7:** Identification of brown plant hopper resistance-related gene from jasmonic acid pathway by microarray analysis	**Huimin Guo** Shanghai Institute of Plant Physiology and Ecology (China)

08:00-12:20	**Symposium D: Chemical Ecology of Invading Species** **Aijun Zhang**, USA **Zhen Zhang,** China	**Bldg. 8 Room No.2+3**
08:00-08:20	**D-1:** Identification of the sex pheromone of the lesser date moth, Batrachedra amydraula, using a new technique of sequential SPME auto-sampling	**Anat Levi-Zada** Agricultural Research Organization (Israel)
08:20-08:40	**D-2:** Semichenmical based monitoring of an invasive species, red turpentine beetle (Dendroctonus valens)	**Zhen Zhang** Chinese Academy of Forestry (China)
08:40-09:00	**D-3:** Monitoring of Opisina arenosella by using female sex pheromones	**Bhanu K.R.M.** Pest Control (India) Pvt. Ltd. (India)
09:00-09:20	**D-4:** Dispersal and detection of invasive Orthotomicus erosus in California	**Deguang Liu** Northwest A&F University (China)
09:20-09:40	**D-5:** Managing the invasive oriental beetle with mating disruption in blueberries	**Cesar Rodriguez-Saona** Rutgers University (USA)
09:40-10:00	**D-6:** Asian longhorned beetle pheromone and potential use in the field	**Aijun Zhang** United States Department of Agriculture (USA)
10:00-10:20	**Tea break**	
10:20-10:35	**D-7:** Attacking behavior and its chemical communications of an invasive bark beetle, Dendroctonus valens	**Zhudong Liu** Chinese Academy of Sciences (China)
10:35-10:50	**D-8:** Trial of eliminating codling moth with sex pheromone disruption plus pesticide spraying	**Hanjie Chen** Chinese Academy of Agricultural Sciences (China)

10:50-11:05	**D-9:** Comparison of male sex pheromonal components after methyl eugenol consumption in seven highly invasive Bactrocera species	**Keng-Hong Tan** Tan Hak Heng Co.(Malaysia)
11:05-11:20	**D-10:** Evolution of cuticular hydrocarbons of Hawaiian Drosophilidae	**Jean-Marc Jallon** University of Paris South 11 (France)
11:20-11:35	**D-11:** EPG recorded feeding behaviors of Bemisia tabaci B and Q biotypes on the artificial diet	**Xiaomin Li** Henan Agricultural University (China)
11:35-11:50	**D-12:** Repellent and Acaricidal Effect of Santalol in Sandalwood Oil against Two-spotted Spider Mite, Tetranychus urticae Koch (Acari: Tetranychidae)Paper:Word document	**Hyun Sik Roh** Gyeongsang National University(Republic of Korea)
11:50-12:05	**D-13:** Adaptation mechanisms of Bemisia tabaci B and Q biotypes on host plants	**Jingjing Li** Henan Agricultural University (China)
12:20-13:30	**Lunch**	

08:00-16:30	**Symposium J: Workshop "Emerging Technology and Research Methodology in Applied Chemical Ecology"** **Alex Il' Ichev**, Australia; **Junwei Jerry Zhu**, USA; **Fengming Yan,** China	**Bldg. 8 Room No.5**
08:00-08:30	**J-1:** More than Three Decades After the First Mating Disruption Registration: Major Successes with Reservoir Dispensers and Lessons Learned for Future Growth	**Don Thomson** Pacific Biocontrol Corporation (USA)
08:30-09:00	**J-2:** Towards multi-species mating disruption in horticulture: advantages and pitfalls	**Alex Ilichev** Department of Primary Industries Victoria (Australia)
09:00-09:30	**J-3:** A successful story of applied chemical ecology: Rescue ® insect traps from Sterling International, Inc.	**Qing-He Zhang** Sterling International, Inc. (USA)
09:30-10:00	**J-4:** Remote Detection and Reporting of Invasive Insect Species Using Satellite and Internet Communication	**Thomas Baker** Penn State University (USA)
10:00-10:20	**Tea break**	
10:20-10:50	**J-5:** Technical aspects in electroantennogram, GC-EAD and single cell recording in insect olfaction	**Kye Chung Park** Plant and Food Research (New Zealand)
10:50-11:20	**J-6:** Proactive Chemical Ecology: Strategies for Identification of Pheromones for Invasive Species	**Jocelyn Millar** University of California (USA)

11:20-11:50	**J-7:** Track3D: a new system for tracking, visualization and analysis of insect flight behavior in 3D	**Lucas Noldus** Noldus Information Technology BV (Netherlands)
11:50-12:10	**J-8:** Competitive trapping and straight flying may explain the edge effect common under mating disruption	**David Williams** Department of Primary Industries Victoria (Australia)
12:20-13:30	**Lunch**	
13:30-13:50	**J-9:** Models for monitoring invasive insect species	**John Byers** United States Department of Agriculture (USA)
13:50-14:10	**J-10:** Novel mating disruption technologies and strategies for managing fruit pests	**Larry Gut** Michigan State University (USA)
14:10-14:30	**J-11:** A new insight for development of attract-and-remove against codling moths, Cydia pomonella	**Juan Huang** Michigan State University (USA)
14:30-14:50	**J-12:** Study on the Taxis of Tea Leafhopper Empoasca vitis (Gothe) to Plant Volatile Oils	**Yi-Jing Cen** South China Agricultural University (China)
14:50-15:10	**J-13:** Assessment of Allelopathic potential of rice on barnyardgrass by inhibitory ring under greenhouse conditions	**Xu-Kui Guo** Fujian Agriculture and Forestry University (China)
15:10-15:30	**J-14:** Functional determination of chemosensory proteins, LmigCSPI, LmigCSPII and LmigCSPIII in Locusta migratoira	**Haozhi Xu** China Agricultural University (China)
15:30-15:50	**Tea break**	
15:50-16:10	**J-15:** Application of a newly developed computer tracking program to locomotion analyses of a small population of Argentine ant, Linepithema humile	**Ritsu Morioka** Kobe University (Japan)
16:10-16:30	**J-16**: Future opportunities in chemical ecology in the Asia-Pacific region	**Eric Jang** USDA-ARS(USA)
16:30-17:30	**Special Lecture:** publishing, common problems with Asian papers, do and don'ts. Etc	**John Romeo** JCE editor in chief, (USA)

13:30-17:50	**Poster** **Vendor Booth** **Photo Salon**	**Bldg. 7 Room No.1+2**
18:00	**Dinner**	
19:30	**Councilor Meeting**	

OCT 14

8:00-12:20	**Symposium H: Insect Plant Interactions and Plant Allelopathy** **Rensen Zeng**, China ; **Ritsuo Nishida,** Japan	**Bldg. 8 Room No.1**
08:00-08:20	**H-8:** Elucidation of the elicitor made Japanese Rice plant (Oryza sativa L.) induce ovicidal substance, benzyl benzoate in the Sogatella furcifera(HORVÁTH)	**Jeong-Oh Yang** Kochi University (Japan)
08:20-08:40	**H-9:** Defense substances in the latex of mulberry tree and other Moraceae plants-The key factors that determine mulberry-silkworm relationship	**Kotaro Konno** National Institute of Agrobiological Sciences (Japan)
08:40-09:00	**H-10:** Multiple trophic interactions among organisms mediated by chemicals in agroecosystems	**Rensen Zeng** South China Agricultural University (China)
09:00-09:15	**H-11**: Attraction of female and male Oriental fruit flies to conspecific males and mating competition following consumption of zingerone and ethyl vanillate	**Alvin Kah-Wei Hee** Universiti Putra Malaysia (Malaysia)
09:15-09:30	**H-12:** Effect of pea and wheat mixing: a laboratory approach on aphid and related predator behaviors	**Haibo Zhou** Academy of Agricultural Sciences (China)
09:30-09:45	**H-13:** Transcriptional analysis of Arabidopsis thaliana defensive response to priming volatiles	**Sufang Zhang** Chinese Academy of Forestry (China)
09:45-10:00	**H-14:** Ferula assafoetida essential oil disrupts some reproductive behavior of the carob moth, Ectomyelois ceratoniae under field and laboratory conditions	**Goldansaz S. H.** University of Tehran(Islamic Republic of)
10:00-10:20	**Tea break**	
10:20-10:40	**H-15:** Competition relationship of allelopathic rice and barnyardgrass in rice/barnyardgrass mixed culture system	**Wen-Xiong Lin** Fujian Agriculture and Forestry University (China)
10:40-10:55	**H-16:** The smell of death: Pollination biology and floral scent of R. cantleyi (Rafflesiaceae) in Malaysia	**Suk-Ling Wee** Universiti Kebangsaan Malaysia (Malaysia)
10:55-11:10	**H-17:** Effects of different sunlight intensities on the constitutive resistances of Larix gmelinii	**Yifang LU** Northeast Forestry University (China)
11:10-11:25	**H-18:** Sex-related larval susceptibility of diamondback moth, Plutella xylostella (Lepidoptera: Plutellidae) to some reduced-risk insecticides	**Hong-Yi Wei** Jiangxi Agricultural University (China)
11:25-11:40	**H-19:** Volatile Organic Compounds (VOCs) of Eucalyptus benthamii before and after herbivory by Thaumastocoris peregrinus (Hemiptera, Thaumastocoridae) influence the preference of females	**Paulo Zarbin** Universidade Federal do Paraná (Brazil)

11:40-11:55	**H-20:** Effect of volatiles from health and herbivore-damaged red pine day or night on the behavioral selection of Dioryctria spp. and parasitoid Macrocentrus sp.	**Qi WANG** Northeast Forestry University (China)
11:55-12:10	**H-21:** Cloning and Expression of Allene Oxide Cyclase Gene from Tea Plant	**Baoyu Han** China Jiliang University (Chian)
12:10-12:25	**H-22:** Pyrichalasin H and chlorosis-inducing toxin from Pyricularia isolates	**Tetsu Tsurushima** Hannan University (Japan)
08:00-12:20	**Symposium F: Receptors and Olfaction** **Chen-Zhu Wang, China** **Wei Xu, Australia**	**Bldg. 8 Room No.2+3**
08:00-08:30	**F-1:** Aversive odorant down-regulates tyrosine decarboxylase gene expression in the antenna of the blowfly, Phormia regina	**Yuko Ishida** Kobe University (Japan)
08:30-09:00	**F-2:** Navel Orangeworm Moth (Amyleois transitella) Pheromone-Binding Protein 1 (AtraPBP1)	**Wei Xu** CSIRO Ecosystem (Australia)
09:00-09:20	**F-3:** Expression in antennae and reproductive organs suggests a dual role of an odorant-binding protein in two sibling Helicoverpa species	**Ya-Lan Sun** Chinese Academy of Sciences (China)
09:20-09:40	**F-4:** cDNA Cloning and Recombinant Expression of the General Odorant Binding protein Ⅱ from Plutella xylostella	**Fengliang Jin** South China Agricultural University (China)
09:40-10:00	**F-5:** Topology and functional analysis of a Bombyx mori gustatory receptor	**Hui-Jie Zhang** Southwest University (China)
10:00-10:20	**Tea break**	
10:20-10:40	**F-6:** Preservation and Enhancement of Intermittent Representation of Natural Odor Plume by Antennal Lobe Circuits in a Moth Brain	**Hong Lei** University of Arizona (USA)
10:40-11:00	**F-7:** The function of plasticity in neural networks of the honey bee brain that process complex floral odors	**Brian H Smith** Arizona State University (USA)
11:00-11:20	**F-8:** Coding of Sex Pheromone Blends with Reverse Ratios in Two Helicoverpa Species and Its Inheritance Pattern	**Chen-Zhu Wang** Chinese Academy of Sciences (China)
11:20-11:40	**F-9:** Scanning electron microscopy studies on antennal sensilla of female Anastatus japonicus Ashmead (Hymenoptera: Eupelmidae)	**Zhao Jun Meng** Northeast Forestry University (China)
11:40-12:00	**F-10:** Types and ditribution of the sensillas on the antennae of the banana pseudostem weevil Odoiporus longicollis Oliver by environmental scanning electron microscopic	**Haiyan Zhao** South China Agricultural University (China)
12:00-12:20	**F-11:**Pheromone binding to general odorant-binding proteins	**Zhao Liu** Southwest University (China)

08:00-9:20	**Symposium B: Application of Sensory Electrophysiology** **Kye Chunk Park**, New Zealand ; **Li Chen**, China	**Bldg. 8 Room No.5**
08:00-08:15	**B-1:** Real-time Odor Discrimination and Source Location Using a Bioelectronic Sensor Array Based on the Insect Electroantennogram	**Thomas Baker** Penn State University (USA)
08:15-08:30	**B-2:** Identification of kairomonal components from the venom alkaloids of Solenopsis imported fire ants attractive to the parasitic phorid fly, Pseudacteon tricuspis	**Li Chen** Chinese Academy of Sciences (China)
08:30-08:45	**B-3:** Antennal responses of Liriomyza spp. to volatile and no volatile compounds	**Jia-Ning Wei** Chinese Academy of Sciences (China)
08:45-09:00	**B-4:** The use of insect sensory electrophysiology for discovering novel attractants and repellents for integrated pest management	**Junwei Zhu** USDA-ARS (USA)
09:00-09:20	**B-5:** Prediction of the range of host plants using single cell recording technique	**Kye Chung Park** Plant and Food Research, (New Zealand)
09:20-09:40	**Tea break**	

09:40-12:30	**Symposium I: Mechanisms of Orientation to Odors** **Ring Carde**, USA; **Long Zhang**, China; **Guirong Wang,** China	**Bldg. 8 Room No.5**
09:40-10:00	**I-1:** Perception of filamentous structure of plumes; effects of air flow on spatial heterogeneity of odorants	**Catherine Loudon** University of California, Irvine (USA)
10:00-10:15	**I-2:** Identification and Characterization of A Novel Chemosensory Protein from Locusta migratoria	**Nan Zheng** China Agricultural University, (China)
10:15-10:30	**I-3:** Ultrastructural characterization of olfactory sensilla and immunolocalization of odorant-binding and chemosensory proteins from an ectoparasitoid Scleroderma guani (Hymenoptera: Bethylidae)	**Xiangrui Li** Chinese Academy of Agricultural Sciences (China)
10:30-10:45	**I-4:** Isolation and Sequence Analysis of cDNA Clones Coding for Odorant Binding Protein, OBP3 and Olfactory Behavior Analysis in Drepanosiphum platanoidis	**Jia Fan** Chinese Academy of Agricultural Sciences (China)
10:45-11:00	**I-5:** Comparative Studies of Pheromone Perception in Two Sibling Moth Spodoptera exigua and S. litura	**Shuang-Lin Dong** Nanjing Agricultural University (China)

11:00-11:20	**I-6:** The Importance of Pheromone Flux and Blend Ratio Reporting In the Upwind Flight Orientation Responses of Moths	**Thomas Baker** Penn State University (USA)
11:20-11:35	**I-7:** Distinct expression profiles and binding properties of odorant binding proteins in Nilaparvata lugens Stål	**Peng He** Nanjing Agricultural University (China)
11:35-11:50	**I-8:** Biological Response of Adult Tribolium castaneum to Stereoisomers of its Aggregation Pheromone	**Yujie Lu** Henan University of Technology (China)
11:50-12:05	**I-9:** Identification and field evaluation of pear fruit volatiles attractive to the oriental fruit moth, Cydia molesta (Lepidoptera: Tortricidae)	**Peng-Fei Lu** Chinese Academy of Sciences (China)
12:05-12:30	**I-10:** Navigation of Moths and Mosquitoes along Wind-Borne Plumes of Odor	**Ring Cardé** University of California (USA)
12:30-13:30	**Lunch**	

13:30-15:30	**Plenary** **Ritsuo Nishida,** Japan	**Multi-Function Hall, Building 1**
13:30-14:10	**P-D:** Analysis and Synthesis of Adaptive Behavior in Insects:From Genes, Neural Networks, and Behavior to Robots	**Ryohei Kanzaki** University of Tokyo (Japan)
14:10-14:50	**P-E:** Signaling pathways regulating rice defense responses	**Yonggen Lou** Zhejiang University(China)
14:50-15:30	**P-F:** Coding of Behaviorally Significant 'Odor Objects' in the Antennal Lobe of a Moth	**John G Hildebrand** University of Arizona (USA)
15:30-15:50	**Tea break**	
16:00-17:30	**Closing Ceremony: Junwei Zhu**	
18:00	**Conference Dinner: Zhen Zhang**	

OCT 15	**Group Social Activities**

OCT 13

13:30-17:50 Poster, Vendor Booth Photo Salon Bldg. 7 Room No.1+2

No.	Title	Author
P-1-B	Prediction of the range of host plants using single cell recording technique	**Kye Chung Park**[1*], Lisa Berndt[2], Toni Withers[2], Kyung Hee Choi[3] [1]Plant and Food Research, New Zealand. [2]Scion, New Zealand. [3]Apple Research Institute, Rural Development Administration, Korea, Republic of kyecpark@gmail.com
P-2-B	Electrophysiological responses of the diamondback moth, Plutella xylostella (L.) to nine crucifer volatiles	**Tian Houjun** *, Chen Yixin , Wei Hui Institute of Plant Protection, Fujian Academy of Agricultural Sciences, China
P-3-C	Pheromone diversity in Japanese hawkmoths	**Takuya Uehara**[1*], Hidesi Naka[2], Shigeru Matsuyama[1], Tetsu Ando[3] and Hiroshi Honda[1] [1]Graduate School of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Ibaraki 305-8572, Japan [2]Department of Agriculture, Tottori University, Tottori 680-8553, Japan [3]Graduate School of Bio-Applications and Systems Engineering, Tokyo University of Agriculture and Technology, Koganei, Tokyo 184-8588, Japan
P-4-C	Trapping effect of 7 chemical lures on Ips nitidus Eggers and the natural enemy	**Yan Wei** *, Liu Li CATAS, China
P-5-C	Trapping effect of 6 kinds of Ips typographus (IT) lures on Ips nitidus	**Liu Li** *, Yan Wei CATAS, China
P-6-C	Testing olfactory responses of a parasitoid, Dastarcus helophoroides, to differ their different populations	**Jian-Rong Wei** * College of Life Sciences, Hebei University, China
P-7-C	Close range mate location behavior of Massicus raddei	**Jian-Rong Wei**[1*], Yan-Long Tang[2] [1]College of Life Sciences, Hebei University, China. [2]Chinese Academy of Forestry, China
P-8-C	The circadian rhythm of adult eclosion and female calling behavior of Omphisa plagialis (Lepidoptera: Pyralidae)	**Gaoping Wang** *, Yu Wang, Tingting He College of Plant Protection, Henan Agricultural University, China
P-9-C	Sex pheromone of an Inner Mongolian population of the Spruce Seed Moth, *Cydia strobilella* L. (Lepidoptera: Tortricidae)	Glenn P. Svensson[1*], **Hong-Lei Wang**[1*], Guo-Fa Chen[2*], Yan-Jun Wang[3], Xiao-Ming Zhou[3], Erling V. Jirle[1], Olle Anderbrant[1], Christer Löfstedt[1*] [1] Department of Biology, Lund University, Sweden [2] General Station of Forest Pest Control, State Forestry Administration, Shenyang, P. R. China [3] KeShiKeTengQi Forestry Administration, Jingpeng, Chifeng, P. R. China
P-10-C	The communication between healthy and pest-fed Pinus massoniana	Yongjian Hu, **Youju Jin** *, Qin Ren, Youqing Luo [1]Beijing Forestry University, China
P-11-C	Antifungal properties of low polar extracts from Taxodium distichum cones	**Norihisa Kusumoto**[1*], Tatsuya Ashitani[2], Koetsu Takahashi[2], Anna-Karin Borg-Karlson[1*] [1]Group of Ecological Chemistry, Department of Chemistry, KTH, Sweden. [2]Forest Environment and Resources, Faculty of Agriculture, Yamagata University, Japan

No.	Title	Author
P-12-C	The aggregation pheromone of Ips duplicatus (Sahlb.)	**Guofa Chen**[1*], Yumin Zhao[2], Yanjun Wang[2], Jingfu Niu[3], Xiaoming Zhou[4] [1]General Station of Forest Pest Management, State Forestry Administration, China. [2]Station of Forest Pest Control, Keshiketeng Qi, Chifeng, Inner Mongolia, China. [3]Forest Pest Control Station of Chifeng City, Inner Mongolia, China. [4]Baiyinaobao National Natural Preserve, China
P-13-C	Electrophysiological Responses of Carpenterworm Moths, *Holcocerus Vicarius* Walker to the Female Sex Pheromone Gland Extracts and Standard Compounds	**YANG Mei-Hong**, **ZHANG Jin-Tong** *,LIU Jin-Long Institute of Chemical Ecology，Shanxi Agricultural University，Taigu，Shanxi 030801，China
P-14-C	Physiological characteristics related to chemical communication system of *Zeuzera leuconotum* Butler (Lepidoptera: Cossidae)	**LIU Jinlong**[1], **ZHANG Jintong**[1*], YANG Meihong[1], JING Xiaoyuan[1] [1]Institute of Chemical Ecology, Shanxi Agricultural University, Taigu Shanxi 030801, China
P-15-C	Volatile Components in Plants of Two Coniferous Species and Damage of Blastesthia sp	Yuhua He[1], **Yongzhi Pan**[1*], Dingkuan Cheng[1] [1]Southwest Forestry University, China
P-16-C	Relationship between outbreak of pine caterpillar (*Dendrolimus punctatus*) and volatiles of Masson pine (*Pinus massoniana*) under drought conditions	**Haize Fei**[1*], Hongbin Wang[1*], Guohong Li[1], Zhen Zhang[1], Xingrong Gao[1] [1]Research Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry, China.
P-17-C	Exogenous Methyl jasmonate induce changes of substance in Populus deltoids leaves and its effect on Clostera anastomosis	Zhou Yanqiong[1], Su Peng[1], Chang Hong[1], **Hao Dejun**[1*] [1]College of Forest Resuorces and Enviroment, Nanjing Forestry University, Nanjing 210037 China
P-18-D	Mating Behavior, Contact Pheromone and Acoustic Signals of the Predatory Stink Bug, Eocanthecona furcellatta	**Hsiao-Yung Ho** *, Chao-Chih Cheng, Chi-Hung Ko Institute of Cellular and Organismic Biology, Academia Sinica, Taiwan
P-19-D	Synthesis and field evaluation of 3-oxo-alpha-ionone derivatives as male attractants for the solanaceous fruit fly, Bactrocera latifrons (Hendel) (Diptera: Tephritidae)	**Yukihiro Yoshida**[1*], Tsuguo Kohama[2], Takashi Matsuyama[2], Hajime Ono[1], Ritsuo Nishida[1] [1]Laboratory of Chemical Ecology, Graduate School of Agriculture, Kyoto University, Japan. [2]Okinawa Prefectural Agricultural Research Center, Japan.
P-20-D	Pheromonal cross-attraction of two allied species, Nezara viridula and N. antennata (Heteroptera: Pentatomidae)	**Nobuyuki Endo**[1*], Nobutaka Shimizu[2], Takafumi Tsutsumi[2], Tomoyuki Yokosuka[3], Shinetsu Muto[4], Rikiya Sasaki[4] [1]NARO Kyushu Okinawa Agricultural Research Center, Japan. [2]Fukuoka Agricultural Research Center, Japan. [3]Ibaraki Agricultural Center, Agricultural Research Institute, Japan. [4]Fuji Flavor Co., Ltd., Japan.
P-21-D	Evidence of Wax Secreted by Female Adult as a Source of Aggregation Pheromone in Crawler of the Spiraling Whitefly *Aleurodicus dispersus*	Liao Yonglin, **Wu Weijian** * Laboratory of Insect Ecology, South China Agricultural University, China

No.	Title	Author
P-22-D	Comparative studies on nestmate recognition in supercolony forming ants, Argentine ant and Formica yessensis	**Midori Kidokoro-Kobayashi**[1*], Keita Kondo[1], Seigo Higashi[2], Mamiko Ozaki[3] [1]Kobe University, Japan. [2]Hokkaido University, Japan. [3]Graduate school of Science, Kobe University, Japan.
P-23-F	Relative importance of olfactory and visual cues in perception of Coccinella septempunctata to Myzus persicae and the effect of sensational impairment on functional response	**Xiao-Le Chai**, **Wei-Zheng Li**, Guo-Hui Yuan [*] College of Plant Protection, Henan Agricultural University, China.
P-24-F	Tarsal gustatory sense in coleopteran insects	**Shuhei Masuta**, Rei Kakazu, Naoshi Masuoka, Kazuhiro Matsuda, Masatoshi Hori [*] Graduate School of Agricultural Science, Tohoku University, Japan
P-25-F	New aphid repellents discovery based on affinities to odorant-binding protein	Yufeng Sun[1], Huili Qiao[3], Yun Ling[1], Shaoxiang Yang[1], Liang Sun[1], Changhui Rui[2], Paolo Pelosi[3], **Xinling Yang**[1*] [1]China Agricultural University, China. [2]Institute of Plant Protection, Chinese Academy of Agricultural Sciences, China. [3]University of Pisa, Italy.
P-26-G	Synthesis of the sex-pheromones of *Omphisa plagialis Wileman*	**Fuchao Yu**, Shengqiang Pan, Shengjiao Yan, Jun Lin[*] Key Laboratory of Medicinal Chemistry for Natural Resources, School of Chemical science and technology, Yunnan University, 650091, Kunming, P. P. China
P-27-G	Attraction of *M. falcana* (Lepidoptera: Tortricidae) by virgin females of a congeneric species, *M. phaseoli* in field trapping, and indistinct reproductive isolation	**Jung Jin Kyo**[1*], Seo Bo Yoo[1], Park Chang Gyu[2], Cho Jum Rae[2] [1]National Institute of Crop Science, Korea, Republic of. [2]National Academy of Agricultural Science, Korea, Republic of.
P-28-G	A yeast cell factory for moth pheromone production: Substrate specificity of a plant-derived Acetyl-transferase	**Bao-Jian Ding**[1*], Timothy Durrett[2], Sten Stymne[3], Christer Löfstedt[1] [1]Lund University, Sweden. [2]Michigan State University, United States. [3]Swedish University of Agricultural Sciences, Sweden
P-29-G	Sex pheromone of fall armyworm Spodoptera frugiperda in Brazilian populations	Jose Mauricio Simoes Bento[*], Luiza Cristiane Fialho Zazycki, Rejane Cristina Roppa Kuss-Roggia, Daniel R. Sosa-Gomez, Kelly Jaqueline Alves, Karina Botini Liva, Fernando Luis Consoli. University of Sao Paulo – ESALQ, Brazil.
P-30-G	Isolation and Characterization of a rice jasmonic acid carboxyl methyltransferase gene	**Jinfeng Qi**, Xiu Han, Ran Li, Jiancai Li, Yutao Xiao, Haixin Yu, **Yonggen Lou** [*] Institute of Insect Sciences, Zhejiang University, Hangzhou, China (310029)
P-31-G	A WRKY transcription factor regulates plant signaling and defense responses in rice	Lingfei Hu, **Ran Li**, Meng Ye, **Yonggen Lou*** *Institute of Insect Sciences, Zhejiang University 310029
P-32-H	Ecological niche differenciation in the pitcher plant Nepenthes rafflesiana: the role of volatile compounds	**Bruno Di Giusto** [1*], Linda Lim[2], David Marshall[2], Jean-Marie Bessiere[3], Laurence Gaume[4*] [1]Ming Chuan University, Taiwan. [2]Universiti Brunei Darussalam,Brunei Darussalam. [3]CNRS/CEFE, France. [4]CNRS/AMAP
P-33-H	The role of host odours in the biology of a quarantine pest, the mango seed weevil	**R. Andrew Hayes** AgriScience Queensland, DEEDI, Australia

No.	Title	Author
P-34-H	Elevated ozone reduces the activities of *Helicoverpa armigera* midgut proteinases by altering the induced defense of the tomato plant	QIN REN [1, 2] **FENG GE** [1 *] AND YUCHENG SUN[1] [1] State Key Laboratory of Integrated Management of Pest Insects and Rodents, Institute of Zoology, Chinese Academy of Sciences, Beijing 100101, China [2] Ji Ning Normal College, Jining, Inner Mongolia 012000, China
P-35-H	Effect of *Ferula assafoetida* essential oil on some life parameters of the carob moth, *Ectomyelois ceratoniae* under laboratory conditions.	Kamelshahi, **G., Goldansa**z, S. H., Hosseininaveh, V. Dep. Plant Protection, University of Tehran, Karaj, Iran. P.O.Box 4111
P-36-H	Performance of Spodoptera litura reared on maize sprayed with methyl jasmonic acid and relationship with defensive proteins of maize	**Tse-Chi Shen** and **Shaw-Yhi Hwang**[*] Department of Entomology, National Chung Hsing University, Taichung, Taiwan
P-37-H	Insect elicitors from different food source cause the changes of plant defense response.	Hsiang-Wei Huang and **Shaw-Yhi Hwang**[*] NCHU, Taiwan
P-38-H	The accumulation of antidiabetic iminosugars in silkworms reared of mulberry leaves	**Shigeto KOMATSUBARA**,[1] Shinji ONOSE,[1] Oki HIGUCHI,[2] Kiyotaka NAKAGAWA,[1] Teruo MIYAZAWA[1] and Masatoshi HORI[1*] [1] Graduate School of Agricultural Science, Tohoku University, Sendai 981-8555, Japan [2] PROJECT M, Sendai 980-8579, Japan
P-39-H	Oviposition biology and function of host plant odor in the yellow peach moth	**Zhixin LUO**, Hiroshi HONDA [*] Graduate School of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Ibaraki 305-8572, Japan
P-40-H	Identification and biosynthesis of fatty acid amino acid conjugates in Drosophila melanogaster larvae and adults	**Tetsuya Yoshida**, Takako Aboshi, Naoko Yoshinaga, Masao Fukui, Ritsuo Nishida and **Naoki Mori** [*] Laboratory of Chemical Ecology, Graduate School of Agriculture, Kyoto University, Japan
P-41-H	Chemicals relating host selection in rice plant for the brown planthopper, N. lugens	**Zhan Zhihui**[*], Matsuo Akane and Shiraki Kana Kochi university, Japan
P-42-H	Why must the cotton aphid (Aphis gossypii) shift the host plant?	**Yu Yamamoto**[*], Mika Yoshi, Kana Nishino and **Chul-Sa Kim**[*] Kochi university, Japan.
P-43-H	Chemicals relating host selection in rice plant for white-backed planthopper, Sogatella furcifer	**Akane Matsuo**[*], Zhihui Zhan and **Chul-Sa Kim** Kochi university, Japan.
P-44-H	Chemicals relating host selection in rice plant for the green rice leafhopper, N. nigropictus	**Kana Shiraki**[*], Zhihui Zhan, Chiaki Nagayasu and **Chul-Sa Kim** Kochi university, Japan
P-45-H	The Attracting Effect of Odorants of Different Chemicals on Whitefly (Bemisia tabaci Gennadius)	Pengliang Pan and **Yuchuan Qin**[*] Dept of Entomology, China Agricultural University, China.

No.	Title	Author
P-46-H	To select vegetables as repellent against the whiteflies on cucumber	Qing Zhao and **Yuchuan Qin*** Dept of Entomology, China Agricultural University, China
P-47-H	An EAR-motif-containing ERF Transcription Factor Affects Herbivore-Induced Signaling, Defense and Resistance in Rice	**Jing Lu,** Hongping Ju, Guoxin Zhou, Chuanshu Zhu, Matthias Erb, Xiaopeng Wang, Peng Wang and **Yonggen Lou*** National Key Laboratory of Rice Biology, Institute of Insect Science, Zhejiang University, China.
P-48-H	Antennal and behavioral response of Heortia vitessoides (Lepidoptera: Pyralidae) females to host plant volatiles from Aquilaria sinensis	**Haili Qiao**[1], Pengfei Lu[2], Jun Chen[1*], Weisi Ma[1], Rongmin Qin[3], Xiangming Li[3] [1]Institute of Medicinal Plant Development, Chinese Academy of Medical Sciences and Peking Union Medical College, China. [2]State Key Laboratory of Integrated Management of Pest Insects and Rodents, Institute of Zoology, Chinese Academy of Sciences, China. [3]Huazhou Green Life Co. Ltd, China.
P-49-H	Chemical Factors Affecting Food Selection by Larvae of Cotton Bollworm, Helicoverpa armigera	**Kozue Kurashima***, Makoto Abe, Koji Noge and Shigeru Tamogami Akita Prefectural University, Japan
P-50-H	Study on Biological Activities and Application of *Lantana camara* Pentacyclic Triterpenoids against Vegetable Insect Pests	**Zhang Maoxin***, Ling Bing, Dong Yizhi Laboratory of Insect Ecology, South China Agricultural University, Guangzhou 510642, China
P-51-H	Antifeedant activitiesof podophyllotoxin, XW-2 and XW-4 against adult of stried leaf beetles, Phllotreta striolata	**Di Xu***, Hui Zhao South China Agriculture University, China
P-52-H	Oviposition and Feeding Deterrent Effect of Plant Sterols from Xanthium sibiricum on two Insect Pests in China	**Qiong Zhou***, Zheng-Yan Xiong and Xu Su College of Life Science， Hunan Normal University, China. College of Forestry, Central South University of Forestry and Technology, China
P-53-H	Olfactory response of *Frankliniella occidentalis* (Thysanoptera: Thripidae) and *Neoseiulus cucumeris* (Acari: Phytoseiidae) to odors of eggplants treaded with exogenous jasmonic acid	**Feng Zhong**[1], Yu-Rong He[2], Li-hua Lu[1*] [1]Plant Protection Research Institute, Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong, China. [2]College of Natural Resources and Environment, South China Agricultural University, Guangzhou, Guangdong 510642, China.
P-54-H	Isolation and identification of plant volatiles from three crucifer cultivars	**Dai Jian-qing**[1*], Han Shi-chou[1], Du Jia-wei[2] [1]Guangdong Entomological Institute, Guangdong Provincial Public Laboratory on Wild Animal Conservation and Management, Guangzhou 510260, China; [2]Shanghai Institute of Plant Physiology & Ecology, Chinese Academy of Sciences, Shanghai 200032, China
P-55-H	Evaluation of Allelochemical Effects of Hordeum vulgare Extracts	**Md Azharul Islam*** Tokyo University of Agriculture and Technology, Japan
P-56-H	Effect of Rhizoma Glycyrrhizae extract on spore germination, fungal growth and aflatoxin production by Aspergillus flavus and Aspergillus parasiticus	**Weiwei Gao** Institute of Medicinal Plant Development, Chinese Academy of Medical Sciences and Peking Union Medical College, China

No.	Title	Author
P-57-H	Effects of inoculating arbuscular mycorrhizal fungi on Artemisia annua growth and its officinal components	**Jing-Hua Huang**[1*], Ju-Fa Tan[1], Hong-Ke Jie[1], Ren-Sen Zeng[2] [1]College of Agronomy, Guangxi University, China. [2]Agriculture Key Laboratory of Eco-agriculture, South China Agricultural University, China.
P-58-H	Silencing *OsAOS*, *OsCOI1*, *OsPAL* genes changes rice resistance to herbivorous insects	**Mao Ye**[1, 2], Yi Juan Su[1,2], Yuan Yuan Song[1, 2], **Ren Sen Zeng**[1, 2*] [1]State Key Laboratory for Conservation and Utilization of Subtropical Agricultural Bio-resources, South China Agricultural University, Guangzhou 510642, China [2]Institute of Tropical & Subtropical Ecology, South China Agricultural University, Wushan, Guangzhou 510642, P.R. China
P-59-I	Age-related changes in olfactory response to host volatiles of a pine weevil, *Pissodes punctatus* Langor et Zhang	**Yan Zhengliang**[1*], Ze Sangzi[1], Zhang Zhen[2], Ma Huifen[1] [1]Yunnan Key Laboratory of Forest Plant Cultivation and Utilization/Yunnan Laboratory for Conservation of Rare, Endangered and Endemic Forest Plants, State Forestry Administration, Yunnan Academy of Forestry, Kunming 650204, China; [1]Research Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry, Beijing 100091, China
P-60-I	Preliminary Verification of Pheromone and Identification of Intestinal Volatile for *Pachypeltis* sp.	**ZE Sang-Zi**, YAN Zheng-Liang, **JI Mei*** Yunnan Academy of Forestry, Yunnan Provincial Key Laboratory for Cultivation and Exploitation of Forest Plants, Kunming Yunnan 650204, China
P-61-I	Influence of conspecific odor on the behavioral response of *Tribolium confusum* to food odor	**Yoshimi AOKI** and Masatoshi HORI* Graduate School of Agricultural Science, Tohoku University, Sendai 981-8555, Japan
P-62-I	Attractiveness of specific tea shoot volatiles and colored sticky plates to the tea green leafhopper, *Empoaca vitis*	**Han Baoyu***, Cuil Lin Zhejiang Provincial Key Laboratory of Biometrology and Inspection & Quarantine, College of Life Sciences of China Jiliang University, Hangzhou 310018 China
P-63-J	Efficient Protocol for Seed Germination of Centella asiatica	**Md. Azharul Islam** *, Promod Dhakal and Shahanara Begum Tokyo University of Agriculture and Technology, Japan
P-64-J	Improving Degree Day Modelling for Oriental Fruit Moth and Codling Moth	Joanne Dawson, **Alex Ilichev***, Ross Coulston, Neil Penfold and David Williams BioSciences Research Division, DPI Victoria, Australia
P-65-J	Cell-based piezoelectric biosensor for measurement of ecological environments	**Tomoko Abe***, Masao Yamana School of Science and Engineering, Tokyo Denki University, Japan
P-66-E (E5)	Pine weevil (Hylobius abietis) repelled by 3-octanol, produced by a fungus isolated from pine weevil frass	

P-A

Honey bee queen pheromone: a recipe for success and survival

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Abstract: Honey bee queens produce a mixture of pheromones known collectively as queen mandibular pheromone (QMP). One intriguing effect of QMP is that it alters dopamine signalling in the brain of young worker bees. Brain dopamine levels, levels of dopamine receptor gene expression and cellular responses to this amine are all affected in young bees exposed to QMP. At a behavioural level, QMP's effects on dopamine signalling have three major consequences: aversive learning in young workers is blocked, activity levels are suppressed, and young bees are more likely to show attraction to their queen. This lecture will discuss the mechanisms through which queen pheromone operates and the sophisticated systems that ensure the success and survival of this highly social insect.

Key words: Apis mellifera, queen pheromone, homovanillyl alcohol, dopamine signaling, associative olfactory learning, olfaction

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P-B

The Molecular Making of a Robust Insect's Olfactory System

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Abstract:Insect perceived the world through semiochemicals with exquisite sensitivity and selectivity. A male moth can detect a female-produced sex pheromone even when the signal-to-noise ratio is very low. Mosquitoes have an even more acute olfactory system for the detection of host-derived odorants. The insect's olfactory systems is able to discriminate pheromones and other semiochemicals from other compounds with minimal structural changes. With the advent of genome sequences we are now able to characterize the entire repertoire(s) of olfactory genes and study their function in olfactory tissues. In this presentation, I will discuss how odorant-binding proteins, odorant-degrading enzymes, and odorant receptors may contribute to the inordinate sensitivity and selective of the insect's olfactory system, answer some and raise many more questions.

P-C

Molecular basis of host-seeking behavior in Anopheles gambiae

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Abstract: Malaria is a mosquito borne disease that infects more than 700 million people annually and causes as many as 4-5 million deaths, most are children in Africa. The mosquitoes, Anopheles gambiae are the principal Afrotropical malaria vector. Olfaction, the sense of smell, plays a predominant role in mediating several key behaviors in adult mosquitoes including nectar feeding, selection of oviposition sites as well as mate and host preference. Adult An. gambiae have three olfactory apparatus: the antenna, the proboscis and the maxillary palp, all of which are populated by several classes of olfactory sensilla. At the molecular level, odor coding in insects is thought to rely on the activation of a large family of highly divergent seven-transmembrane-domain odorant receptor proteins. In An. gambiae, 79 putative odorant receptor (AgOR) genes have been identified by bioinformatics combined with molecular techniques. Of the 79 AgORs that were originally identified, 73 are expressed in the adult and 13 are expressed in larval stages by RT-PCR study. We performed a systemic functional analysis of the OR repertoire from Anopheles gambiae adult olfactory appendages in in vitro Xenopus expression system. Data being presented here suggest there are similar olfactory coding rules as in Drosophila: firstly, the receptive range of AgORs varies smoothly from very narrow to broadly tuned. Secondly, odorant identity and concentration are the major factors affecting odor coding. And thirdly, the odor coding is determined by odor-receptor combination. Previous report suggested narrowly tuned receptors may carry information about odorants of high biological relevance. In our study, several narrowly tuned Anopheles gambiae odor receptors were identified that may act as useful targets for manipulating Anopheles gambiae host-seeking behavior and then decreasing the transmission of malaria.

Key Words: Anopheles gambiae, host-seeking, Malaria, Molecular

P-D

Analysis and Synthesis of Adaptive Behavior in Insects:From Genes, Neural Networks, and Behavior to Robots

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Abstract: Adaptability, the capability to respond with appropriate behaviors to ceaselessly changing environmental conditions, is a hallmark feature of animals. Insects display a diversity of sophisticated behaviors matched to their environments by the processing of a simple nervous system. Insects will become an excellent model for understanding adaptive control in biological systems and in turn, inspire control and communication in engineering applications. In order to understand the neural basis of adaptive behavior in insects, we work at multiple levels, from genes, single cells of the neural system to the actual behavior. To examine the neural basis of behavior, we made a model of the neural circuit, and integrated it in a mobile robot. Moreover, in order to understand the dynamics of the neural circuit, we have been developing an "insect-robot hybrid system" in which the insect or an isolated insect brain controls a robot. In this lecture, focusing on the odor-source orientation behavior in the male silkmoth, brain mechanisms generating behavior revealed by using multidisciplinary approaches will be presented. At first, odor-source orientation in the male silkmoth and its neural basis will be introduced. Second, the extent of adaptation in the behavioral strategy, as governed by the neural system and investigated via a robotic implementation, will be shown. Finally, I will demonstrate an insect-machine hybrid system and an example of genetic manipulation of insect behavior. These analysis and synthesis approaches will lead to important insights for evaluating and understanding the neural basis of adaptive behavior.

Key words: insect Adaptive Behavior, robots, Genes, Neural Networks

P-E

Signaling pathways regulating rice defense responses

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Abstract: Jasmonic acid (JA), salicylic acid (SA) and ethylene signaling pathways, especially JA signaling, have been reported to play important roles in regulating herbivore-induced plant direct and indirect defense responses in many plant species. In rice, it has been observed that infestation by herbivores, including chewing and piercing/sucking insects, dramatically increases levels of JA, SA and ethylene in plants. However, whether these signaling pathways are involved in rice defense responses remain largely unknown. Using an Agrobacterium-based transformation system, we obtained several rice mutants that are, respectively, related to JA, SA and ethylene signaling pathways, such as as-lox, as-ics, as-acs, as-pld, and so on. By comparing the difference in defense chemicals and plant herbivore resistance between mutants and WT plants when they were infested by chewing or piercing/sucking herbivores, we found that rice direct defense to chewing herbivores were mainly modulated by JA and ethylene signaling pathways, whereas rice direct defense to piercing/sucking herbivores were largely mediated by SA, H2O2 and ethylene pathways. Interesting, different from those reported in other plant species, rice indirect defense to chewing and piercing/sucking herbivores seems to be mainly shaped by ethylene signaling. These findings provide new insights into herbivore-induced plant defense responses.

Key words: rice, rice, jasmonic acid, salicylic acid, ethylene, herbivore-induced defense response, plant herbivore resistance.

P-F

Coding of Behaviorally Significant 'Odor Objects' in the Antennal Lobe of a Moth

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A principal goal of our work is to understand neurobiological mechanisms through which information about behaviorally significant olfactory stimuli is encoded and processed in the brain of the of the giant sphinx moth Manduca sexta.

Our studies have focused mainly on the antennal lobes (ALs), the primary olfactory centers in the moth's brain. As in most vertebrates and invertebrates, the ALs are characterized by glomeruli – condensed-neuropil structures in which primary-sensory and central neural elements interact synaptically. We seek to understand how primary-sensory inputs from olfactory receptor cells are processed in glomeruli and represeted in their outputs.

We focus on olfaction-dependent behaviors that are crucial for the survival of the moths − mate-seeking and interactions with host plants for feeding and oviposition. In some of those studies, olfactory neurobiology has led us to recognize naturally occurring volatiles that function in the chemical mediation of such interactions.

Insights from the sex-pheromonal communication system led to recent analysis of olfaction-dependent interactions with host plants. A multidisciplinary approach combining chemical characterization of natural volatiles, behavioral experiments in a laboratory wind tunnel, and electrophysiology has enabled us to determine how mixtures of volatiles, at natural concentrations, control flight behavior and are encoded in the ALs. Mounting evidence points to coincident firing of output neurons of glomeruli as a mechanism for neural coding of the context or significance of an odor. Gas chromatography coupled with multi-channel CNS recording has enabled identification, in complex floral mixtures, of key odorants to which olfactory-lobe neurons are particularly responsive. Mixtures containing only a few of those floral odorants are as effective as the complete, natural floral blend in modulating flight.

Key words: Antennal Lobe, Manduca sexta, behavior, Odor Objects

The research described in this presentation has been supported by research grants and contracts from NIH, NSF, DARPA, Monsanto Company, and the Pew Foundation.

A-1

Sensory ecology of seaweeds and microbes: linking molecular mechanisms with ecological outcomes

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Abstract: Because of the lack of many of the sensory modalities common in "higher" organisms, other modalities such as chemical signalling and sensing should play particularly important roles in the sensory ecology of organisms such as bacteria or macroalgae (seaweeds). Here we present two model systems of chemical signalling in bacteria and seaweeds; i) the role of chemical defenses and quorum-sensing (QS) regulatory systems in bacterial colonization and disease of the red alga Delisea pulchra, and; ii) the regulation of dispersal and differentiation by nitric oxide signalling (NO) in bacterial biofilms. In both models we investigate the links between specific signal-mediated molecular mechanisms and ecological consequences for populations or assemblages of bacteria or seaweeds. We suggest that because of the fundamental role played by chemical signalling in bacteria, and the ease of manipulation of bacterial systems, microbial sensory ecology has much to offer for understanding molecular-ecological linkages in chemical ecology.

Key Words: marine disease, climate change, bacterial biofilms, quorum sensing, nitric oxide, protozoan grazing

A-2

Chemical signaling of coral larval settlement and metamorphosis

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Abstract: The induction of larval attachment and metamorphosis of benthic marine invertebrates is widely considered to rely on habitat specific cues. While microbial biofilms on marine hard substrates have received considerable attention as specific signals for a wide and phylogenetically diverse array of marine invertebrates, the presumed chemical settlement signals produced by the bacteria have to date not been characterized.

In a collaborative project between the Australian Institute of Marine Science (Townsville, QLD) and the Centre for Marine BioInnovation (Sydney, NSW) we have isolated and fully characterized the first chemical signal from bacteria that induced larval metamorphosis of acroporid coral larvae (Acropora millepora). The metamorphic cue was identified as tetrabromopyrrole (TBP) in four bacterial Pseudoalteromonas strains among a culture library of 225 isolates obtained from the crustose coralline algae Neogoniolithon fosliei and Hydrolithon onkodes. Coral planulae transformed into fully developed polyps within less than 2h, but only a small proportion of these polyps attached to the substratum. The biofilm cell density of the four bacterial strains had no influence on the ratio of attached vs. non-attached polyps. Larval bioassays with ethanolic extracts of the bacterial isolates, as well as synthetic TBP resulted in consistent responses of coral planulae to various doses of TBP. The lowest bacterial density of one of the Pseudoalteromonas strains which induced metamorphosis was 7,000 cells mm2 in laboratory assays, which is on the order of 0.1 –1% of the total numbers of bacteria typically found on such surfaces.

In addition to the bacterially produced metamorphic cue TBP, crustose coralline algae harbour cues that result in both metamorphosis and attachment of coral larvae. We will report work-in-progress describing latest results of the isolation and identification of these signaling molecules of algal origin

Key words: corals, larval settlement, crustose coralline algae, bacteria, Great Barrier Reef

A-3

Defensive strategies of tropical Pacific sponges against fish predators and bacterial attack following wounding

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Abstract: Sponges, like any other sessile benthic organisms, have to deal with several ecological threats like predation, fouling, or competition. To overcome these threats, they have evolved a wide array of defensive mechanisms, such as morphological or chemical defenses. The aim of this study was to determine how common sponges from Guam and surrounding Micronesian islands employ secondary metabolites as defense against predators and microbial pathogens. To test for antipredatory defenses choice feeding assays were conducted in the field with omnivorous fishes and in the laboratory with the pufferfish Canthigaster solandri. Therefore, sponge crude extracts were incorporated at natural concentrations into an artificial diet and offered simultaneously with food containing solvent only to potential fish predators. The results indicated that most sponges use secondary metabolites as defense against potential fish predators. A subset of the investigated sponges was further analyzed with regard to dynamic defensive strategies, such as activated or induced defenses, to evaluate whether such strategies are an exception or widely represented among various Porifera species. In the case of the sponge Aplysinella sp. we could clearly demonstrate that an activated defense mechanism was used against feeding by fishes. Furthermore, we investigated whether allocation of defenses followed strategies such as the Optimal Defense Theory and could show that the sponges Oceanapia sp. and Melophlus sarasinorum allocated their defensive metabolites accordingly.

In addition, the same sponge extracts were tested at natural concentrations for possible antimicrobial activity in disc diffusion assays against ecologically relevant bacterial isolates. Bacterial isolates had previously been isolated from biofilms of reef rock and crustose coralline algae. Again we not only tested for the presence of antimicrobial compounds, but also whether the production of the compounds could be induced. Eight different sponge species were directly extracted following collection or artificially grazed for two weeks and than extracted. All extracts were tested in disc diffusion assays against marine bacteria. While several sponges revealed strong antimicrobial activity, only the sponge Melophlus sarasinorum demonstrated an induced antimicrobial response.

Although there have been previously numerous examples that sponges are prolific producers of potent marine natural products to deter potential predators and pathogens, our studies demonstrate that they also optimized defense strategies to be able to adjust to variable predation pressure.

A-4

Antifouling Metabolites from the South China Sea Invertebrates

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Abstract: The ocean covers more than 70% of the blue planet surface and its complicated ecosystems offer vast biodiversities. Natural products have been the most important source of drug leads. Marine organisms produce novel structures-~20000 to date, and have high incidence of biological activity.

Another goal of our research is to develop low or nontoxic antifoulants.

Marine biofouling is undesirable establishment of marine organisms on submerged surfaces of marine installations, it is widely spread phenomenon. Marine biofouling causes leads to more than US$6.0 billion of annual losses world-wide in the maritime industries. Combats against fouling organisms started when humans built boats. Protection of ships' hulls from fouling goes back more than 2000 years. Various toxic materials have been used for control of fouling organisms, among which organotin compounds, especially tributyltin (TBT) and tributyltin oxide (TBTO), are remarkably effective. But due to highly toxicity, non-specific, accumulation in organisms and sediments, waste disposal, hazardous to human, ban of TBT products -2008 by the International Maritime Organization (IMO). Cupuric oxide-based paints and biocide-based "booster" paints have been introduced as alternative paints; however, these paints also showed environmental problems in recent years, in the future, cupric oxide-based paints will be restricted. Therefore, development of nontoxic or environmentally friendly antifoulants has been urgently required. No natural bioactive compounds have been developed into commercial antifoulants yet.

We use anti-larval settlement (macrofouling), Balanus reticulatus Utinomi larval species used as target, to screen antifouling compounds from our natural product library, we find several potential antifouling candidates.

Key words: Antifouling, South China Sea, Invertebrates

A-5

Antifouling agents from sessile marine invertebrates and their symbiotic microorganisms

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Abstract: In coral reef ecosystem, marine sessile invertebrates, especially soft corals, gorgonians and sponges, develop very comprehensive chemical defensive strategies against predators, epibionts and diseases. The bioactive secondary metabolites produced by those organisms are a rich source of marine antifouling agents. In recent years, we have been searching for environmentally friendly antifouling natural products from sessile marine organisms that are often free of fouling organisms on their body surfaces. More than 30 marine species, including 20 species of soft corals, gorgonians and sponges, and 10 strains of symbiotic microorganisms collected from the coral reefs in the South China Sea, were screened and evaluated for their antifouling activities. More than 200 compounds, including sesquiterpenoids, diterpenoids, phenols, macrolides and steroids, were isolated and identified, of which 60 compounds showed antifouling activity against the larval settlement of barnacle Balanus amphitrite at 50 μg/ml and/or 25 μg/ml. Among the active compounds, 23 compounds exhibited potent antifouling activity with EC50 values lower than 8.0 μg/ml; 14 compounds with EC50 values lower than 1.30 μg/ml. The LC50/EC50 ratios of 13 compounds were higher than 15 and thus are considered as low-toxin and high-security.

Keywords: Antifouling agent, marine invertebrate, symbiotic microorganism, secondary metabolite, low-toxin, high-security

A-6

Antifouling and antibacterial compounds from the South China Sea gorgonians and their associated microorganisms

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Abstract: In the marine environment, many sessile organisms such as gorgonians are known to produce a variety of chemicals for defense purposes against predation and epibiont growth. Marine microorganisms are also becoming a new important source of active biological molecules. The use of natural marine products that are efficient against several fouling organisms may provide an acceptable solution for developing new environmentally compatible antifoulants. In order to obtain antifouling compounds from marine organisms and investigate their potential chemical defensive roles, we studied on the antilarval and antibacterial secondary metabolites of five species of the South China Sea gorgonians and their associated microorganisms (including bacteria, actinobacteria and fungi). Culturable microorganisms isolated from the five gorgonian species were grown using agar-plating techniques. Extensive spectral analyses including 1D NMR, 2D NMR spectra and MS were employed for structure elucidation of the compounds. Screening for antilarval substances was performed in settlement inhibition assays with laboratory-reared Balanus amphitrite and Bugula neritina larvae while antibacterial activity was assessed with disc diffusion bioassay on growth inhibition of four marine bacterial species. Totally, 560 gorgonian-associated microbia isolates were isolated, and 262 of these isoalted showed antilarval or antibacterial activity. In further chemical study, 38 antilarval or antibacterial compounds were obtained from the five gorgonians and five gorgonian-associated microorganisms. The results indicated that gorgonian-associated microorganisms may aid the host against colonisation of its surface, and marine gorgonians and their associated microorganisms are efficient producers of antifouling agents.

Key Words: Antifouling and antibacterial compounds, gorgonians, microorganisms

A-7

Allelochemical induces growth and photosynthesis inhibition, oxidative damage in marine diatom Phaeodactylum tricornutum

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Abstract: Algal blooms have been occurring in many regions all over the world and allelochemicals being used for inhibiting microalgae growth are considered as one of the important and promising methods to control algal blooms. Polyphenol compounds are important allelochemicals which are widely present in plants and marine algae. Here, the allelopathy of hydroquinone (HQ) as a structural analogue of plant polyphenols was studied. The results showed that HQ significantly inhibited the growth and specific growth rate of algae under higher concentrations (above 3×10-7 mol/L) of HQ exposure, and the EC50 values reflecting the inhibitory effect on microalgae increased with the treated-time extending, which suggested that HQ stress on the algae gradually weakened with time prolonging. Similarly, higher concentrations of HQ (above 4×10-7 mol/L) significantly decreased the contents of cellular pigments including Chlorophyll a (Chl.a) and carotenoids. However, the ratios of carotenoids to Chl.a increased obviously only when algae were exposed to 6×10-7 and 7×10-7 mol/L of HQ for 72 h, which implied that the ratios of pigments changed in extreme conditions to resist environmental stress. At the same time, HQ also induced the changes of antioxidant enzymes activities including superoxide dismutase (SOD), catalase (CAT), glutathione peroxide (GPX), glutathione S-transferase (GST) and non-enzymatic antioxidant reduced glutathione (GSH) contents. Additionally, flow cytometric assays showed that HQ stress altered the permeability of cell membrane and mitochondrial membrane potential in different degrees. All these results showed that HQ-induced oxidative stress and changes of cellular membrane system might be responsible for HQ inhibition on the growth of P. tricornutum, and HQ might have the potential as an algaecide to control marine microalgae.

Key Words: antioxidant enzyme; hydroquinone; Phaeodactylum tricornutum

The work was financially supported by the Knowledge Innovation Program of Chinese Academy of Sciences (KZCX2-YW-Q07-04) and Yantai Science Technology Bureau (2008155, 2011063).

B-1

Real-time Odor Discrimination and Source Location Using a Bioelectronic Sensor Array Based on the Insect Electroantennogram

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Abstract: The insect olfactory system is able to identify volatiles on a time scale that matches their ability to maneuver, and this sub-second odor classification ability is unmatched by any of the currently available artificial nose systems. We have developed a multiple channel electroantennogram (EAG) to detect and classify (identify) individual strands of odor in a plume passing over the sensor on a sub-second time scale (Myrick et al. 2008). The four-, or eight-, channel antennal array is coupled with a computational analysis strategy that allows discrimination between odors in real time on a sub-second basis. Following a training period, both semi-parametric and k-nearest neighber classifiers with the ability to discard ambiguous responses are applied toward the classification of up to eight odors in strands comprising natural point-source plumes. EAG responses to individual strands in an odor plume are classified according to any of the odors the system was trained to recognize, or else are discarded as ambiguous by the system. Using this multi-channel antennal array system, we have successfully measured the degree of plume-strand mixing in confluent plumes from two different odor sources (Myrick et al. 2009). The system is able to classify individual strands of either of the pure odorants as well as to classify strands as being "mixed" (overlapping) when strands of the two odorants converge on the EAG sensor simultaneously. The array classifies a higher frequency of strands as being "mixed" when the sources are located only 1 or 2cm apart than when the sources are 5 or 10cm apart. The system is also able to measure the proportion of strands of pure, unmixed pheromone, emitted by female Trichoplusia ni and Heliothis virescens females calling less than 5 cm apart from each other, and affect the behavior of responding males of each species 1.5 m downwind (Lelito et al.2008). Further work has involved integrating the multi-antennal EAG with a GPS and digital compass, plus an ultrasonic 2D anemometer. Using the synchronous measurements of a "hit" from a plume strand coupled with wind direction at that instant, in the field at a distance of 15m from an odor source we have been able infer the source's location with an accuracy of ±20 cm (Myrick and Baker, 2011). To do this we use a backward Lagrangian dispersion model based on the Langevin equation. Further, our use of Bayesian inference allows uncertainty to be quantified, which is useful for robotic planning.

Key Words: electroantennogram, bioelectric chemosensor, sex pheromone, odor source location, odor classification, artificial nose

B-2

Identification of kairomonal components from the venom alkaloids of Solenopsis imported fire ants attractive to the parasitic phorid fly, Pseudacteon tricuspis

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Abstract: In the past decade, Pseudacteon tricuspis have been released in many parts of southern United States for biological control of the invasive imported fire ant (IFA) complex consisting of Black, Red and Hybrid IFA, Solenopsis invicta, S. richteri, and S. invicta ´ S. richteri, respectively. Pseudacteon tricuspis behaviorally respond to odor of S. invicta workers. To determine the glandular sources and identity of the semiochemicals mediating this interaction, we tested the electroantennogram response of P. tricuspis to extracts of key body parts and glands of workers of the red imported fire ant, S. invicta Buren. The results confirm that the poison (venom) gland/sac is the key source of compounds which elicited strong antennal activity in P. tricuspis. By using a combination of bioassay-guided fractionation and behavioral bioassays, the two venom alkaloid fractions (cis and trans alkaloid fractions) of S. invicta were proved very attractive to P. tricuspis. To determine possible differential olfactory sensitivity of phorid fly species to different species of IFA, we compared the EAG responses of both sexes of P. tricuspis to body extracts of Black, Red, and Hybrid IFA. Female P. tricuspis generally showed significantly greater EAG response than males to body extracts of the three IFA species. There was no difference in EAG responses to same equivalent extract of all three fire ant species. The GC-EAD analysis data showed that both sexes of P. tricuspis respond similarly to the cis alkaloid fractions from all three fire ant species, and two alkaloidal components, cis C11 and cis C13:1, shared by all three fire ant species triggered significant EAD response in both female and male flies. In four-way olfactory bioassay, worker body extracts of all three fire ant species were significantly attractive to both female and male P. tricuspis, but no difference recorded among them. The EAG and behavioral responses in P. tricuspis suggested that phorid fly might utilize chemical cues from worker ants for host location but not for host preference over closely related Solenopsis fire ants.

Key Words: Phorid fly, Pseudacteon tricuspis, EAG, GC-EAD, Fire ant, Solenopsis invicta, Solenopsis richteri, Hybridization

B-3

Antennal responses of Liriomyza spp. to volatile and no volatile compounds

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Abstract: To date, no sex pheromone used by Liriomyza (Diptera: Agromyzidae) for intraspecific communication has been reported. It appears likely that these leafminers employ plant volatiles for host location and mating. The most distinct EAG responses of adult L. sativae were to plant odors from the most-suitable host plants (kidney bean and tomato) and to synthetic C6 alcohols. Intermediate responses were to less-suitable plants (cucumber, celery, and chrysanthemum) and to C6 esters and aldehydes, and limonene, which is a dominant volatile of tomato plants. Weak responses were to the odors of nonhost plants (tobacco and morning glory) and to most synthetic terpenoids. Whatever the host or nonhost plants of leafminer tested, the volatiles from mechanically damaged plants always elicited higher EAG responses than did volatiles from healthy plants. Recently, in Y-tube, we still do not find any behavioral evidences that adult leafminers have preference for the odor sources from opposite sex compared with control air. Furthermore, there is no any difference in the headspace volatiles between male and female flies revealed by SPME. The results confirm that no volatile was released from the body of adult flies as sex pheromone. However, we found a large number of the cuticular hydrocarbons of L. huidobrensis by SPME, solvent extraction, GC and GC-MS. Furthermore, GC-EAD study reveal that eight hydrocarbons of these no volatles elicted distinct EAG responses in the antennae of male and four in that of females. Therefore, we hypothesized that these compounds may serve as sex pheromone and play important role in intrasepcific recognition and interspecific isolation in Liriomyza species. The role of these chemicals in sex selection of Liriomyza species needs further investigation.

Key Words: Liriomyza leafminers, Electrophysiological responses, Plant volatile, Insect cuticular hydrocarbons, Sex pheromone

B-4

The use of insect sensory electrophysiology for discovering novel attractants and repellents for integrated pest management

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Abstract: Sensory organs on the antennae of insects are know to be used in locating mates, hosts, habitats and oviposition sites. In present study, I report here about our recent efforts in use of EAG technology with the combination of chemical analytical techniques for identifying novel insect attractants and repellents, which have been further developed into commercial products of both pesterious and beneficial insects.

B-5

Prediction of the range of host plants using single cell recording technique

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Abstract: Olfaction is a major sensory modality in a number of phytophagous insects that use the olfactory information for locating their host plants, although other sensory modalities such as contact chemoreception may be involved in the final decision for host selection. Naturally, phytophagous insects have species-specific sets of olfactory receptor neurons (ORNs) for detecting their host plants. Our recent studies on three moth species, Cydia pomonella, C. succedana and Uraba lugens, indicate that the phytophagous insects have not only ORNs specialized for their host-specific volatiles but also separate ORNs specialized for the non-host specific volatiles. Our study clearly shows 1) each moth species has species-specific sets of ORN types each of which is specialized for a narrow range of plant volatiles, 2) a major proportion of these ORN types are used as agonist detecting host-specific volatile compounds, 3) another set of ORN populations are used as antagonist for detecting volatiles from non-host plants, and 4) plants release species-specific sets of volatile compounds. Our research up to present indicates that the species-specific profiles of ORN types are correlated with the volatile emanations of host and non-host plant volatiles, and here we hypothesize that ORN profiles can be used to distinguish between potential host plants and potential non-host plants by comparing the ORN profiles with the volatile emanations from these plants.

Key words: single cell recording, olfactory receptor neuron, host range, Cydia pomonella, Cydia succedana, Uraba lugens, plant volatile

C-1

Pheromones of Cerambycid Beetles

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Abstract: Despite the economic importance of many cerambycid species in their native countries, their importance as invasive species, and their popularity with insect collectors, little is known about the basic biology of even quite common and well-known species. Even less is known about their chemical ecology: as of 2004, pheromones had been identified from only five out of the ~35,000 known species. This is in stark contrast to many other economically important insects (e.g., Lepidoptera, bark beetles) for which pheromone-baited traps are standard tools for integrated pest management. Equally as important, semiochemical-baited traps are indispensible tools for detection, determining the distribution, and eradication of invasive insects.

Until recently, there were no demonstrated examples of powerful pheromones from any cerambycid species, suggesting that cerambycids might use signals or cues other than pheromones for mate location or aggregation on hosts. This conventional wisdom undoubtedly discouraged many researchers from initiating pheromone research in this family. In an Annual Review of Entomology chapter in 1999, Hanks categorized the cerambycids into three groups: 1) those that might use pheromones for relatively short range attraction of mates (over distances of a meter or so), 2) those that use pheromones in combination with host plant odors, and 3) those that did not appear to use volatile pheromones at all.

However, over the past few years this picture has changed dramatically. Extraordinary progress has been made in identifying cerambycid pheromones, with pheromones now identified or demonstrated for ~200 species, in 5 of the 6 recognized cerambycid subfamilies. This in turn is catalyzing studies on the ecological roles of these compounds, and development of applications for pheromones to detect invasive cerambycid species. Furthermore, the first commercial pheromone lures are now being used in IPM programs. In this presentation, I will review:

- The strategies that have driven rapid progress in cerambycid pheromones,
- The emerging patterns in pheromone use and pheromone structures in the different subfamilies,
- Optimized methods of using pheromones in field bioassays,
- Selected important field bioassay results,
- Future research questions.

Overall, the study of cerambycid beetle semiochemicals has become an area of very active and productive research worldwide, with major payoffs in both basic science and practical applications.

Key Words: pheromone, Cerambycidae ,invasive species, detection, monitoring

C-2

A male-produced aggregation pheromone of Monochamus alternatus (Coleoptera: Cerambycidae), a major vector of pine wood nematode

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Abstract: The Japanese pine sawyer, Monochamus alternatus Hope (Coleoptera: Cerambycidae), is an efficient vector of pine wood nematode, the causal pathogen of pine wilt disease, which has resulted in devastating losses of pines in much of Asia. We assessed the response of adult JPS to a male-produced compound in field experiments in Fujian Province, P.R. China. Both sexes of Monochamus alternatus were attracted to lures consisting of the pheromone combined with alpha-pinene and ethanol. A follow-up experiment showed that the pheromone was synergized by both ethanol and alpha-pinene. GC-MS analyses of volatiles collected from field-collected beetles of both sexes revealed that the pheromone was produced only by males. The combination of the pheromone with ethanol and/or alpha-pinene will provide a valuable and badly needed tool for quarantine detection, monitoring, and management of Monochamus alternatus, and subsequently, offer a viable control and management tool for pine wood nematode and pine wilt disease.

Key Words: Monochamus alternatus, aggregration pheromone, 2-(undecyloxy)-ethanol, ethanol, alpha-pinene

C-3

cis-Vaccenyl Acetate, A Female-Produced Sex Pheromone Component of Ortholeptura valida, A Longhorned Beetle in the Subfamily Lepturinae

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Abstract: We report the identification, synthesis, and field bioassays of a female-produced sex attractant pheromone component of the cerambycid beetle Ortholeptura valida (LeConte). Headspace volatiles from females contained a female-specific compound, (Z)-11-octadecen-1-yl acetate, which elicited a strong response from antennae of adult males in coupled gas chromatography-electroantennogram analyses. In field bioassays, significant numbers of males were collected by traps baited with this compound. The pheromone represents a new structural class of cerambycid pheromones, and is the first pheromone identified for a cerambycid species in the subfamily Lepturinae.

Key Words: Cerambycidae, Sex pheromone, (Z)-11-Octadecen-1-yl acetate, cis-Vaccenyl acetate, Woodborer

C-4

Chemical Communication in Asias halodendri (Pallas)

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Abstract: Asias halodendri (Pallas) is an important wood-boring insects of the endangered plant, Tetraena mongolica Maxim, and the number of its host kind are more than 24, including economic forests such as Hippophae rhamnoides, Salix, Populus, Embla and so on, and fruit trees such as Prunus, Persica, Malus and so on. In order to find a new way to controll it and protect the plant , this study preliminary investigated its chemical communications, main research content were incluing morphological structure of olfactory sensillas on head, extraction separation and actinity test of sex pheromone chemical composition and the information connection between adults and hosts. The main results are as follows:

The ultrastructure of sensillas especial the olfactory ones on the head of Asias halodendri (Pallas) adult were observed with scanning electron microscope. The results indicated that the olfactory dispersed on the antenna, maxillary palpus, and labial palpus. There were two types of olfactory sensillas on antenna; the number of sensillas was increasing from scapus to the end of flagellum. The total number of female sensilla was more than male, and the number of dorsal part was more than ventral and lateral parts. There were sensilla styloconica, sensilla placodea, sensilla campaniformia, sensilla eage groove on the maxillary palpus and labial palpus. They were distributing on the telos and hollow of the end of maxillary palpus and labial palpus. The number of ventral sensilla of male was more than dorsal part. In addition to, there were some non-olfaction sensilla such as sensilla chaetica, Böhm bristles, sensilla gemmiformium on the antenna, maxillary palpus and labial palpus.

The adult individuals of Asias halodendri (Pallas) were isolated with the volatiles from with SPME and GC-MS, 16 probable kinds of compound of male sex pheromone and 8 kinds of compound of female ones were screened out. Then the bioactivity of five probable compounds of male sex pheromone including A, B,C,D,E , and two compounds of female one including G and H in the room was tested by electroantennograms (EAGs) and olfactory sensation equipment. Male and female adult individuals had not been obviously performede disciplinary elecphysiology and action reaction. The bioactivity of other 17 kinds of compounds would be further researched.

The effects of plant volatiles on different concentrations of essential oils of insects' three known host plants including Robinia pseudoacacia Linn., Elm and Lycium chinense, and on main associated plants odor of Tetraena mongolica were tested. The elecphysiology and action reaction about it were tested by EAGs and Y-tube olfactometer. The result showed that the best reaction concentrations of three host plants were 0.01 μg/μl、0.001 μg/μl and 1 μg/μl; The result of the olfactory behavioral response in three plants showed that the volatile of Lycium chinense was more sensitived with Asias halodendri than other two plants; The result of the physiological and action reaction on Tetraena mongolica. and its four main associated plants' fresh branch leaves showed that the relative EAG values of Tetraena mongolica were higher than those of the associated plant species and more selectivity was performed in floriferous Tetraena mongolica.

Key Words: Asias halodendri (Pallas), sensilla, sex pheromone, electroantennogram (EAG), behavior

C-5

Mating behavior characteristics and its environmental influence factors of *Apriona germari*

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Abstract: The peak of mating behavior of *Apriona germari* mainly focused on the 19:00 to 21:00 and 8: 00 through indoor observation. The body extracts of both sexes of *Apriona germari* did not elicit attractive responses to the opposite sex by "Y"-tube olfactometer and wind tunnel, but the females showed mating behavioral characteristics, such as excitement, reproductive gland extending and so on when they contacted only live males or their body extracts, and so the male body extracts were determined primarily to function as contact pheromone in chemical communication of the mating behavior of *Apriona germari*. Meanwhile, good enough food was important condition for the mating and oviposition of *Apriona germari*. Temperature, relative humidity and light also affected the mating and oviposition of *Apriona germari*. The mating rate and oviposition increased with increasing temperature, and the activity of male and female adults were the highest at a temperature of 36℃. The oviposition was the most when the relative humidity was 40%, nearly no mating behavior happened when it reached 70%. At a temperature of 24℃, the illumination time of 14h and 16h made oviposition reach the highest.

Key words: *Apriona germari,* mating behavior, oviposition, environmental factors

C-6

Insect Pheromone development and application in China

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Abstract: The first chinese specialized insect pheromone company was established in 2003. Now pheromone has become an important business in China and attracted many attentions. Insect pheromone development and application in China was discussed, including products, application fields, limitations and future aspects. Now, food safety is becoming a real problem. Facing with the large market of chemical pesticide, there are lots of work to do for all the human beings.

Key Words: Insect pheromone, development, application

C-7

Utilization of semiochemicals in forest ecosystems

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Abstract: Host plant kairomone attractants have been developed for capturing or monitoring insect pests from the viewpoint of forest management. Nowadays these chemicals are also utilized for monitoring insect assemblages in natural and planted forests to compare the insect biodiversity between different forest types. In this paper, semiochemicals used for monitoring cerambycid assemblages in forest ecosystems are reviewed.

A combination of α-Pinene and ethyl alcohol was originally developed for catching the Japanese pinesawyer, Monochmus alternatus, which transfers the pathogenic nematode, Bursaphelenchus xylophilus to pine wood. This combination of plant kairomones is demonstrated to be attractive to several species of xylophagous cerambycid beetles.

Benzyl acetate is one of the main components of floral fragrance and was considered to be a potential attractant for the cryptomeria twig borer, Anaglyptus subfasciatus Pic, which is one of the most harmful insect pests of the Japanese cedar and the Japanese cypress. But it was deleted from the list of candidate attractants, because it lured various species of insects. However, such a characteristic is a merit to assess the biodiversity of a forest ecosystem, because it may capture various species of insects. Benzyl acetate was proved to be attractive to flower-visiting longhorn beetles, and is now used as an attractant for those beetles.

Key Words: plant kairomone, alpha-pinene, benzyl acetate, biodiversity

C-8

Conifer resistance reduces aggregation pheromones of spruce bark beetle

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Abstract: Conifers have multiple constitutive and inducible resistance mechanisms against bark beetles and their associated fungi. A few studies have reported that host defense may interfere aggregation of bark beetles to the host, but whether or not tree resistance affect beetle pheromone production is still unknown. In the present experiment, we treated Norway spruce (Picea abies) stems with methyl jasmonate (MeJA) to induce tree defense, and then measured the amounts of 2-methyl-3-buten-2-ol and (S)-cis-verbenol, the two main components of the beetle's aggregation pheromone released from beetle entrance holes in MeJA-treated and untreated Norway spruce logs. As expected, phloem terpene levels were higher and beetle tunnel length was shorter in MeJA-treated logs relative to untreated logs. In addition, beetles in MeJA-treated logs released significantly less 2-methyl-3-buten-2-ol and cis-verbenol, and the ratio between the two pheromone components was significantly altered. These results suggest that host resistance elicited by MeJA application reduce pheromone emission by I. typographus and alter the critical ratio between the two main pheromone components needed to elicit aggregation, and extend our understanding of the ecological functions of conifer resistance against bark beetles.

Key Words: Norway spruce, Methyl jasmonate, Induced defense, Spruce bark beetle, Pheromone, Terpene

C-9

Research and application on aggregation pheromone of Ips subelongatus and Ips typographus (Coleoptera: Curculionidae: Scolytinae) in N.E. China

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Abstract: As one of the major forestry regions in China, northeast China is one of the pioneer regions in China where bark beetle semiochemicals were studied and widely utilized for monitoring as well as mass trapping. Taking Ips subelongatus and Ips typographus as examples, research and application of aggregation pheromone in northeast China were presented in the paper. Behavioral responses of Ips subelongatus to three potential aggregation pheromone components, Ipsenol, Ipsdienol and 3-methyl-3-buten-1-ol, were tested in two provinces of northeastern China, which suggests that there is a strong geographical variation in aggregation pheromone response of I. subelongatus in northeastern China. As to Ips typographus, type of traps were screened on the basic of pheromone baits selected. Meanwhile, the problems existing in application of semiochemicals in forest practice were put forward on both level of decision making and grass roots management.

Key Words: aggregation pheromone, Ips subelongatus, Ips typographus, geographical variation

C-10

Female sex pheromone of the dermestid beetle, Thaumaglossa rufocapillata (Coleoptera: Dermestidae)-II.

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Abstract: Larvae of the dermestid beetle, Thaumaglossa rufocapillata, feed on nymphs of preying mantis in overwintering egg cases. The adults appear in spring. The life history of T. rufocapillata during summer without eggs of preying mantis has long been a mystery. In 1996, it was reported that off-springs of the overwintering generation came out in autumn from hatched egg cases of mantis.

The presence of the adult female sex pheromone that attracts males of the same species was evidenced by behavioral observations and chemical studies (reported in APACE2009). By using an active extract from unmated female volatiles, combination of bioassays and physico-chemical analyses revealed that the pheromone has carbon-carbon double bond(s) and carbonyl group(s) in the molecule. The carbonyl group(s) in the active molecule was suggested to be aldehydic or ketonic from the bioassay results after micro-chemical reactions of the active fraction.

The active extract was obtained by trapping the volatiles from unmated females with a porous polymer (Super Q) packed in a glass tube and by washing the column with hexane. The hexane extract was chromatographed over SiO2, eluting with 100% hexane (100%H), 1% ether in hexane (1%EH), 3% ether in hexane (3%EH), 10% ether in hexane (10%EH), 30% ether in hexane (30%EH) and 100% ether (100%E). Bioassay using filter paper disc showed that a single fraction (3%EH) was active. Further fractionation of the 3%EH on a 10%AgNO3-SiO2 column with the same step wise elution as above resulted in the active component(s) to come out in the 10%EH fraction, which suggested the active molecule bears carbon-carbon double bond(s). The active 10%EH fraction from the AgNO3-SiO2 chromatography was subjected to micro-chemical reactions as follows; a) methylation with diazomethane, b) bromination with Br2/CCl4 solution, c) reduction with LiAlH4, and d) reduction with NaBH4. Bioassay results after the micro-chemical reactions of the active fraction were a) active, b) inactive, c) inactive and d) inactive.

In addition to the chromatographic behavior of the active fraction, the micro-chemical reaction of the active fraction indicated that the pheromone molecule of Thaumaglossa rufocapillata is alkenal or alkenone type of a compound.

Key Words: pheromone, dermestid beetle, Thaumaglossa rufocapillata

C-11

Analysis and Evaluation of the Volatile Compounds In The Neem Trees

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Abstract: Lymantria dispar（Lepidoptera ：Lymantriidae），is an important defoliator pest over the world. The study for the repeling effect of plant volatile material to Lymantria dispar . In this study, chemical compositions of volatile substances of the neem trees which are non-hosts of gypsy moth are extracted accurately by T-neax adsorption and SPME, the compositions can be detected by GC/MS. 50 volatile compounds are identified from the leaves of group seven and 38 from the leaves of group eight.volatile components contain terpenes，alkanes，sulfocompound，alcohol，phenols，esters and aldehydes.Among them， terpenes are the most.. The study shows that by different extraction methods we can get diverse volatile,however the sorts of the main components are basically same .Among the 3 methods, polarity SPME solid phase microextraction method gainthe most volatile. And make clear that in order to get better results various methods should be used at the same time.

Key Words: Neem tree, Volatile Compounds, T-neax, SPME, GC/MS

C-12

Incubation enhances the attractiveness of the yellow-spined bamboo locust, Ceracris kiangsu feeding on human urine

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Abstract: Mud-puddling is the phenomenon of insects includes feeding on mud and various excrements and secretions of vertebrates to obtain nutrients such as sodium and nitrogen, and it commonly seen in the butterflies, moths, bees and flies, The yellow-spined bamboo locust, Ceracris kiangsu Tsai, a serious defoliator of bamboo in China was found to aggregate and puddling on human urine. Recent work has explored incubation of human urine could affect the behaviour of bamboo locust towards urine significantly. The results showed that the yellow-spined bamboo locusts were repelled by fresh human urine and attracted by incubated human urine. Incubation of human urine could enhance the attractiveness of the yellow-spined bamboo locust feeding on human urine. The locusts preferred for the volatiles emitted form the urine incubated for 30 days than that incubated for 7, 15, 60 days. And the bait with 30d-incubated human urine mixed with insecticides disosultap attracted and killed much more locust adults than other baits in the field. This approach offers some evidences that olfactive cues were very important for insect to locate resources in nature and a scope to better target pesticides which is effective to kill pest insects and environment friendly in bio-control methods using bio-characteristics of pest insects.

Key Words: mud-puddling, yellow-spined bamboo locust, incubation of human urine, attractiveness

C-13

Identification of volatiles of ophiostomatoid fungi associated with the red turpentine beetle in China

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Abstract: Bark beetles have complex relationships with microorganisms. One the most common interactions consist on beetles acting as disseminators of fungal conidia. Bark beetles carry fungi conidia in specialized structures in their exoskeleton and inoculate fungi upon digging into the bark. Some fungi contribute to beetle nutrition and others may enhance the beetles ability to colonize living trees by assisting in overcoming their defenses or by contributing to pheromone production. Fungi can also be detrimental to beetles by causing reduced fitness to larvae. In addition it has been shown that beetle larvae release volatiles that influence fungal growth in vitro.

Despite the range and complexity of beetle-fungus interactions, the role of volatiles produced by fungal associates in bark beetles is poorly understood. Fungi are known to produce a wide range of volatiles. Attraction to fungal volatiles is widespread among insects, (including Diptera, Coleoptera, Collembola, Hymenoptera, and Lepidoptera), but few works show promising evidence for the Coleoptera. Odor plume containing volatiles generated by wood-decaying fungi have been shown to generate attraction in the deathwatch beetle Xestobium rufovillosum and parasitoid wasps and dipteran predators have been shown to exploit fungal volatiles to locate bark beetles.

The red turpentine beetle (RTB), Dendroctonus valens, is native to North America, where it is considered as a secondary pest of pine trees. However, D. valens was accidentally introduced to China in the late 1980's and, since then, it has become one of the most notorious pests in China. D. valens has killed more than 6 million healthy trees in Shanxi province and neighboring areas, constituting a serious economical and ecological threat. D. valens has associations with ophiostomatoid fungal strains (Leptographium spp. and Ophiostoma spp). RTB inoculates fungi in the phloem of pines, when females dig galleries for egg laying and when males join them for mating. Isolates from RTB associated fungi have been suggested to play an important role in D. valens success in China by causing mortality to pine seedlings. Volatiles emitted by these fungi may also have important roles in the ecology of RTB, including attraction of beetles to enhance mass attack, stimulating females to release sex pheromones, regulating larval development in galleries, or even attracting natural enemies.

The present work shows preliminary data on volatiles produced by isolates of Leptographium spp. and Ophiostoma spp. Fungal isolates were inoculated in different substrates (malt agar extract, simple agar, and pine phloem extract) and volatiles were collected using headspace solid phase microextraction. Gas chromatography mass spectrometry and comparison to commercial standards was used for identification of compounds. Identification of these volatiles will set an important foundation to test further hypotheses on the importance of fungal volatiles in the ecology of D. valens.

Key Words: Fungi, Volatiles, Bark beetles, Dendroctonus Valens, China

C-14

The sex pheromone of the stink bug Edessa meditabunda (Hemiptera, Pentatomidae)

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Abstract: Brazil is one of the major soybean producers in the world. Among the main soybean pests are stink bugs that feed directly from grains, affecting seed quality. In the piercing-sucking complex that occurs in soybean crops, Edessa meditabunda is considered a secondary pest. The behavioral responses of males and females to aeration extracts from conspecifics suggested the presence of a male sex pheromone. GC analyses of aeration extracts released by males and females revealed the presence of two male-specific compounds in a ratio of 92:8. GC-EAD assays indicated that the major component is bioactive in females, supporting the bioassay data. Analysis of the mass spectra of the male specific compounds suggested that they were both methyl branched long chain methyl esters. The structure of these methyl esters were proposed based on the mass spectra (EI) of the respective hydrocarbons obtained from microderivatizations, as being methyl 4,8,12-trimethylpentadecanoate (major) and methyl 4,8,12-trimethyltetradecanoate (minor). A synthetic route based on a sequence of Grignard reactions, starting from ciclopropyl methyl ketone was developed to obtain the synthetic standards after 11 steps. The synthetic standards were co-injected with the natural pheromone on three different GC stationary phases (RTX-5, RTX-WAX and HP-1), co-eluting in all of them. Y-olfactometer assays employing the synthetic standards were strongly attractive to females, either for the major compound as for the mixture with the minor on the same proportion found in natural extracts. Field tests and studies to establish absolute configuration of the natural pheromone are underway.

Key Words: sex pheromone, pheromone, stink bug

C-15

Body wax hydrocarbons (Z)-9-heptacosene and (Z3, Z6, Z9)-tricosatriene as synergists of the sex pheromone in the yellow peach moth Conogethes punctiferalis (Guenée) (Lepidoptera: Crambidae)

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Abstract: In the yellow peach moth, a synthetic sex pheromone consisting of (E)-10-hexadecenal and (Z)-10-hexadecenal showed significantly lower attraction than crude pheromone extracts in wind tunnel tests. To identify the unknown components, the synergistic effects of a non-polar fraction (NPF) from the crude pheromone extract on the activity of a polar fraction (PF), including the two aldehydes, were assessed in wind tunnel tests. NPF itself showed no activity, but the number of males attracted was significantly increased when NPF was added to PF. Similar synergistic effects were also observed in female body wax (FBW) extracts and its NPF.

Then the NPF of FBW extracts were further separated by column chromatography, synergistic activities were found in the 3% and 50% ether hexane fractions, and they additively increased male responses. The main components of the 3% fraction were (Z)-9-tricosene (Z9-23: HC), (Z)-9-pentacosene (Z9-25: HC), (Z)-9-heptacosene (Z9-27: HC), (Z)-9-nonacosene (Z9-29: HC) and (Z)-9-hentricontene (Z9-31: HC). Only Z9-27: HC synergistically increased male responses to the aldehydes, but not enough to enhance male responses as high as NPF. Meanwhile, the main components in the 50% fraction of NPF from FBW extracts were identified as (Z3, Z6, Z9)-tricosatriene (Z3, Z6, Z9-23: HC), (Z3, Z6, Z9)-pentacosatriene (Z3, Z6, Z9-25: HC), (Z3, Z6, Z9)-heptacosatriene (Z3, Z6, Z9-27: HC) and (Z3, Z6, Z9)-nonacosatriene (Z3, Z6, Z9-29: HC), among which Z3, Z6, Z9-23: HC showed synergism to the aldehyde pheromone. Same compounds with similar chemical profiles but low amounts were also identified in the NPF of the crude pheromone extracts. A combination of Z9-27: HC and Z3, Z6, Z9-23: HC additively enhanced the activity of the aldehyde pheromone. The enhanced activity was as high as the crude pheromone extracts. The two hydrocarbons showed a dose-dependent synergism to the aldehyde pheromone, with a lowest active dose of 30 ng.

During calling, Z3, Z6, Z9-23: HC and Z9-27: HC of female body waxes probably functions simultaneously with pheromone gland compounds to efficiently elicit male moths mating behavior. These synergistic functions of body wax hydrocarbons to highly volatile pheromones suggest sex pheromone systems are more complicated and sophisticated than we have known.

Key Words: body wax hydrocarbons, synergists, sex pheromone, yellow peach moth

C-16

Non-bombykal family pheromones of the Sphingidae moth, Dolbia tancrei

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Abstract: Sphingidae is a large group of Bombyciodea, and ca.1200 species have been recorded in the world. All species are likely to use sex pheromones in mating systems, but sex pheromones or sex attractants were identified from only 14 species so far. All of these species with the exception of *Agrius convolvuli* use bombykal isomers. *Dolbia* tancrei is a commone spesies in East Asia and feeds on Oleaceae shrub trees including *Osmanthus fragrans*, *Ligustrum japonicum* and *L. obtusifolium*. In our studies on the identification of Japanese sphingid species sex pheromones, a unique pheromone system composed of non-bombykal members in *D. tancrei*.

Larvae of *D. tancrei* were collected from Tottori and reared on host plants under ambient conditions until pupation. Pupae were sent to the University of Tsukuba and newly emerged adults were subjected into the extraction of female pheromone glands, GC-EAD, GC, and GC-MS analyses. In the GC-EAD analysis, prominent antennal receptor responses were observed to two peaks, showing peak A and B to have the same mass spectrum characteristic as pentadadienal, containing *m/z* 222 (M^+, 20%) and *m/z* 67 (base peak 100%) in GC-MS. Positions of double bonds in the molecule were determined to be at the 9 and 11th carbons by GC-MS analysis of their MTAD derivatives. These spectral and structural characteristics were also compared with 4 isomers of authentic 9,11-pentadecadienal. Finally, peak A and B were identified as (9*E*.11*Z*)-9,11-pentadecadienal (E,Z-9,11:15Ald) and (9*Z*,11*Z*)-9,11-penta-decadienal (Z,Z-9,11:15Ald) or (9*E*,11*E*)-9,11-pentadedadienal (E,E-9,11:15Ald), respectively. Field trap tests were also conducted at the University of Tsukuba, where sticky traps were baited with each of single isomers, EZ/ZZ (9:1 in ratio), EZ/EE (9:1) and solvent control for 8 to 16 days. No males were attracted to the ZZ, EZ and EE single isomers of 9,11-pentadecadienal, but the EZ-isomer and the EZ/ZZ mixture attracted 40 and 46 males in total for 16days, whereas the EZ/EE mixture attracted only 4 males. Based on these results, we concluded the sex pheromone of *D. tancrei* is consists of E,Z-9,11:15Ald and Z,Z-9,11:15Ald in a ratio of 9:1.

This is the second report of E,Z-9,11:15Ald as an insect sex pheromone, but the first report from a sphingid moth. It was previously reported from a pyralid moth, the pecan nut casebearer (Millar, J.G. et al., 1996). Sex pheromone survey of other Japanese sphingids, which will be also reported by Takuya Uehara in another session of this congress, showed that sphingid moth sex pheromones are consisted of Bombykal analogues and 11-hexadecenals. Pentadecadienals as sex pheromone of a sphingid moth suggests a new phylogeny as well as evolution of pheromone biosynthesis in *D. tancrei*.

Key Words: sex pheromone, Shingidae, Dorbia tancrei, (9E,11Z)-9,11-pentadedadienal, (9Z,11Z)-9,11-pentadecadienal

C-17

Δ11 desaturation is involved in the biosynthesis of wing-produced esters in males of the African butterfly, *Bicyclus martius*

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Abstract: Potential sex pheromone components, including ethyl, *iso*-butyl and 2-phenylethyl esters of hexadecanoic acid and 11*Z*-hexadecenoic acid as well as small amounts of ethyl benzoic acid, were identified in wing extracts from males of the tropical butterfly, *Bicyclus martius*. 11*Z*-hexadecenoic acid, a key biosynthetic precursor of many female-produced moth pheromones, was found in large amounts in a patch-like tissue on the fore-wing of the male butterflies, supporting the hypothesis [1] that biosynthesis of the pheromone-like compounds in the male butterfly involves routes and enzymes similar to those involved in pheromone production among female moths [2, 3]. Deuterium labelled precursors (hexadecanoic acid, 11*Z*-hexadecenoic acid, L-valine and L-phenylalanine) were topically applied to the male wings to study the biosynthesis of the abovementioned esters. Deuterium label was incorporated from hexadecanoic acid into 11*Z*-hexadecenoic acid, for the first time proving the existence of an active Δ11 desaturase in a butterfly. We also showed that hexadecanoic acid and 11*Z*-hexadecenoic acid are used to produce the corresponding saturated and unsaturated esters, and that the two amino acids, L-valine and L-phenylalanine are involved in the formation of iso-butyl and phenylethyl esters by providing the respective corresponding alcohols.

Keywords: sex pheromone; biosynthesis; Δ11 desaturase; butterfly; *Bicyclus martius*; Lepidoptera

C-18

A novel sex pheromone component produced by a female lichen moth, Miltochrista calamina, in the family Arctiidae

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Abstract: (5R,7R)-5-Methylheptadecan-7-ol was identified as a novel sex pheromone component of a female lichen moth, Miltochrista calamina (Arctiidae, Lithosiinae). The larva of this species is a pest of a pastureland clover. Although we obtained a very limited amount of a pheromone extract (only one female), the unique planar structure was successfully determined by GC-MS analyses of the alcohol and a hydrocarbon derived from it by subsequent treatments with methanesulfonyl chloride and LiAlD4 in microscale reactions.

Including the stereochemistry, the first identification of a branched secondary alcohol secreted by female moths was confirmed by synthesis. The four stereoisomers in a ratio of 4:4:1:1, which were prepared from (S)-b-citronellol with 60% ee, were separated by a combination of achiral and chiral HPLC columns. The absolute configuration of each isomer was determined by comparison with the chromatographic behaviors of other samples synthesized by a different scheme, which applied the Jacobsen hydrolytic kinetic resolution of racemic 1,2-epoxydodecane to fix the configuration of the 7-hydroxy group. Since many insect pheromones are volatile, chiral GC has been usually attempted for the analysis of stereochemistry. However, sometimes, the resolution of racemic pheromones and synthetic intermediates by a chiral GC column is difficult. We used a chiral HPLC column for several other pheromone studies, and desirable enantiomeric resolution was accomplished by chiral HPLC also in this study.

Finally, the stereochemistry of the natural pheromone was estimated by field evaluation of the synthetic pheromone. Only the (5R,7R)-isomer attracted male moths among the four isomers, indicating that males strictly recognized the absolute configuration of both the branched-methyl and hydroxyl groups. While many species in the same group (a subfamily in the family Arctiidae) are distributed worldwide (about 80 species have been recorded in Japan), information of their sex pheromones is very limited. Further studies will clarify the novelty or commonness of the branched secondary alcohol among the lepidopteran sex pheromones. We expect that a new pheromone study will develop from this identification.

Keywords: Lepidoptera, female sex pheromone, methyl-branched alcohol, chiral HPLC, asymmetric, synthesis, chemical ecology

C-19

Mate signaling specificity and redundancy in sympatric species Dendrolimus kikuchii and Dendrolimus houi

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Abstract: Volatile pheromone gland components from Dendrolimus kikuchii and D. houi were extensively studied by solid phase microextraction (SPME) techniques followed by gas chromatography (GC)-mass spectrometry (MS). The data demonstrated that, apart from (Z,E)-5,7-isomers of acetate and alcohol pheromone components, not any trace amount of (E,Z)-5,7-isomers of acetate and alcohol pheromone analogs were observed from the pheromone glands of D. kikuchii with CW/DVB fiber coating. In contrast, some (Z)-5- and (Z,E)-5,7-isomers of acetate and alcohol pheromone analogs were also observed from pheromone glands of D. houi. Olfactory reception of conspecific and heterospecific pheromone components by male antennae of D. kikuchii and D. houi was assessed by response differences to stimuli using SPME-GC-electroantennographic detection (EAD) techniques and field behavioral assays. Our results revealed that male response specificity is based on distinctive pheromone blends in these congeners, even though the mutual influence of individual pheromone components of sibling species was observed electrophysilogical and behaviorally. D. kikuchii compete with a sibling species, D. houi, for a distinctive channel, with communication interference as the principal selective force causing the communication channel to diverge.

Key Words: Dendrolimus kikuchii, Dendrolimus houi, sex pheromone, communication interference, sibling species

C-20

Corymbia species and hybrids: chemical and physical foliar attributes and implications for herbivory

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Abstract: Hybridization is an important biological phenomenon that can be used to understand the evolutionary process of speciation of plants and their associated pests and diseases. Interactions between hybrid plants and the herbivores of the parental taxa may be used to elucidate the various cues being used by the pests for host location or other processes. The chemical composition of plants, and their physical foliar attributes, including leaf thickness, trichome density, moisture content and specific leaf weight were compared between allopatric pure and commercial hybrid species of Corymbia, an important subtropical hardwood taxon. The leaf-eating beetle Paropsis atomaria, to which the pure taxa represented host (C. variegata) and non-host (C. torelliana) plants, was used to examine patterns of herbivory in relation to these traits. Hybrid physical foliar traits, chemical profiles, and field and laboratory beetle feeding preference, while showing some variability, were generally intermediate to those exhibited by parent taxa, thus suggesting an additive inheritance pattern. The hybrid susceptibility hypothesis was not supported by our field or laboratory studies, and there was no strong relationship between adult preference and larval performance. The most-preferred adult host was the sympatric taxon, although this species supported the lowest larval survival, while the hybrid produced significantly smaller pupae than the pure species. The results are discussed in relation to plant chemistry and physical characteristics. The findings suggest a chemical basis for host selection behavior and indicate that it may be possible to select for resistance to this insect pest in these commercially important hardwood trees

We also examined the relative concentrations of two monoterpenes (α-pinene and 1,8-cineole), for which meta analyses also showed latitudinal variation, using hybrids of Corymbia torelliana with three congeneric taxa, C. citriodora, C. henryi and C. variegata. These, and pure C. torelliana, were then assessed in common garden field plots for the abundance and distribution of herbivory by four distinct herbivore taxa. Differing feeding strategies among these herbivores allowed us to test hypotheses regarding heritability of susceptibility and relationships to α-pinene and 1,8-cineole. Leaf sample extracts were statistically distinguishable between taxa, and pairwise comparisons further identified these distinctions, especially that samples from C. torelliana × C. variegata clustered separately from C. torelliana and the other hybrids. We found that herbivore species showed differential responses to different taxa and monoterpene contents. For example, eriophyid mites, the most monophagous of our censused herbivores, avoided the pure species, but fed on hybrid taxa, supporting hypotheses on hybrid susceptibility. The most polyphagous herbivore (leaf blister sawfly Phylacteophaga froggatti) showed no evidence of response to plant secondary metabolites (PSMs), while the distribution and abundance patterns of Paropsis atomaria showed some relationship to monoterpene yields.

Key Words: Eucalypt, Kairomones, Plantation forests

C-21

Pheromone System and Reproductive Isolation of Synanthedon bicingulata and Synanthedon haitangvora (Lepidoptera: Sesiidae)

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Abstract: Two closely related species in the genus *Synanthedon* (Lepidoptera: Sesiidae), *S. bicingulata* (Staudinger) and *S. haitangvora* Yang, are sympatric but have different host plant ranges in many regions of northeast Asia. *S. bicingulata* is an economically important pest of peach and plum trees, whereas *S. haitangvora* is a pest of apple and pear trees. We tested differences in female pheromone production and male response of these two species. GC-MS analyses revealed that two major components from the gland extracts of female *S. bicingulata* were *Z*3,*Z*13-18:OAc and *E*3,*Z*13-18:OAc. On the other hand, *S. haitangvora* females produced a mixture of *Z*3,*Z*13-18:OAc and *E*2,*Z*13-18:OAc. Field tests showed that *Z*3,*Z*13-18:OAc and *E*3,*Z*13-18:OAc were essential for attraction of *S. bicingulata* males and the presence of *E*2,*Z*13-18:OAc in primary binary blend did not induce any synergistic or inhibitory effect. Male *S. haitangvora* were attracted to *Z*3,*Z*13-18:OAc alone, but the maximum number of males was attracted to the binary blend of *Z*3,*Z*13-18:OAc and *E*2,*Z*13-18:OAc. Addition of *E*3,*Z*13-18:OAc, a major component of *S. bicingulata,* did not affect captures of *S. haitangvora* males to the primary binary blend, suggesting that male *S. haitangvora* would be attracted to *S. bicingulata* females emitting *Z*3,*Z*13-18:OAc and *E*3,*Z*13-18:OAc.

Key Words: Synanthedon bicingulata, Synanthedon haitangvora, Pheromone, Reproductive Isolation

C-22

Release rates for pine caterpillar moths pheromones from Polyethylene vial and gray rubber dispensers

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Abstract: The release rate of synthetic pheromone components of Dendrolimμs spp. loaded with 1 mg of each in rubber and polyethylene (PE) dispensers was evaluated in a wind tunnel (25-27ºC, 5 cm/s wind speed) for a period of 12 weeks. The released compounds from two types of dispensers were collected once a week by glass tubes using Porapak Q and Tenax GR as absorbent with a air flow rate 100 mL/min for 20 min, and then the hexane eluted compounds were quantified by gas chromatography (GC) which equipped with DB-5MS capillary column. The results demonstrated that the release rates of (5Z,7E)-5,7-dodecadien-1-yl acetate (Z5,E7-12:OAc), (5Z,7E)-5,7-dodecadien-1-ol (Z5,E7-12:OH), and (5Z,7E)-5,7-dodecadienal (Z5,E7-12:Ald) as well as their (5E,7Z)-isomers in the PE dispensers increase slowly during the first two weeks, and a mean of 14.07±2.89 SD μg/day of E5,Z7-12:OH, for example, was measured in this period. From 15th day to 29th day, the release rate of E5,Z7-12:OH increase sharply with a peak of 48.92±31.33 μg/day on the 29th day, and then it decreases sharply to 1.28±1.20 μg/day on the 57th day; finally, the release rate maintains steady from 57th day to 81th day at a mean level of 1.16±069 μg/day. The other alcohols, aldehydes, and acetates with conjugated double bonds showed the same release pattern as E5,Z7-12:OH in the PE dispensers. In contrary to the PE dispensers, a relative high release rates of pheromone components was observed after impregnation of the rubber dispensers. For example, the release rate of E5,Z7-12:OH was 8.22±6.65 μg/day on the 2th day, followed by 3.90±1.77μg/day on the 9th day, 2.92±1.55 μg/day on the 15th day, and by 29 day this component output was more or less steady at the level of 0.1-1.0 μg/day. The other alcohols, aldehydes, and acetates with conjugated double bonds also showed the same release pattern as E5,Z7-12:OH in the rubber dispensers. The release rates of synthetic pheromones from PE dispensers were higher than rubber dispensers showing extremely significant difference at their peak release period, but the difference between absorbents was not significant. The residual pheromones in different dispensers were quantified by GC: residual quantities in rubber were greater than PE showing significant difference. In addition, the two types of dispensers have no differences on isomerization rate, but the elements of EE were greater than ZZ. Longer-lasting dispensers with lower residual load at the end of trials will greatly improve the efficacy of lures for Dendrolimus spp.

Keyword: Dendrolimus; sex pheromone; gas chromatography, isomerization; release rate, dispenser

D-1

Identification of the sex pheromone of the lesser date moth, Batrachedra amydraula, using a new technique of sequential SPME auto-sampling

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Abstract: The lesser date moth, Batrachedra amydraula (Lepidoptera: Batrachedridae), is one of the most serious pest of date palms in Israel and the entire Middle East where dates are an important crop. The injury is caused by the larvae that bore into the premature fruits. After several weeks the fruit become dark, dry and drop to the ground. In some date palm varieties, the direct damage may exceed 50% of the yield, resulting in a significant economical loss. Until today the common way to control the pest was by applying insecticides, yet, monitoring the population is still a problem. Pheromone traps are the preferred means for monitoring, but efforts to identify the sex pheromone of B. amydraula failed until the present work. Two problems hampered progress: 1. limited availability of the moth because its rearing requires fresh green fruits which are available only during a limited time of the year, 2. low release rate of the pheromone by females. Improvement of the diet and rearing of the moth and using a new collection and analysis technique solved the problem. Application of a sequential SPME auto-sampling, interfaced with GC-MS analysis, along with GC-EAD analysis were crucial for the identification of the sex pheromone. A 100µm polydimethylsiloxane SPME fiber was programmed to perform sequential auto-sampling and GC–MS analysis of the volatiles released by virgin females continuously for 3 days every 2 hours. Four compounds were observed which were released in a circadian cycle at the same time of the day indicating that they are potential components of the sex pheromone. Comparison by GC-MS with available and new standards enabled the identification of (4Z,7Z)-4,7-decadien-1-yl acetate, 4Z-decen-1-yl acetate, 5Z-decen-1-yl acetate and decan-1-yl acetate. Field trials conducted in date plantation showed that white delta sticky traps equipped with grey rubber septa which were impregnated with (4Z,7Z)-4,7-decadien-1-yl acetate and 5Z-decen-1-yl acetate in a ratio of 1:2 captured a significant number of males, proving that these are the essential components of the sex pheromone of B. amydraula. Addition of 4Z-decen-1-yl acetate and decan-1-yl acetate did not significantly affect trap capture. The lesser date moth is the first member of the Batrachedridae whose sex pheromone has been identified and (4Z,7Z)-4,7-decadien-1-yl acetate is a novel compound among moth sex pheromones.

Key Words: Lesser date moth, Batrachedra amydraula, sex pheromone, 4Z,7Z)-4,7-decadien-1-yl acetate, sequential GC-MS sampling

D-2

Semichenmical based monitoring of an invasive species, red turpentine beetle (*Dendroctonus valens*)

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Abstract: The red turpentine beetle (RTB), Dendroctonus valens LeConte, originally distributed in North and Central America, was introduced into China in early 1980's and since 1998 has caused great damage to Chinese pines, Pinus tabulaeformis Carr. Field tests verified that multi-funnel traps and slot traps baited with main component of (S)-(+)-3-carene can be used for the monitoring of RTB. RTB could be caught by the traps in the field when it was under invisible population level. Several year's monitoring shown that flight period of RTB ranged from late April to late August with the peaks varied from one peak in mid May or two peaks in mid May and mid August based on weather. The RTB damage models were set up and proved that trap catches were correlated with population level and damage level. When the trap catch was below 20 beetles per trap the number of pitch tubes were ranged from 0 to 2 per 100 trees. Above this level the management measures should be taken. A GIS based management system was developed to manage the monitoring data and make population prediction. The techniques are used in all RTB distributed area in China.

Key Words: invasive species, Dendroctonus valens, monitoring, semiochemical

D-3

Monitoring of *Opisina arenosella* by using female sex pheromones

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Abstract: The black headed caterpillar (BHC), *Opisina arenosella* (Walker) is a serious pest of coconut palms in India since 1926. It is also present in Sri Lanka, Pakistan, Bangladesh, Myanmar and Indonesia. The BHC has been recently reported as a serious pest of coconut in Thailand. Researchers have tried to manage this pest by using systemic insecticides and inundative release of natural enemies. Since the coconut fronds are at a height, one cannot understand the status of pest infestation to determine the optimum time to release of larval parasitoids. Timely release of these natural enemies is the main problem in implementation of biological control method. Pheromones may be a useful tool for monitoring and identifying the adult emergence period and helpful in managing this pest. Female sex pheromone was identified by NRI, UK during 1980s (1) and synthesized by us in 2007. The female sex pheromone, (Z,Z,Z)-3,6,9- tricosatriene was synthesized and field tested for standardization of pheromone dispenser, dosage and trap under a project partially funded by Coconut Development Board, India. It was established during our field trials that 100 µg of pheromone impregnated in pvc vial dispenser is working effectively under field conditions. Currently the evaluation of mass trapping of BHC is under progress with different trap densities.

Key words: Female sex pheromone, Monitoring, (Z,Z,Z)-3,6,9- tricosatriene and Field trials.

D-4

Dispersal and detection of invasive Orthotomicus erosus in California

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Abstract: The Mediterranean pine engraver, Orthotomicus erosus (Wollaston), was first discovered in Fresno, California in 2004, and it was then found that it thrived in urban areas of Central Valley of California due to abundant pine trees and green waste piles. To evaluate the risk and invasion process of this new invasive species, small-scale (in a 3.14 km2 area) and large-scale (in a 314 km2 area) mark-recapture studies under different weather conditions were conducted using newly identified pheromone baits and commercial baits. Transects of funnel traps baited with O. erosus pheromones were established extending from urban areas to native forests in mountains (up to 1840 m in elevation) in both 2009 and 2010. Mark-recapture study results showed that beetles were captured primarily in the southern and eastern traps, reflecting the prevailing winds from the northwest. Most recaptured beetles dispersed less than 1 km from the release point, and these moved to these locations within 20 to 60 minutes of release. Few individuals dispersed long distances (2 to 10 km from the release point). Preliminary results from transect studies showed that O. erosus was moving toward southeastern mountains relatively quickly compared to northern or western directions. Pheromone traps detected O. erosus in the Sierra and Angeles National forests, suggesting that it has successfully invaded into native forests in surrounding mountains from urban areas. The significance of wind conditions in dispersal and range expansion of O. erosus will be discussed.

Key Words: Orthotomicus erosus (Wollaston), Dispersal, Mark-recapture, Pheromone

D-5

Managing the invasive oriental beetle with mating disruption in blueberries

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Abstract: Native to Asia, the oriental beetle, *Anomala orientalis* (Waterhouse) (Coleoptera: Scarabaeidae), was introduced to North America sometime during the early 20th century and was first detected in Connecticut in 1920. It has since become a pest throughout the mid-Atlantic region, with an invasive range extending from Maine (North) to South Carolina (South) and Wisconsin (West). In New Jersey, oriental beetle is considered a pest of turf, ornamentals, and blueberries. In 1994, the main sex pheromone component was identified as (*Z*)-7-tetradecen-2-one. Studies were conducted since 1998 to test this pheromone to disrupt mating of oriental beetle in commercial New Jersey blueberry farms. Recently, I evaluated two pheromone formulations: point-source plastic dispensers and SPLAT-OrB, a new pheromone formulation that can be mechanically applied. In all studies, success of mating disruption was measured using trap shutdown (as measured by the disruption index (DI)), caged females, and sentinel potted-plants with tethered females. First, a study was conducted in 2005-2007 to test the possibility of reducing the number of dispensers and pheromone rates, while maintaining mating disruption. Compared with control plots, disrupted plots had DI values of ≥93% in all years, and a lower percentage of mated females. However, DI values were ≥95% at ≥50 dispensers per hectare. The number of males in female cages and larvae in sentinel pots were similar to controls when 25 dispensers containing 0.05 g of active ingredient (AI) were used per hectare. Thus, dispenser density was critical for successful mating disruption of oriental beetle. A subsequent study was conducted in 2008-2009 to compare the efficacy of SPLAT-OrB with hand-applied plastic dispensers. Both formulations were tested at 2.5 and 5 g of AI per hectare. Compared with untreated plots, all pheromone-treated plots had fewer male captures in traps and lower mating success of caged females. SPLAT-OrB, and plastic dispensers at the higher rate, also reduced the number of grubs in sentinel pots. To understand the mechanism of mating disruption in oriental beetle, males were observed approaching the pheromone sources in disrupted plots. In addition, male oriental beetle captures were quantified in plots treated with varying SPLAT-OrB dollop densities per hectare. Consistent with predictions for competitive attraction, field observations revealed males approaching the pheromone source and male captures decreasing concavely with increasing dollop density. These studies demonstrate the feasibility of using mating disruption for oriental beetle management in blueberries, and conclusively reveal that a principal behavioral mechanism is via competitive attraction of males.

Key Words: oriental beetle, mating disruption, blueberries, plastic dispensers

D-6

Asian longhorned beetle pheromone and potential use in the field

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Abstract: The Asian Longhorned Beetle (ALB), Anoplophora glabripennis (Coleoptera: Cerambycidae), is an exotic species in the U.S. Two male-produced volatiles were isolated from ALB that elicited strong gas chromatographic-electroanntennographic responses from both sexes of beetles in 2002. The pheromone was consisted of an aldehyde (4-(n-heptyloxy)butanal) and an alcohol (4-(n-heptyloxy)butan-1-ol). In addition, field observations of ALB mating behavior in China suggested that a female-produced contact pheromone was almost certainly involved in sex recognition. These compounds were identified as (Z)-9-tricosene, (Z)-9-pentacosene, (Z)-7-pentacosene, (Z)-9-heptacosene, and (Z)-7-heptacosene in the approximate ratio of 1:2:2:8:1, respectively. Many lab and field tests were conducted for biological activity evaluation. Results showed that the male-produced pheromone attracted primarily virgin females, even at low concentrations. Antennal contact to a polypropylene micro-centrifuge tube coated with a synthetic mixture of the five compounds stimulated copulatory behavior in males. This finding is a vital step in the process of building a potentially effective monitoring tool for ALB in the field. Further studies will be conducted to determine the distance over which attraction occurs and field experiments in China.

Key Words: Asian Long Horned Beetle, Pheromone, Biological Activity

D-7

Attacking behavior and its chemical communications of an invasive bark beetle, Dendroctonus valens

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Abstract: Red turpentine beetle, Dendroctonus valens LeConte (Coleoptera: Curculionidae: Scolytinae), is invasive tree-killing species native to North America. Since 1999 outbreak in Shanxi Province, it has spread to adjacent provinces causing millions pines dead. Although its population density decreased down due to massive trapping and other measurements, it is still urgent to understand its special behavior and underlying chemical communications since this pest is still possible to outbreak sometime. RTB attacking behavior and its chemical communications were studied in both the field and the laboratory. Field investigation showed that RTB prefers to attack large pine trees and further analysis showed it is mediated by monoterpenes variation among variable size of hosts. In field RTB female adult initiates attack first, and one female and one male are in the same tunnel normally. In the laboratory, several treatments (single female, single male, one female and one male, two females and one male, and two females and two males) were set up to confirm the family structure of monogamy. We found single male can't bore into the bark without female beetle bored into the bark first and each tunnel was consisted of a female and a male beetle or only one female there waiting for a male beetle. Further experiment showed that male who joined with female already, can prevent other male to meeting with its partner through its stridulation to keep monogamy family structure. Volatiles were collected for single males, single females, and paired RTB feeding with head space method and bioassay showed that females run away from the volatiles collected from female feeding which was attracted to males and males were away from the volatiles collected from male feeding. Further analysis with GC-MS showed that some volatiles such as verbenol, verbenone, myrtenol, myrtenal, and frontalin, were released. Further experiments indicated that frontalin was produced by female and its function act as sex pheromone and aggregation pheromone. The further function of these pheromone candidates were explored and discussed during RTB attacking procession from female pioneer attack to switch attack.

Key Words: Dendroctonus valens, behavior, chemical communication

D-8

Trial of eliminating codling moth with sex pheromone disruption plus pesticide spraying

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Abstract: codling moth is one of the most important pests in the world, but it just occur in Xinjiang Uyghur Autonomous Region ten years ago in China. Recently, it is spreading rapidly to the other parts, because of the convenience of transportation. Now codling moth has invaded to the west area of Gansu and Ningxia Province. In order to preventing the pest spreading to the main apple production area, we tested the efficiency of sex pheromone disruption plus insecticide spraying in two years. Treated a 8 ha orchard 1.8% bored fruit last season with 1000 dispenser/ha(120mg/dispenser) in 2009, no moth and bored fruit were detected in the center part, but a few moth were trapped at the edge of orchard in the succession two years trial. In a new detected orchard about 2 ha in 2010, 3 moth were trapped, the dispensers were hung on the top of trees in 1000dispenser/ha (120mg/dispenser), and spraying 4 times insecticide, no moth were trapped and no damaged fruits were found after treatment up to now. tests also were done in two other orchards ,in one orchard it was not isolated well, in the other one the tree is too high, the dispensers were not hung so high ,the results were not so good. So to eliminating new invaded codling moth with insect sex pheromone, there are some key measures must be taken into account. One is the orchard must be isolated well; the all trees must be treated. Next is the dispenser must be hung on the top of the tree before the moth emergences. The other one is the insecticide should be sprayed at the peak of moth flying for about 3~4 times. The last one is the orchard had to be treated with the sex pheromone dispenser for 2~3 years.

Key Words: the codling moth, insect sex phorenmone disruption, eliminating

D-9

Comparison of male sex pheromonal components after methyl eugenol consumption in seven highly invasive Bactrocera species

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Abstract: Males of > 80 Bactrocera species are strongly attracted to and compulsively feed on methyl eugenol (ME) which is found in > 450 species of plants. Upon consumption of ME, males of the oriental fruit fly, Bactrocera dorsalis, and B. papayae (both of which readily interbreed and produce viable offspring) were first shown to selectively sequester two metabolites - 2-allyl-4,5-dimethoxyphenol (DMP) and (E)-coniferyl alcohol (E-CF) - into the rectal/pheromone gland. B. carambolae males however, sequestered only E-CF in addition to the endogenously produced sex pheromonal components. We further compared the profiles of phenylpropanoid metabolites accumulated by four other invasive species of very high economic, and quarantine importance — Bactrocera correcta, B. invadens, B. philippinensis and B. zonata, with that of B. dorsalis. Chromatographic and spectroscopic analyses showed that of the five putative B. dorsalis sibling species; four namely B. dorsalis, B. invadens, B. papayae and B. philippinensis sequestered the same compounds DMP and E-CF in similar ratio, while B. carambolae sequestered only E-CF. For the B. zonata sibling species, males of B. zonata accumulated DMP and (Z)-coniferyl alcohol (Z-CF); while its sibling species B. correcta converted ME to (Z)-3,4-dimethoxycinnamyl alcohol and Z-CF – both in an approximately 1:1 ratio.

Given the genetic similarities of the four B. dorsalis sibling species (B. dorsalis, B. invadens, B. papayae and B. philippinensis) and the fact that they can readily interbreed, resulting in viable offspring, this new evidence in terms of identical sex pheromones points to the fact that they may all be the same biological species. This will be further discussed in the presentation.

Key Words: Bactrocera dorsalis, Bactrocera invadens, Bactrocera zonata, Bactrocera correcta, Bactrocera philippinensis, sex pheromone, methyl eugenol metabolites, phenylpropanoids, pharmacophagy, DNA analyses

D-10

Evolution of cuticular hydrocarbons of Hawaiian Drosophilidae.

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Abstract: Hawaiian Drosophila offer an excellent model for adaptative evolution. More than 500 species are reported in Hawaiian islands, and there is considerable diversity in behavior and morphology. Such diversity is mainly driven by sexual selection. In this study qualitative and quantitative chemical compositions of cuticular hydrocarbons (CHCs) in 138 flies belonging to 27 Hawaiian Drosophila species, picture-winged and non picture-winged, were analyzed regarding sexual dimorphism, differences in saturation, branching position, and lengths of CHCs. We found significant variation in the CHC patterns. In several subgroups, new species show decreases in unsaturated hydrocarbons, and gradual increases in branched compounds, monomethylalkanes and dimethylalkanes, not commonly found in Drosophila. Moreover, branching positions gradually shifted towards internal carbons, and chain lengths increased in the new species. The long-term evolution of CHCs in the light of the recent evolutionary migration and adaptation history of Hawaiian Drosophila species along the developing archipelago was discussed.

Key Words: Hawaiian Drosophila, Cuticular hydrocarbons, Evolution, Island speciation

D-11

EPG recorded feeding behaviors of *Bemisia tabaci* B and Q biotypes on the artificial diet

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Abstract: Feeding behaviors of *Bemisia tabaci* B and Q biotypes on the artificial diet (10% sucrose) with or without plant chemicals were recorded using electrical penetration graph (EPG) technique. On the artificial diet without plant chemicals, Q biotype took longer time on feeding than B biotype, while on the diet with nicotine and gossypol, feeding of both biotypes was significantly inhibited, showing more probes, shorter feeding times. There were significant differences in probes and feeding times between B and Q biotypes on artificial diets with plant chemicals.

Key words: artificial diet, electrical penetration graph (EPG), nicotine, gossypol, feeding behaviors

D-12

Repellent and Acaricidal Effect of Santalol in Sandalwood Oil against Two-spotted Spider Mite, *Tetranychus urticae* Koch (Acari: Tetranychidae)

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Abstract: Thirty-four essential oils were screened for their repellent and acaricidal activities against the two-spotted spider mite, *Tetranychus urticae* Koch (Acarina: Tetranychidae) at 0.1% concentration level. Choice and no-choice test were performed in repellency test, and leaf-dip bioassay was done in the test of acaricidal effect in the laboratory. Twenty essential oils showed significant repellencies against *T. urticae* in the choice tests. In subsequent no-choice tests using these twenty essential oils, only sandalwood oil showed significant repellency against *T. urticae*. Total number of eggs oviposited by *T. urticae* was significantly lower than control in the choice tests when the kidney bean leaves were treated with one of thirteen essential oils. The significant repellency of sandalwood oil against *T. urticae* lasted at least for five hours.

Test on acaricidal activities of sandalwood and common thyme oils were observed to be most toxic against adult females. Subsequent trials confirmed that only sandalwood oil was significantly active (87.2 ± 2.9 % mortality) against adult females. Sandalwood oil also demonstrated oviposition deterring effects based on a 89.3% reduction of the total number of eggs on leaf discs treated with the oil.

GC-MS analysis revealed that the main components of the sandalwood oil were *α*-santalol (45.8%), *β*-santalol (20.6%), *β*-sinensal (9.4%), and *epi-β*-santalol (3.3%). Santanol, the major compound in the sandalwood oil, appear to be responsible for the repellency of sandalwood oil and significantly higher mortality (85.5±2.9%) and oviposition deterrent effects (94.7% reduction in the number of eggs) against *T. urticae* than the control. Phytotoxicity was not shown on rose shoots to which a 0.1% solution of sandalwood oil was applied.

Key Words: Essential oil, Repellency, Acaricide, Sandalwood, Santalol, *Tetranychus urticae*

D-13

Adaptation mechanisms of *Bemisia tabaci* B and Q biotypes on host plants

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Abstract: *Bemisia tabaci* is one of the most important pests in the world in agricultural production, with many biotypes, among which B and Q are two invasive biotypes with much more adaptive abilities than other ones. Therefore, studies on adaptive mechanisms of *B. tabaci* biotypes would be of theoretical and practical significance in the effective management of this pest. In our researches, life tables, electrical penetration graph (EPG) and proteomics approaches were used to investigate ecological adaptation, feeding behavior and molecular interactions of B and Q biotypes with host plants. The results showed that Q biotype is more adaptive on host plants and therefore more dangerous.

Key words: *Bemisia tabaci*, B biotype, Q biotype, host plants, adaptation mechanism

E-1

Bacterial volatiles

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Abstract: During the last years bacteria has been recognized as important producers of odors in the environment. Therefore, they might influence many odor-based chemical communication systems, although there involvement has been established only in few cases so far. A comprehensive analysis of these compounds produced by different bacteria and the elucidation of the biosynthetic pathways to their formation is necessary. Thes knowledge is the basis for the understanding of the bacterial odor space.
Up to know five major pathways to bacterial volatiles can be recognized. These are derivatives of the fatty acid metabolism, terpenes, sufur compounds, pyrazines and acetoines, as well as aromatic compounds. These compound classes will be discussed. Furthermore, characteristic bacterial odor compounds as well as some interactiones mediated by bacterial volatiles will be presented, as the attraction of mosquitos to bacteria growing on human skin.

Key Words: Bacteria, Volatiles, Mosquito, Biosynthesis, Terpenes, Pyrazines, Sulfur compounds, Aromatic compounds, Fatty acid metabolism

E-2

Bacteria are ecosystem engineers in the container habitats of Aedes (Stegomyia) mosquitoes

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Abstract: Bacteria perform multiple biological functions in water-filled, human-made containers that are critical to the life cycle of Aedes (Stegomyia) mosquitoes. Bacteria are an integral component of the diet of larvae mosquitoes. Bacterial catabolism of organic detritus produces volatile and nonvolatile organic compounds that guide gravid mosquitoes to containers and stimulate them to lay eggs. This talk will review our progress on (a) volatile bacterial compounds that attract gravid females to oviposition sites; (b) involvement of bacteria in stimulating oviposition; and (c) demonstrating a role for bacteria in stimulating mosquito eggs to hatch. Progress on present efforts to develop a “lure and kill” strategy by combining bio-active bacteria with a lethal oviposition trap will be described.

E-3

Infochemical interactions between microbial community and pest flies: Oviposition Selection

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Abstract: Pest flies and screwworms are major economically important pest species to both livestock and humans causing economic losses through transmission of various pathogenic disease agents. Gravid females are attracted to decomposing carcasses, carrion or rotten meat and manures to deposit their eggs; the hatched larvae develop on these decaying organic matters, which is rich in microbiota. In this presentation we report our recent findings on how females use semiochemicals associated to their environments (microbial community) to search their oviposition sites, as well as how some antibiotic agents from botanical-based materials to interact within the microbial community (bacteria and fungus) inside the media, therefore either attract/deter their egg-laying and effects on their larval development. In addition, some novel product development using current finds for field practical control will also be discussed.

Key Words: chemical ecology, pest flies, bacteria, oviposition, practical control

E-4

House fly eggs, *Musca domestica* (Diptera: Muscidae), are associated with bacterial symbionts that act as ovipositional cues, anti-fungal agents, and larval food, and are vertically transmitted by house flies.

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Abstract: House fly larvae face several challenges during their development to adulthood. They must (1) condition their nutritional resources while avoiding intraspecific competition; (2) avoid competitive fungi and/or inhibit their growth; and (3) obtain sufficient bacteria as food supplements. We have shown that house fly eggs are provisioned with bacterial symbionts that play a major role in addressing all of these challenges, and that these bacterial symbionts can be vertically transmitted by house flies from one generation to the next, as follows: (1) Gravid female flies condition resources, oviposit in groups, and minimize the risk of larval cannibalism by older larvae by depositing, together with their eggs, the symbiotic bacterium *Klebsiella oxytoca.* This bacterium proliferates over time on the egg surface and inhibits further oviposition when a threshold bacterial density is reached. (2) Gravid females avoid competition with, and inhibit the growth of, harmful fungi by responding to olfactory cues from fungus-infested resources and by provisioning eggs with bacterial strains that have anti-fungal activity. (3) Gravid female flies ensure sufficient nutrition for larvae by depositing bacteria that increase larval survival in resources lacking in appropriate bacterial food.

Using pEGFP-transformed K. oxytoca, we have demonstrated that K. oxytoca we introduced onto the surface of house fly eggs is maintained on and in house flies throughout larval, pupal, and adult stages.

Key Words: House flies, *Musca domestica*, Bacterial symbiont, Communication ecology, Microhabitat strategy, Reproductive strategy.

E-5

Pine weevil (*Hylobius abietis*) are repelled by 3-octanol produced by a fungus isolated from pine weevil frass

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Abstract: Back ground: Chemical cues are important for insects to locate suitable food and sites for egg laying. Volatile organic compounds are most important in this respect as insects can detect host and non-host volatiles from long distances. The adult pine weevil (*Hylobius abietis*) feed on soft bark of conifers. Newly grown seedlings of pine and spruce are on major risk of mortality because of the pine weevil feeding, making them a severe pest in those areas of the world where clear cutting of forest is followed by reforestation. Pine weevil lay their eggs in moist soil near roots or in special cavities in root bark of fresh stumps and place their feces and pieces of bark (frass) along with eggs to protect them from conspecific predation. Methanol extract of pine weevil feces are antifeedant for the weevils.

Objective: To identify repelling or antifeedant substances for pine weevil from renewable cheap waste products of forest

Results: From aseptically collected pine weevil frass, obtained by feeding pine (*Pinus sylvestris*) twigs from different areas of Sweden, many *Penicillium* species were isolated from the microbial consortium grown on pine weevil frass using agar with added natural frass (NFA) as culturing media. Isolated fungi strains were cultured on NFA in glass E-flasks and volatiles were collected by SPME (solid phase microextraction) and analysed by GCMS. 3-octanol, 3-octanone and 1-octene-3-ol were the major compounds detected in the head space of *Penicillium sp.* Quantitative production rates of 3-octanol, 3-octanone and 1-octene-3-ol were determined by growing the fungal strain on NF liquid broth over a time span of 50 days using Tenax TA tubes. Production rates of 3-octanol, 3-octanone and 1-octene-3-ol were 9ug/h, 4ug/h and 3ug/h respectively after 25 days of incubation. In an open multi choice arena test 3-octanol showed potent repelling activity for pine weevils. These results showed that 3-octanol could be a good candidate to be used to repel pine weevils to protect conifer seedlings.

Key Words: Hylobius abietis, repellent, 3-octanol, Penicillium sp

E-6

Chemical Analyses of Wasp-Associated Streptomyces Bacteria Reveal a Prolific Potential for Natural Products Discovery

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Abstract: Identifying new sources of small molecules is necessary to help mitigate the continuous emergence of antibiotic resistance in pathogenic microbes. Recent studies indicate that one potentially rich source of novel natural products is Actinobacterial symbionts associated with insects. Here we test this possibility by examining two species of solitary mud dauber wasps, Sceliphron caementarium and Chalybion californicum. We performed enrichment isolations from 33 wasps and obtained more than 200 isolates of Streptomyces Actinobacteria. Chemical analyses of 15 of these isolates identified 11 distinct and structurally diverse secondary metabolites, including a novel polyunsaturated and polyoxygenated macrocyclic lactam, which we name sceliphrolactam. By pairing the 15 Streptomyces strains against a collection of fungi and bacteria, we document their antifungal and antibacterial activity. The prevalence and anti-microbial properties of Actinobacteria associated with these two solitary wasp species suggest the potential role of these Streptomyces as antibiotic-producing symbionts, potentially helping defend their wasp hosts from pathogenic microbes. Finding phylogenetically diverse and chemically prolific Actinobacteria from solitary wasps suggests that insect-associated Actinobacteria can provide a valuable source of novel natural products of pharmaceutical interest.

Key Words: Actinobacteria, Antibiotics, Defensive mutualism, Symbiosis

E-7

Olfactory receptor neurons for pheromone and plant volatile compounds in Sitona weevils

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Abstract: We identified the olfactory receptor neurons (ORNs) in two Sitona weevil species, Sitona lepidus (the clover root weevil) and S. discoideus (the lucerne weevil) (Coleoptera: Curculionidae), and investigated the electrophysiological response characteristics of these ORNs to plant volatile and potential pheromone compounds. Our study indicates that these two Sitona species have species-specific sets of antennal ORNs for detecting pheromone-related compounds and separate antennal ORNs for detecting plant volatile compounds. Different types of ORN populations for 4-methyl-3,5-heptanedione and four stereoisomers of 5-hdroxy-4-methyl-3-heptanone were present in both male and female antennae in these weevils, and the types and response characteristics of the ORNs were different between S. lepidus and S. discoideus. Our results also indicate that the antennae of both species contain stereospecific ORN populations that can distinguish between some of the stereoisomers. It appears that two different combinations of these compounds may be used as sex pheromone and aggregation pheromone in these weevils. The major proportions of the plant volatile-sensitive ORNs in the male and female antennae of both species strongly responded to various green leaf volatiles with high sensitivity and selectivity, and the profiles of the plant volatile-sensitive ORNs were different between S. lepidus and S. discoideus. Based on our findings, it is suggested that these Sitona weevils use stereoselective pheromone communication system, and green leaf volatiles play an important role in their chemical communication.

Abstract: olfactory receptor neuron, single cell recording, Sitona lepidus, Sitona discoideus, weevil, pheromone, plant volatile, olfactory sensilla

E-8

Analysis of the Secondary Compounds among Various Host Plants of Huanglongbing

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Abstract: Huanglongbing (HLB) is a devastating citrus disease, which has caused enormous economic losses in the world citrus industry. In this study, the secondary compounds in both healthy and HLB-infected leaves of 10 host plant species of HLB were detected and compared by using GC-MS. The main results were as follows:

1. Serial secondary compounds were detected and identified. Among them, 29 were from Murraya paniculata; 22 from healthy leaves and 36 from diseased leaves of Citrus. maxima cv. Shatian pomelo; 36 from healthy leaves and 38 from diseased leaves of Nianju; 32 from healthy leaves and 41 from diseased leaves of sweet orange Hongjiangcheng; 38 from healthy leaves and 40 from diseased leaves of C. ponki Hort. Ex Tanka; 36 from healthy leaves and 38 from diseased leaves of C. sinensis; 9 from healthy leaves and 16 from diseased leaves of C. trticulata Banco; 10 from healthy leaves and 8 from diseased leaves of C. sunki Hort ex. Tanaka; 18 from healthy leaves and 19 from diseased leaves of C. medicavar; 22 from healthy leaves and 20 from diseased leaves of C. limon (L.) Burm. f..

2. Analysing the secondary compounds of the healthy and HLB infected leaves from the same host plant species, and the results showed that:

(1) Terpenoids were relatively stable in the ten host plant species, which were not different between healthy and infected leaves. The content of (-)-.beta.-Pinen in healthy leaves of C. maxima cv. Shatian pomelo was 6.32%, and 4.12% in disease leaves. Healthy leaves of C. limon (L.) Burm. f. contained 4.49% of beta.-Phellandrene, and 4.96% in disease leaves. (2) Flavonoids were found in the orange, tangerine and mandarin Ponkan, but showed differences between healthy and disease leaves only in the orange species. The flavonoid compounds were not found in the Healthy leaves of sweet orange Hongjiangcheng, but they existed in the diseased leaves, which was 25.12% of the total detected secondary compounds. The content of flavonoids in C. ponki Hort. ex Tanka was 27.89% in the healthy leaves, 27.34% in infected leaves, showing no much difference. (3) In all host plants (with the exception of bergamot), the content of Phytol in the healthy leaves was significantly higher than the HLB infected leaves. The content of Phytol was 31.04% in the healthy leaves, but only 6.37% in diseased leaves of C. maxima cv. Shatian pomelo; 30.10% in the healthy and 8.96% in diseased leaves of C. sunki Hort ex. Tanka. But the contents of Phytol in the healthy and the diseased leaves of C. medicavar were similar, 22.82% and 23.95% respectively.

3. The same compounds among the 10 varieties were not significantly different. And there were different compounds which were remarkable between disease-resistant and susceptible cultivars. The content of some compounds, such as 2-Methoxy-4-vinylphenol, beta.-Citral and Cyclohexene, 1-methyl-4-(5-methyl-1-methylene-4-hexenyl)-,(S)- in the disease-resistant plants were apparently higher than in the Susceptible ones. Diseased leaves also contained some compounds whose differences were significant between disease-resistant and susceptible varieties, for instance (-)-.beta.-Pinen, D-Limonene, beta.-Citral, alpha.-Citral, Acetic acid, geraniol ester, Cyclohexene, 1-methyl-4-(5-methyl-1-methylene-4-hexenyl)-, (S)-,. These compounds in the disease-resistant varieties were significantly higher than that in the susceptible varieties.

Key Words: Huanglongbing, host plant, secondary compound

E-9

Sustainable linkage between Hylobius abietis, Rahnella and conifer trees

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Abstract: The pine weevil, Hylobius abietis (L.), is a deleterious insect feeding on economically important conifer seedlings in Northern Europe and in Chinese territory. We are attempting to screen an effective repellents and/or antifeedants for this pine weevil. The weevil especially feed on the bark of newly planted conifer seedlings which has abundant lignin in particular. Therefore it is considered that efficient lignin degradation system exists in H. abietis. In this respect, H. abietis is also an interesting insect.

In this study, isolation of microbes from the gut and feces from H. abietis was done using a 2% NF (natural frass i.e. a combination of feces and bark pieces produced by the feeding pine weevil) medium consisting of feces and frass of H. abietis. Microorganisms were isolated and classified into six groups based on the volatiles produced as measured by SPME.

Under both acidic (pH4.5) and alkaline (pH7.8) culture conditions, Rahnella sp., might have an important role involved in the degradation of lignin and act as a “regulator” for the preparation of the alkaline intestinal environment in the life-cycle of this insect. There were no fungi involved in lignin metabolism at acidic conditions. To break the sustainable linkage of H. abietis and conifer trees, Rahnella sp. is considered a potential target microbe. Screening of microbes involved in cellulose degradation is now in progress.

Key Words: Hylobius abietis (L.), Rahnella sp., conifer, Microorganisms, gut, sustainable linkage

F-1

Aversive odorant down-regulates tyrosine decarboxylase gene expression in the antenna of the blowfly, Phormia regina

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Abstract: In the blowfly Phormia regina, exposure to D-limonene during feeding inhibits proboscis extension reflex (PER) behavior due to decreasing tyramine (TA) titer in the brain. TA is synthesized by tyrosine decarboxylase (Tdc) and catalyzed into octopamine (OA) by tyramine ß-hydroxylase (Tbh). To address the mechanisms of TA titer regulation in the blowfly, we cloned Tdc and Tbh cDNAs from P. regina (PregTdc and PregTbh). PregTdc was expressed in the antenna, labellum, and tarsus whereas PregTbh was expressed in the head, indicating that TA is mainly synthesized in the sensory organs whereas OA is primarily synthesized in the brain. D-limonene exposure significantly decreased PregTdc expression in the antenna but not in the labellum and the tarsus, indicating that PregTdc expressed in the antenna is responsible for decreasing TA titer. PregTdc-like immunoreactive material was localized in the thin-walled sensillum. In contrast, the OA/TA receptor (PregOAR/TAR) was localized to the thick-walled sensillum. Our results suggest that D-limonene inhibits PregTdc expression in the olfactory receptor neurons in the thin-walled sensilla, likely resulting in reduced TA levels in the receptor neurons in the antenna. TA may be transferred from the receptor neuron expressing PregTdc to the specific glomerulus in the antennal lobe of the brain through the projection neurons in a manner similar to that found in Drosophila, by which low TA levels in the brain is elicited in our paradigm.

Key Words: D-limonene, tyrosine decarboxylase, olfactory neuron, Phormia regina

F-2

Navel Orangeworm Moth (Amyleois transitella) Pheromone-Binding Protein 1 (AtraPBP1)

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Abstract: The navel orangeworm, Amyelois transitella Walker (Lepioptera: Pyralidae), is the most serious insect pest of almonds and pistachios in California. Environmentally friendly alternative control methods such as pheromone-based approaches (trap attraction or mating disruption) are highly desirable for them. Insect pheromone-binding proteins (PBPs) provide fast transport of hydrophobic pheromones through the aqueous sensillar lymph and promote sensitive delivery of pheromones to receptors. In previous study we have cloned a PBP from A. transitella (AtraPBP1) with two other general odorant-binding proteins (GOBPs) and one chemosensory protein (CSP).AtraPBP1 is highly expressed in male antennae and showed a dramatic pH-dependent conformational change, with high affinity to pheromone constituents at neutral pH but not low pH. Here we present the three-dimensional structure of AtraPBP1 in solution at pH 4.5 by nuclear magnetic resonance (NMR) spectroscopy. To evaluate how the C-terminal helix in this protein controls pheromone binding and releasing, we further present a mutational analysis on AtraPBP1. Deletion of the entire C-terminal helix (residues 129–142) causes more than 100-fold increase in pheromone-binding affinity at pH 5 and only a 1.5fold increase at pH 7. A similar pH-dependent increase in pheromone binding is also seen for the H80A/ H95A double mutant that promotes extrusion of the C-terminal helix by disabling salt bridges at each end of the helix. The single mutants (H80A and H95A) also exhibit pheromone binding at pH below 5, but with 2-fold weaker affinity. NMR and circular dichroism data demonstrate a large overall structural change in each of these mutants at pH 4.5, indicating an extrusion of the C-terminal helix that profoundly affects the overall structure of the low pH form. Our results confirm that sequestration of the C-terminal helix at low pH may serve to block pheromone binding. We propose that extrusion of these C-terminal residues at neutral pH (or by the mutations in this study) exposes a hydrophobic cleft that promotes high affinity pheromone binding. An improved understanding of the function and mechanism of insect PBPs may contribute to the development of more efficient and environmentally friendly insect controlling strategies.

Key Words: Pheromone Binding Protein, PBP, AtraPBP1, Navel Orangeworm, Amyleois transitella

F-3

Expression in antennae and reproductive organs suggests a dual role of an odorant-binding protein in two sibling Helicoverpa species

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Abstract: Odorant-binding proteins (OBPs) mediate both perception and release of semiochemicals in insects. These proteins are the ideal targets for understanding the chemical language of insects as well as for interfering with their communication system in order to control pest species. The two sibling Lepidopteran species Helicoverpa armigera and H. assulta are two major agricultural pests, and get wide and intense research in China. As part of our aim to characterize the OBP repertoire of these two species, here we focus our attention on a member of this family, OBP10, particularly interesting for its expression pattern. The protein is specifically expressed in the antennae of both sexes, being absent from other sensory organs. However, it is highly abundant in the sperm, is transferred to females during mating and is eventually found on the surface of fertilised eggs. Among the several different volatile compounds present in reproductive organs, OBP10 preferentially binds 1-dodecene, a compound reported as an insect repellent. These results have been verified in both H. armigera and H. assulta with no apparent differences between the two species. Ligand-binding experiments, performed with the recombinant OBP10, show good affinity to 1-dodecene, some linear alcohols and several aromatic compounds. The structural similarity of OBP10 with OBP1 of the mosquito Culex quinquefasciatus, a protein reported to bind an oviposition pheromone, and its affinity with 1-dodecene suggest that OBP10 could be a carrier for oviposition deterrents, favouring spreading of the eggs in these species where cannibalism is very active among larvae.

Key Words: odorant-binding protein, Helicoverpa armigera, Helicoverpa assulta, 1-dodecene, oviposition, reproductive organs

F-4

cDNA Cloning and Recombinant Expression of the General Odorant Binding protein Ⅱ from Plutella xylostella

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Abstract: A cDNA encoding the general odorant binding protein Ⅱ (GOBP Ⅱ) was isolated from the antennae of Plutella xylostella (PxGOBP Ⅱ, Gene Bank Accession No. EU086371) by homologous cloning and rapid amplification of cDNA ends (RACE). Sequencing and structural analyses revealed that the open reading frame (ORF) of PxGOBP Ⅱ was 489 bp, encoding 162 amino acids with a predicted MW of 18.2 kD and pI of 5.72. PxGOPB II shared typical structural features of odorant binding proteins with other insects, including the six conservative cysteine residues. The deduced amino acid sequence of PxGOPB II shared significant identity with the GOBP Ⅱ from S. frugiperda and S. exigua. RT-PCR and Northern-blot analyses showed that PxGOBP Ⅱ was specifically expressed in the antennae. cDNA encoding PxGOBP Ⅱ was constructed into the pET-32a vector and the recombinant protein was highly expressed in Escherichia coli BL21 (DE3) after induction with IPTG. SDS electrophoresis and western blot analysis confirmed the molecular weight of the recombinant PxGOBPII was 32.KD, which has a 6xHis tag at the N-terminus. The recombinant PxGOBP II was purified by single-step Ni-NTA affinity chromatography and used to raise antiserum in rabbits. ELISA showed that the titer of antiserum was 1:12800, while western blot analysis showed that the recombinant PxGOBP Ⅱ was recognized as anti-PxGOBP Ⅱ antiserum.

Key Words: Plutella xylostella, vantennae, general odorant binding protein, gene cloning, prokaryotic expression

F-5

Topology and functional analysis of a *Bombyx mori* gustatory receptor

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Abstract: "Sugar" and "bitter" receptors construct two large clades in insect gustatory receptor (GR) phylogeny. Based on the homologies with identified receptors, five putative sugar receptors and a large number of putative bitter receptors have been identified from the first fully sequenced lepidopteran genome of *Bombyx mori*. Despite almost 60 putative sugar GRs being identified across insects, ligands have only been assigned to a few of the *Drosophila* receptors and, in July of this year, a D-fructose receptor from *B. mori* was characterized. Insect gustatory receptors are predicted to have seven-transmembrane domains. They are distantly related to insect olfactory receptors, which have an inverted topology compared with G-protein coupled receptors, including mammalian olfactory receptors. In contrast, the topology of insect gustatory receptors remains unknown. In this study, the total number of identified gustatory receptors in *B. mori* was expanded from 65 to 69. BmGr8, a silkmoth gustatory receptor from the sugar receptor subfamily, was expressed in insect cells and the transmembrane topology was determined. Functional analysis, using a modified calcium-imaging assay, showed that BmGr8 can function independently in *Sf9* cells and that it responds specifically and in a concentration-dependent manner to inositol, an essential nutrient for *B. mori*. The selectivity of BmGr8 responses is consistent with the known responses of one of the gustatory receptor neurons in the lateral styloconic sensilla of this species. We also show that an orphan receptor from the 'bitter' receptor subfamily, BmGr53, has the same topology as BmGr8. This is the first time that the topology of any insect gustatory receptor has been determined.

Key Words: Lepidotera, receptor, gestation

F-6

Preservation and Enhancement of Intermittent Representation of Natural Odor Plume by Antennal Lobe Circuits in a Moth Brain

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Abstract: Due to air turbulence natural odor plumes are never continuous; instead they are highly intermittent with packets of odor molecules mixed with pockets of clean air. Wind tunnel experiments have demonstrated that many species of insects have evolved to utilize such dynamic stimuli to successfully locate an odor source of interest such as mating partner, nectar source etc. Experimental creation of evenly distributed odor cloud results in failure of finding odor source despite the odor concentration and composition are within normal range. These results indicate the necessity of intermittent stimuli in producing the odor-modulated flight behaviors in insects. A crucial question, therefore, is how the insect olfactory system encodes intermittent stimuli. Cut-tip recordings from the olfactory sensilla on the antennae of the tobacco hornworm, Manduca sexta, show that receptor neurons are able to respond to pulsatile stimuli but with "noisy" spikes between responses. On the contrary, the projection neurons in the antennal lobe produce biphasic responses with hyperpolarization period that separates adjacent excitatory responses. More importantly, pharmacological block of the hyperpolarization period results in ineffective odor-source searching behaviors. These results strongly suggest that the biphasic responses of projection neurons effectively encode the intermittency of natural odor plume. Further experiments using various GABA receptor antagonists suggest that both intrinsic and extrinsic cellular mechanisms may be responsible for the maintenance of the biphasic responses. In summary, our results reveal an important mechanism in antennal lobe circuits that particularly preserve and enhance the discontinuity of natural odor plumes.

Key Words: receptor neurons, projection neurons, odor plume, antennal lobe, intermittency, neural code, moth, Manduca sexta

F-7

The function of plasticity in neural networks of the honey bee brain that process complex floral odors

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Abstract: Natural odors are typically mixtures of several different chemical components. Changes in the composition of the mixture, by deleting or replacing components or by changing the ratios of components in the mixture, can have a significant impact on the perceptual properties of the mixture. It has been now widely shown that these types of differences separate odor "objects" that animals must identify and discriminate for their survival. The use of floral odor bouquets by honey bees is a classic example. The odor bouquets can contain many chemical constituents, which collectively give rise to the unique perfumes of many varieties of flowers both and between species. Moreover, these perfumes are distinguishable to both humans and to honey bees in behavioral experiments, which likely reflects the broad similarities in odor coding and processing in the early parts of their olfactory systems.

Sensory cells transduce pure (single component) odors via expression of one, or in the case of insects two, molecular receptors among the dozens to hundreds of functional receptors in the genome. Typically sensory cells respond to a range of odorants that possess the same or similar molecular structures. Thus any sensory neuron responds to several odorants, and any odorant is encoded by different rates of activity across a subset of sensory cells that express different receptors. This combinatorial, cross-fiber coding enables the detection of a very large number of odorant molecules.

The neural networks in the insect antennal lobe provide the first level of processing of these codes in the brain. These networks extract features of the odor signature such as, for example, the precise mixture of components, the temporal signature the odor plume at the antennae, and the association of the odor with important events such as food. Yet, in spite of the complex chemical composition of odor bouquets, most studies of sensory and antennal lobe processing of odors focus on single components or on mixtures that have not been systematically altered.

Our work focuses on how the antennal lobes process and differentiate among complex floral odor bouquets. We have shown for simple mixtures that the antennal lobe separates these mixtures to a degree correlated with the honey bee's ability to behaviorally discriminate the odors. Furthermore, associative and nonassociative plasticity manifested in the antennal lobe further separate the odors. We have extended this work to show that the same types of plasticity operate on more complex synthetic – and systematically varied - blends that mimic natural floral odor bouquets. This presentation will summarize this work, discuss how plasticity is implemented in the antennal lobe, how this plasticity functions in the larger brain context, and lastly on the role of plasticity in the ecology of foraging behavior.

Key Words: honey bee, natural floral odors, coding, antennal lobe, plasticity

F-8

Coding of Sex Pheromone Blends with Reverse Ratios in Two Helicoverpa Species and Its Inheritance Pattern

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Abstract: The two sibling sympatric species, Helicoverpa armigera (Hübner) and Helicoverpa assulta Guenée (Lepidoptera: Noctuidae) share two major sex pheromone components, cis-11-Hexadecenal (Z11-16:Ald) and cis-9-Hexadecenal (Z9-16:Ald), but in almost reversed relative concentrations, 100: 2.1 and 5.8:100 respectively. In the laboratory, reciprocal hybridization between the two species followed by backcrossing of the hybrids (F1) with H. armigera produced backcross (BC) lines consisting of partial fertile females and males. Thus, isolation between H. armigera and H. assulta is caused by a combination of several prezygotic and postzygotic factors. Here we report about coding of their sex pheromone blends with reverse ratios in males and its inheritance pattern. Our behavioral and electrophysiological results show that the pheromone coding in H. armigera and H. assulta mainly occurs in two types of highly specific receptor neurons in two types (A–type and C-type) of antennal sensilla, which recognize the two-components of the pheromone blend. In A–type sensillum the neuron responds to Z11–16:Ald, and in C-type sensillum the neuron responds to Z9–16:Ald. As labeled lines, the two neurons each send unique information based on their firing rate, and continuously signal to the antennal lobe the levels of Z11–16:Ald and Z9–16:Ald in the air. The different sensitivity, abundance and distribution of the neurons in the two species further increase the differences between the two signals, reflecting the importance of pheromone components in the pheromone system of these two species. We focus on the olfactory receptors and associated transduction molecules to study their contributions to the specificity and sensitivity of relative neurons to the signals. The genetic architecture of pheromone coding at the periphery is quite complex, and the alleles of H. armigera seem to be dominant or partially dominant over those of H. assulta. The projection of the axons of receptor neurons to the male specific macroglomerular complex (MGC) in the antennal lobe was reported to be also different between the two species. The central nervous system may use a simple mechanism to compare the paired input, and accordingly trigger the appropriate behavior.

Key Words: sex pheromone, coding, olfactory receptor neuron, macroglomerular complex, Helicoverpa armigera, Helicoverpa assulta

F-9

Scanning electron microscopy studies on antennal sensilla of female Anastatus japonicus Ashmead (Hymenoptera: Eupelmidae)

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Abstract: Antennae of insects, in particular parasitic hymenoptera, have various types of sensilla with different functions (mechanical, olfactory and gustatory) and play important role in perceiving physical, chemical and/or chemotactile stimuli. *Anastatus japonicus* Ashmead (Hymenoptera: Eupelmidae) is an important egg parasitoid of some important insect pests, such as *Dendrolimus superans* Butler, a larch defoliator. In order to definitude its host location mechanisms, we measured the number of the antennal sensilla and detailed examination of sensilla morphological features of female *A. japonicus* by scanning electron microscopy. The antennae of the female parasitoids are geniculation in shape, 1400μm in length, and consist of 14 antennomeres. Nine morphological sensilla types were found and recorded in the antenna surface of female parasitoids, including sensilla trichodea, sensilla chaetica, sensilla basiconica, sensilla placodea, sensilla coeloconica, sensilla i-type, sensilla corneous, sensilla campaniformia, and sensilla lance. Sensilla campaniformia and sensilla lance were reported for the first time and named here after their shapes. The size, type, and abundant of these sensilla on the left and right antenna surface or on the internal and external side of the antenna were very different. Sensilla placodea was the biggest in length, followed by sensilla trichodea and sensilla lance, and then they also were the three types of sensilla widely distributed on the antennae surface of female parasitoids. Sensilla chaetica were distributed on the radicle and at the scape-pedicel elbow joint of the antennae, while sensilla i-types were only presented on the distal portion of the antennal clava. Sensilla campaniformia and sensilla corneous were distributed on the internal side of the antennal clava, whereas sensilla coeloconica and sensilla lance were presented on the external side of the antennal flagellum and clava. Sensilla trichodea and sensilla basiconica were significantly more abundant on the internal than on the external side of the flagellum and clava surface of the left and right antenna, whereas sensilla placodea tended to be more abundant on the external than on the internal side of the flagellum and clava surface of the right antenna, and then the contrary results were observed on the left antenna. While on the scape and pedicle surface of the left and right antenna, sensilla trichodea were significantly more abundant on the external than on the internal side. However, we found that there was not significant difference for the number of these sensilla on the internal side of the left antenna compared to the internal side of the right antenna. And then on the external side of the left and right antenna, sensilla placodea tended to be more abundant on the right than on the left antenna surface, while there was not significant difference for the number of the other sensilla. Our results showed that the distributions of the sensilla on female *A. japonicus* antennae were asymmetries, and multiporous sensilla placodea most distributed on the right antenna surface compared to the left antenna. Two new types of sensilla, sensilla campaniformia and sensilla lance were found. Their possible functions were discussed in light of previously published literature.

Keywords: *Anastatus japonicus*, antennal sensilla, scanning electron microscopy, Hymenoptera, sensilla placodea

F-10

Types and ditribution of the sensillas on the antennae of the banana pseudostem weevil Odoiporus longicollis Oliver by environmental scanning electron microscopic

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Abstract: Ultra-structure, number and distribution of the sensillas on the antennae of the banana pseudostem weevil Odoiporus longicollis Oliver were observed with environmental scanning electron microscope. The results showed that the geniculate antenna consists of the scape, six pedicel and flagellomeres. There were 5 types which included 12 kinds of sensillas on the antennae of both males and females. They were 6 kinds of sensilla trichodeas, 3 kinds of sensilla chaeticas, 1 kinds of sensilla basiconcas，1 kind of sensilla gemmiformium，and 1 kind of sensilla doleiform. There were wavy grooves on the anterma surface. It was different among the distribution and number of the sensillas on the Scape, Pedieel and Flagellum of the antenna.

Key Words: Odoiporus longicollis Oliver, antenna, sensilla

F-11

PHEROMONE BINDING TO GENERAL ODORANT-BINDING PROTEINS FROM THE NAVEL ORANGEWORM

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Abstract: General odorant-binding proteins (GOBPs) from moths are postulated to be involved in the reception of semiochemical other than sex pheromones, the so-called “general odorants.” We have expressed two GOBPs, AtraGOBP1 and AtraGOBP2, which were previously isolated from the antennae of the navel orangeworm, Amyelois transitella. Surprisingly, these two proteins did not bind compounds which are known to attract adult moths, particularly females. That the recombinant proteins were properly folded and functional was inferred from circular dichroism analysis and demonstration that both GOBPs bound nonanal in a pH-dependent manner. EAG experiments demonstrated that the female attractants are detected with high sensitivity by the antennae of day-0 to day-4 adult females, with response declining in older moths. The same age-dependence was shown for male antennae responding to constituents of the sex pheromone. Interestingly, AtraGOBP2 bound the major constituent of the sex pheromone, Z11Z13-16Ald, with affinity comparable to that shown by a pheromone-binding protein, AtraPBP1. The related alcohol bound to AtraPBP1 with higher affinity than to AtraGOBP2. AtraGOBP1 bound both ligands with low but nearly the same affinity.

Key words: AtraGOBP1, AtraGOBP2, AtraPBP1, female ttractants, Amyelois transitella

G-1

A sex pheromone desaturase functioning in a primitive *Ostrinia* moth is cryptically conserved in congeners' genomes

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Abstract: Moths of the genus *Ostrinia* (Lepidoptera: Crambidae), which show distinct differences in sex pheromones, are useful for studying the evolution of sex pheromone communication systems. Among the 21 species of *Ostrinia* recorded worldwide, the sex pheromones of nine species including the European corn borer *O. nubilalis* have been characterized to date. (*E*)-11- and (*Z*)-11-tetradecenyl acetate are the most common female sex pheromone components in *Ostrinia* moths. Δ11-desaturase expressed in the pheromone gland (PG) of female moths is a key enzyme that introduces a double bond into pheromone molecules. A single Δ11-desaturase of *O. nubilalis*, OnubZ/E11, has been shown to produce an ≈7:3 mixture of (*E*)-11- and (*Z*)-11-tetradecenoate from the substrate tetradecanoate. In contrast, the sex pheromone of the Far-Eastern knotweed borer *O. latipennis*, a primitive species of *Ostrinia,* is (*E*)-11-tetradecenol. This pheromone is unique in that it is not acetylated, and includes no *Z* isomer. In the present study, through the cloning and functional analysis of a PG-specific Δ11-desaturase in *O. latipennis*, we showed that the absence of the *Z* isomer in the pheromone is attributable to the strict product specificity of the Δ11-desaturase in this species, LATPG1. Phylogenetic analysis revealed that LATPG1 was not closely related to OnubZ/E11. Rather, it was closely related to retroposon-linked cryptic Δ11-desaturases (*ezi*-Δ11) found in the genomes of *O. nubilalis* and *O. furnacalis*. Taken together, the results showed that an unusual Δ11-desaturase is functionally expressed in *O. latipennis*, although the genes encoding this enzyme appear to be cryptic in congeners.

Key Words: Ostrinia, desaturase, pheromone, biosynthesis, evolution, retroposon

G-2

Molecular Cloning, Sequence Analysis and Tissue Expression of Two Putative Desaturase Genes from *Spodoptera exigua* (Hübner)

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Abstract: Acyl-CoA desaturases are key enzymes in the biosynthesis of sex pheromone and they account for the great diversity of sex pheromone structures in Lepidopteran insects. This paper reported the study results on *Spodoptera exigua* (Hübner), an important polyphagous insect pest. By homologue searching of the *S. exigua* transcriptome data, we found two fragments of putative desaturase genes, and then obtained their full-length cDNA sequences by RACE technique. These two putative desaturase genes were named as *SexiDes1* and *SexiDes2*, respectively. The deduced amino acid sequence of *SexiDes1* contained an open reading-fram (ORF) of 1059bp, encoding 353 amino acid residues, with the predicted mature weight of 40.53 KDa and isoelectric point of 8.95; *SexiDes2* contained an ORF of 1113bp, encoding 371 amino acid residues, with the predicted mature weight of 43.41 KDa and isoelectric point of 7.08. According to the sequence alignment and evolutionary analysis, the two desaturases shared high identities with reported desaturases of other Lepidopteran insects. By RT-PCR, the tissue expression patterns of the two genes were investigated. The results showed that both *SexiDes1* and *SexiDes2* expressed in female sex pheromone glands, but *SexiDes1* had a wider range of tissue distribution than *SexiDes2*. Further *in vitro* expression and function analysis of these genes are ongoing.

Key words: *Spodoptera exigua* (Hübner); desaturase; gene cloning; sequence analysis; tissue expression.
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G-3

Genomics as a tool for chemical ecology

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Abstract: The understanding of mechanism for semiochemical production, perception and regulation has promoted the application of new knowledge from genomics. As sex pheromone production of moth is regulated by PBAN, we would like to know how PBAN is regulated by other factors. With available genome sequence of silkworm and more than 400 miRNAs identified so far and the functional genomic platform, we sequenced the 3'-UTR nucleotide of PBAN and predicted miRNA target on PBAN gene using microTar and Miranda software. The 3'-UTR was integrated into a plasmid with luciferase as a report gene. The predicted miRNAs were transfected with the constructed plasmid into a cell line to observe the depression of the gene expression. This approach is an effort to understand the gene regulation at the gene level.

Key Words: Genomics, PBAN, miRNA, 3'UTR

G-4

Os08g0167800 gene plays an important role in food chain of rice, striped stem borer and parasitic wasps

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Abstract: Striped stem borer (SSB), Chilo suppressalis Walker, is an important insect pest of rice, SSBs could cause significant hazard on rice products every year. The wasp Cotesia chilonis Munakata is an important natural enemy of SSB, could attack the SSB larvae at each stage. The food chain of Rice--SSB--Cotesia chilonis Munakata plays an important role in the Integrated Pest Management (IPM) strategies of rice, and understanding the mutual-action mode among them at the molecular level would provide fundamental meaningful way in improving SSB IPM strategies. In the chemical communication process of the food chain, Cotesia chilonis Munakata accepts the SSB-induced pheromones volatized by rice via olfactory receptor to complete an important exchange of information. To understand the regulation process of rice specific volatiles on the molecular level has become a hotspot study field at present, and would provide new strategies and approaches for controlling insect pests by natural enemies. The object of our work is to put insight into the regulatory mechanism of rice volatiles-associated genes induced by SSB larvae by molecular approaches. In this study, we cloned the terpene synthase (TPS) gene Os08g07100 of rice by the suppression subtractive library, whose transcripts were up-regulated in response to feeding by the 1st to 2nd rice striped stem borer (SSB) Chilo suppressalis (Walker) for 24h, and then the RNAi interference technique was used to study the functions of Os08g07100. The observation that suppression of Os08g07100 gene expression in rice makes the rice unattractive to Cotesia chilonis even though rice induced by SSB larvae. These indicate that Os08g07100 was an important gene for rice defensing against Chilo suppressalis (Walker). Therefore the identification of Os08g07100 gene functions could greatly facilitate the development of rice varieties or other plant varieties by transgenic technique with resistance to Chilo suppressalis larvae so as to reduce pesticide usage and decrease economic and environmental costs simultaneously. In this study, we also demonstrated that the volatiles products of Os08g07100 showed difference when rice plants were at different stage.

Key Words: Cotesia chilonis Munakata, Terpene synthase gene, Chilo suppressalis, Walker, suppression subtractive library

G-5

Two WRKY transcription factors mediate herbivore-induced defense responses in rice

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Abstract: Using a microarray, we found that 22 WRKY transcription factors (TFs) were up-regulated following infestation by rice striped stem borer (SSB) Chilo suppressalis. Among them, two WRKY TFs, OsHIWRKY1 and OsHIWRKY2, which belongs to group I type and are the homolog of NaWRKY3 and NaWRKY6 in Nicotiana attenuata, were induced by treatment with mechanical wounding, infestation of SSB and rice brown planthopper (BPH) Nilaparvata lugens, but not by treatment with defense-related signal molecules, SA and JA. In vitro pull down assay demonstrated that OsHIWRKY1 interacted with OsMPK3 and OsMPK6. OsHIWRKY1 positively regulated herbivore-induced JA levels and plant resistance to SSB, whereas negatively regulated rice resistance to BPH. In contrast, OsHIWRKY2 only slightly affected herbivore-induced JA levels. Our results demonstrate that OsHIWRKY1 and OsHIWRKY2 are downstream components of MAPK cascades and play an overlapping and crucial role in herbivore-induced defense responses by regulating the JA singaling pathway.

Key words: rice, WRKY, plant defense response, signaling pathway, Nilaparvata lugens, Chilo suppressalis

G-6

New Methodologies for the Asymmetric Synthesis of Pheromones and other Eco-Chemicals

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Abstract: Pheromones play an important role in chemical communication among organisms. A number of pheromones have been identified with many of them being chiral and non-racemic. Extensive studies on the relationships between stereochemistry and bioactivity of insect pheromones confirm the key role played by the stereochemistry in the bioactivity of the pheromones. In addition, the minus amounts of pheromones available from natural sources prevent a profound bio- and ecological study. Therefore the enantioselective synthesis constitutes an important tool, not only for the establishment of the absolute configuration of the naturally occurring pheromones, and the clarification of the relationship between absolute configuration and the bioactivity of the chiral pheromones, but also for the pests monitoring and control.

In this talk, we shall present new methods for the asymmetric synthesis of the pheromones of pine sawflies,[1] Gypsy Moth pheromone disparlure, and the pheromone components of the Fall Webworm Moth),[2] as well as some alkaloidal pheromones and ant venom/poison frog alkaloids.

Key Words: Pheromones, pine sawflies, Gypsy Moth, disparlure, Fall Webworm Moth, ant venom/poison frog alkaloids, Synthesis, Chirality

G-7

Mechanisms of age-dependent division of labor in a social aphid

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Abstract: Social aphids produce altruistic nymphal individuals termed soldiers that perform colony defense, housekeeping, and gall repair for their colony mates. In highly social aphids, soldiers are morphologically differentiated from reproductive nymphs of the same instar and unable to grow, constituting a sterile caste. As aphids reproduce parthenogenetically, all members of a genetic clone have identical genomes. Nevertheless, social aphids display adaptive caste polyphenism and short-term behavioral plasticity.

Tuberaphis styraci is a highly social aphid with a sterile soldier caste in the second instar. The soldiers not only defend the colony against predators but also clean the gall by removing waste products. When the soldiers are young, they preferentially perform relatively safe tasks inside the colony such as gall cleaning. As the soldiers age, their tasks involve more dangerous outside activities such as colony defense. This division of labor through age polyethism is parallel to those of eusocial Hymenoptera such as honeybees and ants, although its neural bases are not well understood.

To understand the underlying mechanisms of age-dependent division of labor in the aphid social system, we focused on cGMP-dependent protein kinase（PKG） pathway as a candidate factor because PKG pathway is found in social insects and related to their division of labor. Using the cGMP-analog that increases PKG activity, we conducted a feeding experiment to assess the role of PKG pathway in the transition from non-aggressive to aggressive in soldier behavioral development. Young soldiers which fed higher concentrations of the cGMP-analog were significantly more aggressive than those which fed lower concentrations of the cGMP-analog or distillated water only. This result suggests that PKG pathway is involved in the expression of defensive behavior in age-dependent division of labor in social aphids.

Key Words: social aphid, soldier, colony defense, division of labor, electrophysiology, PKG pathway

G-8

Cotton aphid signal transduction genes derived from aphid genome sequences

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Abstract: It is well known that the semiochemicals from outside, such as pheromones, plant volatiles could induce the insect behavioral responses. There are reports from other animals and drosophila that the genes and signal transduction are critical in the procession. Recently, we sequenced the whole genome sequence of cotton aphid. The assemble of the gene sequences obtained from 454 pyrosequencing, high throughput gene sequences showed that cotton aphid has similarity to that of pea aphid, but the significant difference does exist between the two aphid species. Based on the annotation and gene function analysis, we derived the genes and signal transduction pathways from cotton aphid. Some of the gene expression and their possible function were discussed.

Key Words: cotton aphid, signal transduction, genome, sequencing

H-1

Phenylpropanoid bouquets of Bulbophyllum orchids act as floral synomones to attract Bactrocera fruit flies

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Abstract: Flowers of Bulbophyllum elevatopunctatum (Orchidaceae) selectively attract male fruit flies of several Bactrocera species with a specific fragrance in the rain-forests of Malaysia. The major attractant component in this fragrance has been identified as methyl eugenol (ME). This strongly attracts the oriental fruit fly (Bactrocera dorsalis), its sibling and other ME-responsive species. Once a fly has been attracted to the flower, it usually moves towards the lip. The hinged lip then pivots with the weight of the fly and hence temporarily traps the fly between the lip and column. This fruit fly visitor is rewarded by an abundance of ME to feed on and in return it helps to pollinate the flower by removing and then transferring the pollinarium to another flower. Males of B. dorsalis biotransform the acquired ME into oxidized ME-analogs [2-allyl-4,5-dimethoxyphenol (DMP) and E-coniferyl alcohol (CF)] and this is then stored in the rectal pheromone gland. These chemicals are subsequently emitted as male sex pheromone to attract conspecific females. This provides a good example of true mutualism between insects and plants via a floral synomone. Both the interacting organisms obtain advantages that directly benefit their respective reproductive systems. Interestingly, Bu. elevatopunctatum flowers possess DMP and CF together with several other related components such as eugenol (E), elemicin (EL), euasarone and E-coniferyl acetate in small quantities in the floral organs, although their ecological/physiological functions are unknown. While ME was distributed in all floral organs, namely, petals, lip, sepals and column, in similar concentrations, E was more or less localized in the petals. However the ratio of EL:ME remained constant in all floral organs. This paper will compare the Bu. elevatopunctatum with two other oriental fruit fly-attracting orchid species, Bu. cheiri and Bu. vinaceum, which also produce DMP and CF as minor components in addition to the major synomone ME. Chemical profiles of phenylpropanoid volatiles are compared among these closely related congeneric orchid species of the section Sestochilus.

Key Words: fruit fly orchid, Bulbophyllum elevatopunctatum, Bactrocera dorsalis, oriental fruit fly, methyl eugenol, phenylpropanoid, synomone, pheromone

H-2

Co-evolution of piercing-sucking insects and plants

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Abstract: Piercing-sucking insects can be categorized, depending on their feeding habits, into plant-sap feeders and animal-blood feeders. We here discuss the co-evolution of plant-sap feeders and plants. Thrips, aphids, leafhoppers, whiteflies, bugs, etc, belong to plant-sap feeders. These insects are very problematic in crop production, especially in plant virus transmission. They are different greatly in their host plant ranges, feeding strategies, virus transmission abilities, as well as in their responses to the induced plant resistance. Feeding strategies of herbivorous piercing-sucking insects vary with insect groups, including mesophyl feeding, phloem feeding, xylem feeding, and mixed feeding types. Plant secondary metabolites are very important factors in shaping insect feeding behavioral patterns, and in turn insect feeding has enhanced diversity of plant chemicals. The understanding of feeding strategies in piercing-sucking insects can be very helpful in development of transgenic crops resistant to these insects.

Key words: Piercing-sucking insects; Co-evolution; Feeding strategy; Plant secondary metabolites; Transgenic crop development

H-3

Nepenthes rafflesiana, a carnivorous pitcher plant smells like a flower to attract insect prey

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Abstract: Carnivorous plants overcome low nitrogen availability in their habitats by capturing and digesting insects. Their leaves modified as traps attract insects via a number of flower-like cues, such as nectar, color and UV guides. Using the Bornean pitcher plant Nepenthes rafflesiana as model species, we tested whether this carnivorous plant may also use floral odors to attract prey.

Nepenthes pitcher plants display pitcher dimorphism with aerial (upper) and ground (lower) pitchers. In Nepenthes rafflesiana, fragrant upper pitchers of climbing plants were shown to trap an unusual diversity of flying insects compared to less-fragrant lower pitchers, essentially restricted to an ant diet. To investigate the role of odor in prey attraction, (1) we analyzed both the diversity of arthropod visitors and the scent composition of the two types of pitchers and (2) we tested whether odor alone was sufficient to attract prey. The volatile compounds of N. rafflesiana were collected using dynamic headspace adsorption and analyzed by gas chromatography and mass spectrometry. To test the efficiency of odors in insect attraction, we carried out olfactometer bioassays with flies and ants, representative of two important prey categories in Nepenthes.

Upper pitchers showed higher numbers and diversity of both insect visitors and volatile compounds than lower pitchers. Furthermore, upper pitchers differed from lower pitchers in (1) attracting potential pollinators, such as flies, butterflies, moths, bees, wasps and beetles and in (2) emitting a blend of odors rich in terpenoids and benzenoids, compounds classically found in flower scents. Choice bioassays showed that the scents of upper pitchers attracted both ants and flies while the scent of lower pitchers attracted ants only.

Our results suggest that the foliar traps of N. rafflesiana biochemically mimic flowers and present a convergent strategy with insect-pollination floral systems.

Key Words: Carnivorous pitcher plant, insect attraction, Nepenthes rafflesiana, volatile compounds, odor cues, headspace adsorption, GC-MS, olfactometer bioassays, plant-insect interaction

H-4

Feeding deterrence of *Zanthoxylum bungeanum* and *Piper nigrum* extracts to H*elicoverpa armigera* larvae

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Abstract: for polyphagous species, the presence of chemical attractants or stimulants is less important than the lack of deterrents in making a given substrate acceptable, therefore, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae), a typical polyphagous insect species, might be an optimal model species for feeding deterrent researches. By leaf disc bioassay method, the author compared the feeding preference of the 4th instar larvae offered with corn, tomato, pepper, cotton, and peanut leaves, each paired with tobacco leaf, and found tobacco was the most suitable substrate for feeding deterrent bioassay. Ethanol, compared to distilled water, dichloromethane, *n*-hexane, and acetone, was the most suitable solvent for extracting *Zanthoxylum bungeanum*, a material exhibiting fairly strong anti-feeding activity to the larvae previously reported by our group members. Then the author tested the feeding deterrence of ethanol extracts of 32 spices to search for stronger feeding deterrents. The result shows that the extracts of *Piper nigrum* L. (black piper and white piper, these two materials were from the same plant species but experienced different processes) (Piperaceae), *Piper longum* L. (Piperaceae), and *Angelica dahurica* Benth. et Hook. f. (Apiaceae), had extremely significant effect, only a few biting dots were observed on the leaf discs coated with the four extracts. Eleven rinses of *Zanthoxylum bungeanum*[n-hexane (2×15 mL), ether (2×15 mL), dichloromethane (2×15 mL)，and alcohol (5×15 mL)] and 9 rinses of *Piper nigrum* [n-hexane (15 mL), ether (2×15 mL), dichloromethane (2×15 mL), and alcohol (4×15 mL)] were fractionated by bioassay-guided column chromatography. The active rinses showing extremely significant deterrence were combined and performed on gas chromatography-mass spectrometry, and the major volatiles of *Zanthoxylum bungeanum* active fractions were D-limonene and linalool, and the major unvolatile components was sanshool; the major volatiles in *Piper nigrum* active fractions were β-phellandrene, 3-carene, and β-caryophyllene, and the unvolatile components was piperine. We speculate that the two compounds, sanshool and piperine, sharing the common ampicin structure, may be used as potential feeding deterrents against Lepidopteran caterpillars in the field.

Key words: *Helicoverpa armigera*, *Zanthoxylum bungeanum*, *Piper nigrum*, feeding deterrence; sanshool, piperine

H-5

Insect-feeding and jasmonate inducible phenylalanine is a precursor for nitrile biosynthesis via decarboxylation in the giant knotweed, Fallopia sachalinensis

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Abstract: Plants emit a series of characteristic volatile blends, such as terpenes and green leaf volatiles when they are damaged by insect feeding. These herbivore-induced plant volatiles are known to either attract natural enemies of the herbivores or induce defense responses of other plants in the vicinity, and thus the volatiles play an important role in plant defense against herbivores.

Phenylacetonitrile, (E)-beta-ocimene, linalool, (E)-4,8-dimethyl-1,3,7-nonatriene and (E,E)-alpha-farnesene were identified as the Japanese beetle, Popillia japonica, feeding-induced volatiles from the leaves of the giant knotweed, Fallopia sachalinensis, but not by mechanical damage. The volatile emission was also induced by the treatment of cellular signaling molecule, methyl jasmonate (MeJA) that lies downstream of insect feeding. During our field research around Akita City in Japan, the beetles are often found to aggregate on the infested leaves of F. sachalinensis, suggesting that the beetle-induced volatiles are likely to serve as host location cues for the beetles. These terpenes are well known volatiles induced by insect feeding, while nitrile emission is not usual as herbivore-induced plant response.

Plant nitriles are known as one of the degradation products of glucosinolates, mostly found in the Brassicaceae family. In this biosynthesis, glucosinolates are initially hydrolyzed by myrosinase which catalyzes the glucosinolates when plant tissue is physically damaged by cutting, grinding or chewing. In F. sachalinensis, nitrile emission was not observed when the plant tissue was mechanically damaged, suggesting that the nitrile was not derived from a corresponding glucosinolate. The induction of phenylacetonitrile emission from undamaged leaves by MeJA also indicates that the nitrile is synthesized de novo in F. sachalinensis.

The beetle-feeding and MeJA also induced phenylalanine and phenethylamine in the leaves of F. sachalinensis which were not found in undamaged leaves. These results suggest that phenylacetonitrile could be biosynthesized from beetle-feeding and MeJA inducible phenylalanine via decarboxylation step. Tyramine, a decarboxylated product of tyrosine, is constantly found in either undamaged or infested leaves of F. sachalinensis, suggesting the presence of decarboxylase that catalyze the formation of tyramine and phenetylamine from corresponding aromatic amino acids.

Key Words: Amino acids, Decarboxylation, Fallopia sachalinensis, Herbivore-feeding, Methyl jasmonate, Phenylacetonitrile

H-6

Effects of *Ferula assafoetida* essential oil on some biological traits of *Trichogramma embryophagum* (Hym.:Trichogrammatidae), egg parasitoid of carob moth.

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Abstract: The essential oil of *Ferula assafoetida* (Umbellifereae) has been used traditionally by some farmers against the carob moth, *Ectomyelois ceratoniae* (Zeller) (Lep.: Pyralidae), in pomegranate orchards in Iran. It acts as a larvicide, but may also disrupt mating and/or repel the adult carob moth. The present study was carried out to investigate the effects of the essential oil on some biological characteristics of *Trichogramma embryophagum* (Hym.: Trichogrammatidae) a used biological control agent in pomegranate orchards. The LC_{50} value for adult wasps was 4112 ppm but exposure to 810 ppm significantly reduced the longevity and fecundity of females, as well as the survival, developmental time, wing morphology and sex ratio of her progeny. When virgin adults were treated, mate searching time increased whiles the percentage of mating, and the duration of copulation declined. Given the negative effects of the essential oil on *T. embryophagum* complementary studies are needed to develop the best management strategy for the use essential oils and parasitoids intermittently in pomegranate orchards against the carob moth.

Key Words: essential oil, Oral toxicity, environmentally friendly product

H-7

Identification of brown planthopper resistance-related gene from jasmonic acid pathway by microarray analysis

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Abstract: Rice (*Oryza sativa* L.) is the staple food for over half of the world's population. The brown planthopper (BPH), *Nilaparvata lugens* Stål, is one of the most serious insect pests of rice and causes significant yield loss in most rice cultivars cultivated in Asia. The Sri Lankan rice cultivar Rathu Heenati (RHT) displays a strong and broad-spectrum resistance to all the main four BPH biotypes. RHT was confirmed to carry the dominant resistance gene *Bph3*. The *Bph3* gene has been studied extensively and assigned to four different rice chromosomes (3, 4, 6 and 10) by different research groups, but the gene has not been cloned previously. An Affymetrix rice genome array containing 48,564 *japonica* and 1,260 *indica* sequences was used to analyze the potential resistance-related genes on the four chromosomes by comparative analysis of the differentially expressed genes between resistant and susceptible rice cultivars exposed to BPH attack. The microarray results showed that at least 17 genes related to induced resistance and at least 193 genes related to constitutive resistance in RHT. The analysis results indicated that BPH resistance in RHT is probably controlled by a series of resistance-related genes. On chromosome 3, the *AOC4* was hypothesized to be the most important candidate gene. The AOC4 gene is involved in the jasmonic acid (JA) synthesis pathway. JA is the final product of this pathway and functions as a bioactive hormone that plays a central role as a signaling molecule in plant defense against herbivorous insects. AOC4 was confirmed to show a constitutive high expression level in RHT in contrast to susceptible rice TN1 and thus should be considered as an important candidate gene. This study provides valuable information for cloning, functional analysis and marker-assisted breeding of BPH resistance genes.

Keywords: *Oryza sativa*; Brown plnathopper; Rathu Heenati; Microarray; *Bph3*.

H-8

Elucidation of the elicitor made Japanese Rice plant (Oryza sativa L.) induce ovicidal substance, benzyl benzoate in the Sogatella furcifera(HORVÁTH)

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Abstract: Some Japanese rice plant (Oryza sativa L.) varieties show resistance to the whitebacked planthopper (Sogatella furcifera HORVÁTH). The resistance is characterized by formation of watery lesions and production of ovicidal active compound, benzyl benzoate, in the case of female of S. furcifera lays egg in the Japonica rice plant varieties. This benzyl benzoate results in a high mortality to egg of S. furcifera and reduces to egg hatchability. Therefore, we have tried to elucidate this phenomenon.

Females of S. furcifera were extracted with 80% MeOH/H2O. When 20 females equivalent extract was applied to rice plant (Ver. Natsuhikari) after the plant was hurt by 50 of needles, the benzyl benzoate was produced with the formation of watery lesions. This result clearly showed that this resistance was induced by elicitor(s) in the females of S. furcifera. The active 80% MeOH/H2O extract was chromatographed on ODS open column and separated into 6 fractions; 100% H2O, 20% MeOH/H2O, 60% MeOH/H2O, 80% MeOH/H2O, 100% MeOH, 100% EtOH. Of these 6 fractions, 100% MeOH and 100% EtOH fractions evidently induced benzyl benzoate at 43.95 μg/g of fresh rice plant (frp) and 31.04 μg/g frp, respectively. The active 100% MeOH fraction was further separated by reverse phased HPLC into fractions from A to E. The bioassay reveled the activities of each fraction (A fraction: 1.58 μg/g frp, B fraction: 5.19 μg/g frp, C fraction: 22.25 μg/g frp, D fraction: 6.21 μg/g frp, E fraction: 14.64 μg/g frp.). Most active C fraction was separated from C-1 to C-3 and each fraction was evaluated by the bioassay (C–1 fraction: 2.46 μg/g frp, C-2 fraction: 5.97 μg/g frp, and C-3 fraction 4.19 μg/g frp.). C-2 fraction was further divided 4 fractions (C-2–1 fraction: 2.81 μg/g frp, C-2-2 fraction: 4.38 μg/g frp, C-2-3 fraction: 5.45 μg/g frp., C-2-4 fraction: 3.21 μg/g frp.) by HPLC.

C-2-3 fraction consists in only one compound (compound A) and this compound was submitted to analyses by using NMR and GC- and LC-MS in order to elucidate the structure. As a result, the structure is confirmed as 1, 2-dilinoleoyl phosphatidylcholine. 3.60 μg of the compound are contained in 20 females and 3.61 μg of 1, 2-dilinoleoyl phosphatidylcholine induced rice plant to produce 3.74 μg/g frp. of benzyl benzoate

Key Words: Sogatella furcifera， benzyl benzoate， 1, 2-dilinoleoyl phosphatidycholine， ovicidal compound， elicitor

H-9

Defense substances in the latex of mulberry tree and other Moraceae plants-The key factors that determine mulberry-silkworm relationship

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Abstract: Since sericulture originated in China more than 4,000 years ago, mulberry-silkworm relationship has always been one of the best known plant-insect relationships to the mankind. The toxicities and defensive activities of mulberry leaves against herbivorous insects, however, have been neglected. We recently found that mulberry leaves are toxic to caterpillars other than B. mori, (such as Samia ricini and Mamestra brassicae), due to the ingredients of latex that exudes from damaged leaf veins[1]. Mulberry (M. australis) latex contained high concentrations of toxic alkaloidal sugar-mimic glycosidase inhibitors such as 1,4-dideoxy-1,4-imino-D-arabinitol (D-AB1) and 1-deoxy nojirimycin (DNJ), and their concentrations, altogether, in latex reached 1.5-2.5% (8-18% to dry weight) in several mulberry varieties.

Further, the latex contained a novel defense protein MLX56 (MW 56kDa, 394 amino acids) with two hevein-like chitin-binding domains and an extensin domain[2]. It showed growth inhibitory effects on caterpillars at low concentrations (0.01-0.02 % to wet diet).

Sugar-mimic alkaloids showed toxicities to generalists such as S. ricini, but not at all to B. mori, a mulberry specialist[1,3]. In S. ricini, sucrose absorption, and trehalose metabolism, are inhibited by sugar-mimic alkaloids, but not at all in B. mori. In S. ricini, sucrase and trehalase activities were inhibited by low concentrations of D-AB1 and DNJ (IC50s of D-AB1: 0.9 m M and 5.5 m M, respectively for midgut sucrase and muscle trehalase), but in B. mori, these enzymes were not inhibited even at high concentrations (IC50s: >1000 m M and 160 m M, respectively)[3], which shows that B. mori, has developed enzymatic adaptations to mulberry defense. Similarly, MLX56 did not show toxicity to B. mori[2], suggesting that the mulberry specialist developed adaptation also to MLX56.

This study shows, for the first time in the long history of sericulture, the existence of strong latex-borne defense in mulberry trees, and gives a practical answer to mulberry-silkworm relationship.

Fig trees (Ficus spp., Moraceae) also exude latex that contains diverse defense substances. For example, F. virgata, ampelas, carica, and benjamina exude latex rich in cysteine protease that showed strong toxicity against caterpillars. Meanwhile, the latex of F. septica and benguetensis contained several highly toxic phenanthroindolizidine alkaloids (PIA) such as antofine.

Above results clearly show that diverse secondary metabolites and defense proteins in plant latex, which may have evolved through hostile relationships between plants and herbivores, play important roles in plant defense against insect herbivores and plant insect interaction in present ecosystem.

Key Words: Plant latex, Mulberry-Silkworm Interaction, Sugar-mimic alkaloids, MLX56, Defense protein, Cysteine potease, Phenanthroindolizidine alkaloids, Ficus, Morus, Bombyx mori, Moraceae

H-10

Multiple trophic interactions among organisms mediated by chemicals in agroecosystems

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Abstract: Plants and other sessile organisms are characterized by the production of a broad range of secondary metabolites (allelochemicals), which can be considered as chemical defense and signal compounds.

Insect damage and pathogen infection in many plants led to initiate a series of signal transduction processes, which in turn induced an array of defense genes to produce more compounds which can mount resistance against subsequent infection. These allelochemicals were also allelopathic to many neighbor competitors. The root exudates of Brassicaceae species strongly stimulated the hyphal growth of several ectomycorrhizal (ECM) fungi. Isothiocyanates and other related compounds degraded from indole GLSs are responsible for growth stimulation of ECM fungi. Polyphagous herbivores encounter numerous allelochemicals in their many host plants. Certain plant allelochemicals (e.g. coumarin and flavone) alleviated toxicity of co-occurring compounds and insecticides to insects by inducing detoxification systems, including cytochrome P450 monooxygenases (P450s), which can metabolize a broad range of substances. Ecological significances of xenobiotic resistance induced by plant allelochemicals will be discussed. These results suggest that allelochemicals in plants mediate multiple interactions among various organisms in agroecosystems. Appropriate manipulation of plant allelochemicals may provide a promising approach to reduce human dependency on synthetic chemicals.

Keywords: Allelochemicals, ecological function, species interactions, allelopathy, agroecosystem

H-11

Attraction of female and male Oriental fruit flies to conspecific males and mating competition following consumption of zingerone and ethyl vanillate

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Abstract: Floral volatiles containing methyl eugenol, raspberry ketone or zingerone (Z) are known to modulate interactions between *Bulbophyllum* orchids and *Bactrocera* fruit flies. Recently, flowers of *Bulbophyllum elevatopunctatum* containing ethyl vanillate (EV) as one of the volatile component, was observed to attract fruit flies, which then probe on floral lip, petals and sepals. But the effects of consumption of the floral chemical on the behavioural ecology of the fruit fly are not known. We studied the attraction of virgin females and males of the Oriental fruit fly, *Bactrocera dorsalis,* to conspecific males fed with either Z or EV in a wind tunnel. Concomitant with decreasing light intensity, males fed with either Z or EV attracted significantly higher numbers of conspecific males and females during the courtship period at dusk. When groups of attractant-deprived, Z-and EV-fed males were released together into a large field cage containing virgin females, significantly higher numbers of the Z- and EV-fed males were caught *in copula* than the attractant-deprived males . This suggests that both Z and EV may act as precursors to the male pheromone that promotes the mating competitiveness.

Key Words: Bactrocera dorsalis, Bulbophyllum, Sex pheromone, Zingerone, Ethyl vanillate, Mating competition

H-12

Effect of pea and wheat mixing: a laboratory approach on aphid and related predator behaviors

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Abstract: Semiochemicals are involved in multitrophic interactions, affecting the behaviors of both the herbivores and the beneficial insects. Several volatile molecules are emitted by infested plants but also from the herbivores. In most of the study, volatile organic compounds of herbivore-plant associations were assessed on the entomophagous beneficials. Assessment of wheat and pea, not only healthy but also aphid infested plants in several combinations, on Harmonia axyridis, Episyrphus balteatus as well as Sitobion avenae was carried out in laboratory using behavioral observation. E. balteatus was tested using the Noldus Observer v. 5.0, which allows observed insect behavior to be subdivided into different stages. The frequencies of searching acceptance and oviposition of hoverfly were influenced by the combinations. In addition, the oviposition frequency of E. balteatus female was improved when related to the presence of pea in wheat plant. Dual choice tests using a two way olfactormeter revealed that odors from combinations of wheat and pea had limited effect on the preference of H. axyridis that the presence of pea did not induced a significant attractive effect. Apterae and alate Sitobion avenae were observed when presenting different kinds of dual choices. Healthy plants were preferred by S. avenae to empty control. Also, the presence of conspecific on wheat proposed plant did not provide any more attraction to tested S. avenae alate. The presence of Acyrthosiphon pisum infested pea induced a significant repulsive effect on S. avenae. Our focal-insect observations were consistent with results from wheat-pea intercropping in field and suggested that short-term, behavioral studies may help predict the occurrence of aphids and its natural enemies at larger spatial and temporal scales. These results were discussed to promote intercropping and aphid control in further field experiments including the effect on beneficials in a push-pull approach by attracting the beneficial and repelling aphid pests.

Key Words: wheat, pea, Sitobion avenae, Harmonia axyridis, Episyrphus balteatus, behavioral observation

H-13

Transcriptional analysis of *Arabidopsis thaliana* defensive response to Lima bean volatiles

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Abstract: Plants are not only defensively responsive to direct feeding by herbivorous insects, but can also be prepared or primed by herbivore-induced plant volatiles (HIPVs) even before the attack occurs. However, the mechanisms underlying these defensive responses are not clear. We firstly used the Affymetrix ATH1 genome array to examine gene expression patterns of *Arabidopsis thaliana* in feeding-induced and HIPV primed states. The results showed that *A. thaliana* was able to receive and respond to leafminer-induced volatiles from Lima bean through up-regulation of genes related to ethylene (ET) and jasmonic acid (JA) pathways. Further experiments using either *A. thaliana* ET mutant *ein2-1* or JA mutant *coi1-2* indicated that both pathways were involved in the priming process, but the ET pathway was indispensable in detecting the priming volatiles. Furthermore, a transcriptional comparison showed that responses of plant to larval feeding were not a simple magnification of the priming effects. Finally, (*Z*)-3-hexen-ol, ocimene, DMNT, and TMTT caused responses in *A. thaliana* similar to the entire suite of Lima bean volatiles both after 24h and 48h. Our data gives a further understanding of the mechanisms and evolutional meaning of plant-plant communication.

Keywords: Plant-plant Communication, Leafminer, Direct defense, Microarray, Ethylene, Priming.

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H-14

Ferula assafoetida essential oil disrupts some reproductive behavior of the carob moth, *Ectomyelois ceratoniae* under field and laboratory conditions.

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Abstract: Using organic compounds such as plant essential oils has been interested in IPM due to adverse effects of chemical pesticides and their environmental issues. In the present study, effect of *F. assafoetida* essential oil was investigated on some reproductive behavior of *E. ceratoniae* (Lep.: Pyralidae), a polyphagus insect pest worldwide and the major pest in pomegranate orchards in Iran. Three treatments were used: essential oil solution, solvent, and control to see if the oil affects pheromone trap efficiency. In the traps natural sex pheromone (calling female) with one of treatments was used. Three similar pomegranate orchards in Meybod (Yazd Province, Iran) were the site of experiments. Data analysis revealed significant lower capture in the trap with essential oil than those in the control ($p< 0.001$). Also calling behavior of one-day old females was observed in laboratory conditions with and without oil treatments. Data analysis indicated that essential oil affected onset time of calling ($p<0.001$) and percentage of calling females ($p<0.001$). In addition, male searching behavior was studied in wind tunnel. Orientation and upwind flying to the source significantly reduced in the presence of essential oil compared with control ($p<0.001$).

Key Words: essential oil, sex pheromone, wind tunnel

H-15

Competition relationship of allelopathic rice and barnyardgrass in rice/barnyardgrass mixed culture system

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Abstract: In order to explore the competition relationship of allelopathic rice and barnyardgrass, allelopathic rice accession PI312777 and non-allelopathic rice accession Lemont were mixed culture with barnyardgrass (Echinochloa crus-galli L. Beauv) respectively, at the rice: weed ratio of 1:1 (20 rice seedlings with 20 barnyardgrass seedlings) in hydroponic. Absolute Competitive Intensity (ACI), Relative Competitive Intensity (RCI), and Relative Neighbor Effect (RNE) were calculated for the root length, plant height and plant dry weight of two rice accessions and barnyardgrass, to evaluate their competition intensity. The results showed that ACI, RCI, and RNE were all positive values for PI312777 and were all negative values for Lemont, indicating that barnyardgrass showed stimulative effect for PI312777 and inhibitory effect for Lemont in rice/barnyardgrass mixed culture system. All ACI, RCI, and RNE of barnyardgrass mixed culture with two rice accessions were positive values, showing inhibitory effect of rice on barnyardgrass. However, the inhibitory effect of PI312777 on root length, plant height and plant dry weight of barnyardgrass were 2-fold, 2.5-fold and 2-fold than that of Lemont. These results suggested that the higher competition potential of PI312777 was derived from its allelopathic trait, which could possible become a useful component of IWM systems in rice production.

Key Word: Rice (Oryza sativa L.), Barnyardgrass, Allelopathy, Competitive intensity

H-16

The smell of death: Pollination biology and floral scent of *R. cantleyi* (Rafflesiaceae) in Malaysia

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Abstract: Flowers that attract carrion and dung flies (sapromyiophilous flowers) have evolved in many angiosperm families. Most plants associated with carrion flies as pollinators emit a foul-smelling stench and it has been shown in several studies that the chemical compounds emitted by the flowers are the same cues that are normally used by flies to locate carrion or dung. However, investigations of the chemical composition of the scent of sapromyiophilous flowers indicate that there may be a number of different chemical strategies including mimicry of carrion (characterized by high content of oligosulphides), mimicry of faeces (characterized by emission of p-cresol, phenol and skatole) and mimicry of urine (various acids). We investigated the floral scent composition of *Raffflesia cantleyi* in Malaysia via dynamic headspace and thermo-desorption/GC-MS. A total of 18 compounds were identified including aliphatic compounds (4), monoterpenes (5), sulphur containing compounds (2), and benzenoids (7). However, many of the compounds were found only in small relative amounts and the scent of *R. cantleyi* was clearly dominated by the sulphur containing compounds DMDS (dimethyl disulphide) and DMTS (dimethyl trisulphide). The relative amounts of DMDS and DMTS in the floral bouquet of flowers in full bloom accounted for more than 85%. Our findings suggest that the scent of *R. cantleyi* mimics carrion or carnivore faeces. At least seven insect orders were found to associate with *Rafflesia*; with more than 80% were the dipterans from 17 families. Of all the five species of calliphorid flies caught, only *Chrysomya chani* was found to bear the pollen of *Rafflesia cantleyi.*

Key words: Rafflesia, sapromyiophily, Calliphoridae, dimethyl disulphide, dimethyl trisulphide

H-17

Effects of different sunlight intensities on the constitutive resistances of *Larix gmelinii*

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Abstract: Dahurian larch, *Larix gmelinii*, is one of the main timber species in northeast China with the characters of cold hardiness, drought resistance and fast growing. Gypsy moth, *Lymantria dispar*, is an important defoliator to dahurian larch. The constitutive resistances of forests play an important role to against the pest damage. In order to understand the impact of sunlight on dahurian larch constitutive resistances, sunlight control treatment with three intensities，natural sunlight CK, 50% and 25% of natural sunlight, was conducted to simulate the light conditions where larch grow. It was achieved by building shade shelters covered by woven black nylon nets. The activities of the primary defense protein in the needles of larch seedlings under different light conditions were analyzed. The results showed that the activities of POD, SOD, PAL, PPO and CI under 50% and 25% of natural sunlight were significantly ($P<0.05$) higher than CK. The activities of POD and CI reached a peak value under 50% of natural sunlight. The activities of SOD, PAL and PPO reached a peak value under 25% of natural sunlight. The CAT activities were significantly ($P<0.05$) lower than CK. The activities of TI were significant ($P<0.05$) differences under the different light treatments ($P<0.05$). We also analyzed the activities of detoxification and protective enzymes in gypsy moth larvae to probe into sunlight intensity impacts on the ability of the larvae detoxification. The fourth instar larvae fed 7 days and fifth instar larvae fed 11 days on the seedlings under different sunlight intensities. The activities of ACP, AKP, CarE, GSTs, CAT and POD of the larvae were significantly ($P<0.05$) inhibited under shading condition. However, the activities of SOD was significantly ($P<0.05$) higher than CK. The larval development was restricted which reflected in the less weight, lower survival rate and pupal less weight. Studies have shown that there were more accumulations of the primary metabolisms carbohydrate, protein and amino acids which is the essential substances for the insect growth under adequate light conditions. Therefore in this research, probably because the shading weakened larch photosynthesis and primary metabolism while enhanced the secondary metabolism, and result in larch lower palatability. Maybe this could explain to some extent why more serious insect pest damages occur under adequate light and drought conditions.

Keywords: sunlight intensity; defense protain; *Lymantria dispar*; *Larix gmelinii*

H-18

Sex-related larval susceptibility of diamondback moth, Plutella xylostella (Lepidoptera: Plutellidae) to some reduced-risk insecticides

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Abstract: Five reduced-risk insecticides were compared for their toxicities to male and female third instar larvae of diamondback moth, Plutella xylostella (L.) (Lepidoptera: Plutellidae) obtained from a laboratory colony. Leaf-dip bioassays were used to assess larval mortality at different insecticides rates (ranging from 0.01mg [AI] / liter to 100 mg [AI]/ liter) and exposure times (24, 48 and 72 h after treatment). Toxicity of the insecticides generally increased with rate and exposure time. At 72 h after treatment, median lethal concentrations (LC50s) of methoxyfenozide, spinosad, novaluron, indoxacarb and Bacillus thuringiensis (Bt) against the male third instar larvae of P. xylostella were 0.0524, 0.1117, 0.9149, 1.1939 and 4.4983 mg [AI]/liter, respectively, and were 0.1008, 0.2583, 1.0649, 0.285 and 5.3053 mg [AI/] liter against female third instar larvae, respectively. At one-thousandth of the approximate recommended field rates, methoxyfenozide (60-75%) and spinosad (53-57%) were the most toxic, while Bt (30-45% mortality) was the least toxic to male and female P. xylostella larvae. Spinosad was the fastest acting and the only insecticide that caused significant larval mortality (17%) at 24 h after exposure. Significant sexual differences were recorded in the susceptibility of P. xylostella larvae to two of the insecticides: spinosad and indoxacarb. Male larvae were ~ two-fold more susceptible to spinosad but ~ 10-fold more tolerant to indoxacarb than female larvae.

Key Words: Diamondback moth, Plutella xylostella, insecticides, toxicity, susceptibility

H-19

Volatile Organic Compounds (VOCs) of Eucalyptus benthamii before and after herbivory by Thaumastocoris peregrinus (Hemiptera, Thaumastocoridae) influence the preference of females

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Abstract: It has been demonstrated that plants respond to insect herbivory by synthesizing and releasing volatile organic compounds (VOCs). The VOCs released by Eucalyptus when attacked by herbivores are unknown. The objective of this study was to compare the VOCs released by young Eucalyptus benthamii plants before and after the herbivory of Thaumastocoris peregrinus, and after mechanical damage, and to verify the difference in the VOCs released by infested plants during photophase and scotophase. We tested three treatments: herbivory (H); mechanical damage (MD); and photoperiod emission (Pho). Ten males, after feeding for 24h, were removed from the aeration chambers, and the collection of volatiles initiated for a period of 5 (H and MD) or 4 days (Pho). For MD, an E. benthamii leaf was cut in half before aeration. VOCs extractions were made with 200uL of hexane every 24h (H and MD) or 12h (Pho), and analyzed immediately by GC-MS and GC-FTIR spectrometers. The mean quantity of VOCs released was calculated (in ng) based on 3 repetitions for all treatments. Y olfactometer bioassays were performed with control and 24h herbivory plant extracts. Statistics for the bioassays were performed with Binomial Test in BioEstat 3.0. The VOCs released by the E. benthamii plants are mainly monoterpenes and sesquiterpenes. Three major compounds were released after herbivory: α-pinene (1), aromadendrene (11), and viridiflorol (18). α-pinene is the main compound and ranged from 14.5 ng ± 22.46 to 180.58 ng ± 17.83 in H. Seven compounds are generally found in H (2, 6, 9, 10, 12, 13, 19), and two others are released specifically in very low quantities by control plants and MD (compounds 5 and 16). In MD, the amount of α-pinene increased. However, it was still lower than in H, as occurred with other compounds. In Pho, monoterpenes 7, 10 and 12 were released only in scotophase. The other compounds had minor differences between treatments, except for the compound 9, over 15 times in scotophase the amount of photophase. Bioassays revealed that mated females prefer the control extract (undamaged plant) (p-value= 0.019), when compared with 24h herbivory extract. Supporting this result, the essential oil of different species of Eucalyptus is considered a natural pesticide, and could be influencing the preference for the healthy plants.

Key Words: Thaumastocoris peregrinus, VOCs, Herbivory

H-20

Effect of volatiles from health and herbivore-damaged red pine day or night on the behavioral selection of *Dioryctria* spp. and parasitoid *Macrocentrus* sp.

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Abstract: *Dioryctria abietella* (DA) and *D. sylvestrella* (DS) are close relative species in the same genus, both damage cones of red pine, *Pinus koraiensis* concomitantly, with quite different biological and ecological behaviors. DA larvae only feed in cone, while DS larvae feed transpositively between cone and tip. The moths are active at night, and most oviposit in June.The former oviposit on cone, the later oviposit on cone or current year tip. *Macrocentrus* sp. (MS) parasitize in larvae of DA and DS species, and active in the day. This research focus on three questions: 1) Bioassayed the day-night behavioral response of the moth and parasitoid to cone, tip and branch from healthy or larvae damaged red pines with Y tube. 2) The profiles of volatiles released from the cone, tip and branch in day and night were analyzed using GC-MS for investigating which volatile compounds released from host pines regulated behavioral responses of moth and wasps. 3) Tested electroantennogram and bioassayed behavioral responses of DA, DS and MS to different concentrations of single volatiles. Bioassay suggested that virgin female, mated female and male moths of DA and DS tended to healthy cone and tip volatiles released at night. In addition, virgin and mated female of DS also susceptible to larvae damaged cone at night. Male and female parasitic wasps tended to damaged cone and tip volatiles released in day. The volatile components and contents had significant differences between healthy and pest damaged pine released in day and night. The variations of terpenes released from three parts of healthy and pest damaged pine presented diel differences. These volatiles attracted parasitic wasps in day, and were more effective on the moth oviposition behavior at night.

The males, virgin and mated females of DA and DS were attracted by proper concentration of S-α-pinene, ocimene and 3-carene, and then high-concentration ocimene repulsed the mated females of DS. Camphene volatilized form the cones fed significantly increased at night. The cones fed attracted female DS and repelled female DA. We proposed that camphene would play an important role in larva induction host sensitivity, effecting on the behavior response of moths. *D*-limonene volatilize from the lateral branches only, and repelled the females of DA and DS. This repelled function would be an important reason for the ovipositional moths evading the lateral branchs. *R*-α-pinene had no bioactivity to host selective behavior of the moths, but attracted both of the male and female parasitoids. We can conclude that bioactive single terpenes play important roles on the three trophic relationship regulation of host plant red pine-herbivore DA and DS-parasite MS.

Keyword: *Pinus koraiensis*; volatiles; *Dioryctria abietella*; *D. sylvestrella*; *Macrocentrus* sp.; behavioral response; chemical analysis

H-21

Cloning and Expression of Allene Oxide Cyclase Gene from Tea Plant

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Abstract: Allene Oxide Cyclase is an important enzyme and plays a essential regulatory role in the biosynthesis pathway of jasmonate. It catalyze the stereospecific cyclization of unstable allene oxide to (9S,13S)-12 oxo-(10,15Z)-phytodienoic acid. Degenerate primers were designed based on the conservative AOC gene sequence of other plants in the GenBank to clone the full-length cDNA of AOC genes of the tea plant by using the RACE and RT-PCR methods. It is deposited to the GenBank (Accession NO.HQ889679). The tea plant AOC gene cDNA is 916 bp in length, encoding 245 amino acids, the putative molecular weight is 26.5kD and the *pI* is 9.0. Prokaryotic expression recombinant vector, pET32a(+)/AOC, was successfully constructed. SDS-PAGE assay showed that the target was highly expressed in BL21(DE3) and the molecular weight of fusion protein was similar to the predicted molecular weight. It indicated that *Cs*AOC was expressed correctly in BL21(DE3).

Keywords: tea plant (*Camellia sinensis*), AOC, gene cloning, prokaryotic expression

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H-22

Pyrichalasin H and chlorosis-inducing toxin from Pyricularia isolates

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Abstract: Pyricularia isolates are causal agents of blast disease of gramineous plants. Especially, rice blast is one of diseases influence on food supply of the world. Pyricularia isolates consist of several host-specific subgroups. Each of these subgroups produces typical blast lesion on the original host plant, but not on other plants. For example Oryza isolates from rice (Oryza sativa) produced blast lesions on rice, but not on foxtail millet, common millet and crabgrass. Pyricularia isolates might produce active factors such as host-specific toxins Pyrichalasin H has been isolated from a Pyricularia isolate on crabgrass (Digitaria sanguinalis). We examined the production of pyrichalasin H in Pyricularia isolates from various gramineous host plants and the ability of their isolates to infect Digitaria plants. There is a correlation between pyrichalsin H production and the ability of a Pyricularia isolate to infect Digitaria plants. We consider that pyrichalasin H might be responsible for the specific pathogenicity of a Pyricularia isolate toward the Digitaria genus.

We found that acetone extract of fungal culture from an Avena isolate (Br58) of Pyricularia oryzae had chrosis-inducing activity on oat leaf segments. Acetone extract was evaporated to obtain an aqueous fraction, which was extracted with ethyl acetate. The ethyl acetate extract was chromatographed by stepwise gradient elution (chloroform-MeOH). The active fraction was purified by HPLC. The active compound is named Mag-toxin. The molecular weight of Mag-toxin was estimated to be 294 by LC/MS. We show that Mag-toxin was the oxidized C18 unsaturated fatty acid by NMR. The induction of chlorosis was observed on the segments after 36 h of the toxin treatment with 250 μg/ml. Chlorosis was induced by Mag-toxin in the light but not in the dark. Reactive oxygen species (ROS) could be visualized with 2',7'-dichlorofluorescein diacetate (H2DCF-DA) after 1h of toxin treatment. Cell death was detected with FDA after 2h of the toxin treatment. Next, segments treated with Mag-toxin were double-labeled with H2DCF-DA and Mito Tracker Red and were observed by fluorescence microscope. The autofluorescence of chlorophyll in chloroplasts of oat cells was also observed. ROS generation in oat cells were consistent with mitochondria but not with chloroplasts. Interestingly, their induction was light-independent.

Key Words: Pyricularia, oat, chlorosis, ROS, pathogenicity

I-1

Perception of filamentous structure of plumes; effects of air flow on spatial heterogeneity of odorants

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Abstract: Air swirls and eddies as it moves through natural environments. These air movements, influenced by the interaction of the air with physical objects such as vegetation, generate spatially-complex odorant plume structures. In order to evaluate the potential of these spatially-heterogeneous odorant plumes to influence orientation, it is helpful to consider how long the heterogeneity will be maintained before it dissipates due to diffusion of the odorant molecules. The heterogeneity will dissipate more rapidly if the chemical gradients are steep within the odorant plume, which will occur with a finer filamentous structure. The physical structure of a chemosensory organ, such as an insect antenna, will also perturb the air flow and therefore influence the spatial structure of the odorant plume during sampling or chemoreception by that antenna. Pectinate or feathery antennae have high resistance to air flow, and will sample only a small fraction of the approaching air, while most of the air will be diverted around the antenna. This divergence of the streamlines will cause a distortion of the air in the plane perpendicular to air flow, with a stretching or magnification of the spatial pattern of the odorants. The way in which a cylindrical or filamentous antenna will sample the odorant plume will depend on its geometry, its orientation relative to the air, and the speed with which it moves relative to the air. Depending on these factors, the air may either flow across a filamentous antenna at a right angle relative to its long axis, or flow parallel to its long axis, changing the pattern of exposure of the sensory hairs arrayed on the antenna to the odorant plume.

Key Words: Airflow, odorant, chemosensory

I-2

Identification and Characterization of A Novel Chemosensory Protein from *Locusta migratoria*

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Abstract: Insects have evolved their procession chemical communication systems. With this important system they locate foods, predators, partners, adapt to environments, and keep their populations. There are several kinds of molecules in the peri-chemoreception system of insect, Odorant binding proteins, odorant receptors and chemosensory proteins. Chemosensory proteins (CSPs) were a class of small acidic soluble proteins widely expressed in insect at high concentration and were believed to be involved in chemical communication through transporting hydrophobic chemicals. More than 70 CSPs have been identified in *L. migratoria*, belong to 2 classes, *Lmig*CSPI and *Lmig*CSPII. None was however functionally determined.
Here we first report a novel chemosensory protein, *Lmig*CSPIII in *L. migratoria*. To determine its function, we firstly detected the expression profile in different tissue at different developmental stages. The result indicated that CSPIII is widely expressed in antennae、 tarsi and mouthparts of the adults and the 5th instars nymph. Then we performed fluorescent competitive binding assay to assess its ligand-binding specificity with 70 semiochemicals. the binding assay demonstrated that a-Amylcinnamaldehyde、1-AMA and oleamide showed the strongest binding capacity. Interestingly, oleamide is a compound extracted from locust body, we believe it is one of native ligands for this CSP. Additionally, esters have better binding capacity than other kinds of compounds. Together, this CSP has relative binding specificity.

Key words: Chemosensory protein, expression, binding ability, native ligand, locust

I-3

Ultrastructural characterization of olfactory sensilla and immunolocalization of odorant-binding and chemosensory proteins from an ectoparasitoid Scleroderma guani (Hymenoptera: Bethylidae)

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Abstract: The ant-like bethylid wasp Scleroderma guani (Hymenoptera: Bethylidae) is a generalist ectoparasitoid of wood-boring insects. Indigenous to China, this polyphagous parasitoid can attack more than 50 insect species across 22 families among three orders. S. guani has been widely adopted as a biocontrol agent in China to control longhorned beetles such as Japanese pine sawyer beetle, Monochamus alternatus Hope (Coleoptera: Cerambycidae). Parasitic hymenopterans are typically equipped with specialized sensory organs such as antennal sensilla to facilitate their biological functions. To better understand the chemical communication of these potential biological control agents, we observed the antennal sensilla types in S. guani and compared them with 19 other parasitic hymenopterans. There are 11 types of sensilla in the flagellum and pedicel segments of antennae in both male and female wasps. Seven of them, including sensilla placodea (SP), long sensilla basiconica (LSB), sensilla coeloconica (SC), two types of double-walled wall pore sensilla (DWPS-I and DWPS-II), and two types of sensilla trichodea (ST-I and ST-II),are multiporous chemosensilla. The ultralsturctures of these sensilla are morphologically characterized. In comparison to monophagous specialists, the highly polyphagous generalist ectoparasitoids such as S. guani equip with more diverse sensilla types due to their broad host ranges and complex life styles. Immunocytochemistry study demonstrated that each of the seven sensilla immunoreacts with at least one antiserum against SguaOBP1, OBP2, and CSP1, respectively. Anti-OBP2 is specifically labeled in DWPS-II, whereas the anti-OBP1 shows a broad spectrum of immunoactivity toward four different sensilla (LSB, SP, ST-I and ST-II). On the other hand, anti-CSP1 is immunoactive toward SP, DWPS-I and SC. Interestingly, a cross co-localization pattern between SguaOBP1 and CSP1 is documented for the first time. Given the fact that the numbers of OBPs and CSPs in many insect species greatly outnumber their antennal sensilla types, it is germane to suggest such phenomenon could be the rule rather than the exception.

Key Words: Scleroderma guani, Odorant-binding Protein, Chemosensory Protein, Sensilla, Immunolocalization

I-4

Isolation and Sequence Analysis of cDNA Clones Coding for Odorant Binding Protein, OBP3 and Olfactory Behavior Analysis in *Drepanosiphum platanoidis*

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Abstract: ApisOBP3 from *Acyrthosiphum pisum* was known as its affinity to EBF, and the volatile substances released by *Drepanosiphum platanoidis* contains no E-β-farnesene (EBF) which is a conventional component secreted by most of aphids, whereas two odorant binding proteins named as DplaOBP3-1 and DplaOBP3-2 share high identities (95.8％ and 98.32%, respectively) with ApisOBP3 were identified in *D. platanoidis*. The lengths of both coding sequences of *DplaOBP3-1* and *DplaOBP3-2* are 426bp, and 69bp of which code for signal peptide at the 5' end. DplaOBP3-1, DplaOBP3-2 and ApisOBP3 share 6 highly conserved cysteines residues in the same position among sequences. Based on the 3D structure of LmadPBP, a pheromone binding protein, from cockroach *Leucophaea maderae*, we have modeled the structures of DplaOBP3-1 and DplaOBP3-2, all five hydrophobic amino acids and the aromatic amino acid residue, Tyr84, located in the binding cavity probably participating in interacting with ligands have their counterparts in the structure of ApisOBP3. Further, four-arm olfactometer assay showed that *D. platanoidis* were significantly repelled by both EBF and crushed aphids（P=0.01）. Here, we report that volatile product from crushed bodies could be intraspecies alarm pheromone in *D. platanoidis*; *D. platanoidis* are repelled by allogenetic EBF whereas they never release EBF.

Key words: *Drepanosiphum platanoidis*; odorant binding protein; alarm pheromone; E-β-farnesene (EBF); cDNA cloning; four-arm olfactometer

I-5

Comparative Studies of Pheromone Perception in Two Sibling Moth Spodoptera exigua and S. litura

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Abstract: The beet armyworm Spodoptera exigua and the common cutworm S. litura，two notorious pests of various agricultural crops, are sibling species and sympatric in many parts of China and other Asian countries. The sex pheromone comprise of Z9,E12-14:Ac, Z9-14:OH, Z9-14:Ac and Z9,E12-14:OH for S. exigua, and Z9,E11-14:Ac, Z9,E12-14:Ac, Z9-14:Ac and E11-14:Ac for S. litura. Although two species employ structurally similar pheromone components and share two of the components, they are well reproductively isolated in field conditions. Therefore, it would be very interesting to compare differences in pheromone perception between the two species. Focusing on the pheromone binding proteins (PBP), the folowing works have been done in the two species. 1) cloning and analyses of cDNAs and gDNAs of 3 pheromone binding proteins (PBP) from each species; 2) expression patterns and relative expression levels of PBPs in two species; and 3) functional studies of these PBPs by using binding assay and RNAi approaches. Beside of PBPs, olfactory receptor proteins (OR) and pheromone degrading enzymes (PDE) from these two species were also studied on some aspects. The results would be helpful for the elucidation of mechanisms underlying the pheromone perception of and the reproductive isolation between these two moths. It would be also helpful for the development of new pest control techniques based on the manupulation of insect olfaction.

Key Words: pheromone perception, pheromone binding protein, olfactory receptor, pheromone degrading enzyme

I-6

The Importance of Pheromone Flux and Blend Ratio Reporting In the Upwind Flight Orientation Responses of Moths

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Abstract: We have learned over decades of research on male moth responses to sex pheromone that it is the pheromone blend to which males have the lowest threshold for initiating and sustaining upwind flight behavior. Thus, fidelity of blend ratio reporting from the olfactory receptor neurons (ORNs) to the antennal lobe is of primary importance to pheromone communication. Given the exquisite sensitivity that has been selected for in the huge numbers of male moth ORNs, a puzzling and perplexing question has persisted over the decades. Why, in several large groups such as noctuids is the greatest proportion of ORNs tuned to the most abundant pheromone component in a species' sex pheromone blend? A second, unresolved question exists for other moth families such as tortricid, pyralid, saturniid, and yponomeutid moths in which two or more pheromone-component-tuned ORNs are co-compartmentalized in the same sensillum. Why does the ORN tuned to the most abundant pheromone component in the blend produce a larger amplitude action potential than the ORN tuned to the minor component and apparently have a larger diameter dendrite? Is this somehow related to sensitivity of detection, and if so, why would the dendrite having the greater surface area for accommodating multitudes of ORs be the one that is tuned to the most abundant component and not to the trace component? We are proposing that the answer to both questions involves evolutionary adjustments that have had to be made by major pheromone-component-sensitive sensilla-ORN units to accurately transduce the more widely differing ranges of molecular flux occurring in the plume-strands of their species' pheromone blend.

Flux involves a time component, e.g., "molecules per second", and for reporting changes in flux, a flux detector should not allow the system to come into equilibrium but rather should continually return the baseline to its original set-point by clearing out odorant molecules quickly. This will allow for rapid registration and reporting of widely varying flux in each newly encountered strand of pheromone and the clean-air pockets between strands. The molecules of all the pheromone blend components contained in each plume-strand rush over the antenna relative to the insect's airspeed as the insect flies upwind. However, the major component is often present in 10 or 100 times the amount of the minor components and the blend-strands can vary from very high to very low concentration depending on the degree to which they have been shredded by micro-turbulence. Therefore, the upwind flight system that depends on precise pheromone component blend ratios must be able to receive accurate reports about the molecular abundance ratios that are present in each strand, and this is accomplished via the differing ranges of molecular flux transduction that has been selected for in differentially tuned ORNs.

Key Words: sex pheromone olfaction, upwind flight behavior, molecular flux, blend ratio reporting

I-7

Distinct expression profiles and binding properties of odorant binding proteins in Nilaparvata lugens Stål

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Abstract: Odorant binding proteins (OBPs) play important roles in insect olfaction. The brown planthopper (BPH), Nilaparvata lugens, is one of the most important rice pests. Its monophagy (only feed on rice), wing-from (long and short wing) variation and annual long distance migration (for rice plants of high nutrition) imply that the olfaction would play a central role in BPH behavior. However, the olfaction related proteins were not addressed in this insect. In the present study, gene cloning, expression profile and binding property of OBPs in BPH were addressed. Full length cDNA of three OBPs were obtained and distinct expression profiles were revealed regarding to tissue, developmental stage, wing form and gender, providing important clues in functional differentiation of these genes. Binding assay of three NlugOBPs with 41 compounds demonstrated that NlugOBP3 had markedly wider binding spectrum than two other OBPs, and that Terpenes and Ketones displayed higher binding while Alkanes showed no binding to three OBPs. The results provide basis for the elucidation of the functions of these proteins and further the biochemistry and molecular mechanisms under olfaction in BPH.

Key Words: The brown planthopper, Olfaction, Wing form, Ligand binding

I-8

Biological Response of Adult Tribolium castaneum to Enantiomers of its Aggregative Pheromone

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Abstract: The red flour beetle, *Tribolium castaneum* (Coleoptera: Tenebrionidae), is a cosmopolitan pest of stored agricultural products worldwide. The pheromone 4,8-dimethyldecanal (DMD) released by feeding male contained four enantiomers and the relative ratio of four isomers (4*R*,8*R*): (4*R*,8*S*): (4*S*,8*R*): (4*S*,8*S*) at approximately 4:4:1:1. This paper reported that the biological response of adult *T. castaneum* to different blends of four enantiomers by a walking bioassay in a wind tunnel and electroantenngrams(EAG) with the four synthetic enantiomers. Compared with the commercial lure mixture, which is 1:1 (4*R*,8*R*) : (4*R*,8*S*), the blends that that mimics ratio that produced naturally by male, which is 4:4:1:1 (4*R*,8*R*): (4*R*,8*S*): (4*S*,8*R*): (4*S*,8*S*) –DMD could elicited the highest walking response of mix sex of *T. castaneum* in wind tunnel bioassay in each dose from 0.01ng to 100ng. The individual four enantiomers (4*R*,8*R*)-,(4*R*,8*S*)-, (4*S*,8*R*)-,: (4*S*,8*S*)- DMD induced significant difference behavior response compared with hexane solvent control and (4*R*, 8*R*) -DMD and commercial lure mixture had no significant difference behavior response at dose 100ng. The result of dose responses of *T. castaneum* indicated that the threshold of commercial lure was 10 ng. Compared with the mixture 4:1of (4R,8R)- and (4R.8S)- DMD, the blends mimicked commercial lure could elicit the significant difference walking response only at dose 50ng and the results confirmed that relative ratio of four enantiomers (4*R*,8*R*)-I: (4*R*,8*S*)-I: (4*S*,8*R*)-I: (4*S*,8*S*)-I of natural pheromone components at approximately 4:4:1:1 had highest bioassay response. EAG response to four individual enantiomers and their different blends confirmed that the blends mimicked natural pheromone components (mixture of 4:4:1:1 (4*R*,8*R*)-I: (4*R*,8*S*)-I: (4*S*,8*R*)-I: (4*S*,8*S*)-I) had no significantly different with that of eluate from Porapak-Q-collected volatiles from feeding males either at 0.1ng or at 1.0ng. The lab. strain GA-1, originally field-collected in Georgia, USA and the KS strain, originally field-collected in Kansas, USA had no significant differences in response to the 4:4:1:1 (4*R*,8*R*)-I: (4*R*,8*S*)-I: (4*S*,8*R*)-I: (4*S*,8*S*)-I synthetic blend and the natural volatiles collected on Porapak-Q from feeding males at 0.1ng.

Keywords: Walking bioassay, EAG response, Enantiomers, Aggregative pheromone, red flour beetle

I-9

Identification and field evaluation of pear fruit volatiles attractive to the oriental fruit moth, Cydia molesta (Lepidoptera: Tortricidae)

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Abstract: The oriental fruit moth Cydia molesta is an economically important pest of pear fruit in the late season. Attractiveness of pear fruit volatiles to adults of C. molesta was investigated in both laboratory and field. We identified and quantified volatiles from immature and mature fruits of 6 pear varieties by gas chromatography (GC)-mass spectrometry (MS) and GC-electroantennogram detection (EAD). Both wind tunnel bioassays and field trials were carried out for attraction of synthetic blends of all six varieties to the adults. Consistent EAG activity was obtained for 12 compounds from headspace collections of the matured fruits of the 6 varieties. Qualitative and quantitative differences were found among 6 odor profiles. In field experiments, all the 6 odor mixtures were attractive to adults. The eight-component mixture from the variety Jimi and the six-component mixture from the variety Huangjin were more attractive to the both sexes than the mixtures from other varieties. The number of males captured was higher than that of the females. The further fight-tunnel trials which involved pear fruits and rubber septa loaded with Huangjin and Jimi mimics revealed both males and females made upwind orientation flight and closed the source, but only males landed on the lures. Our finding indicates that odour mixtures of mature pear fruits play an important role in C. molesta host recognition. The mechanisms behind host recognition are different between sexes.

Key Words: Cydia molesta, pear, host plant volatiles, GC-EAD, field experiments, wind tunnel

I-10

Navigation of Moths and Mosquitoes along Wind-Borne Plumes of Odor

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Abstract: Flying insects find many kinds of resources by navigating along plumes of odor linked to these resources. The principal mechanism used in orientation is to head upwind (anemotaxis) when in contact with the plume, with the wind's direction being gauged by visual feedback. When an insect is headed due upwind, it experiences front-to-rear flow of its visual field; when the insect is headed at an angle to upwind, then it also experiences transverse image flow. Simply heading upwind, however, will not routinely bring the insect to the plume's source. Turbulence can generate large gaps in the continuity of the plume and the wind frequently shifts direction; both of these meteorological phenomena create challenges to plume tracking. In the case of male moths navigating along a pheromone plume from a female, the plume's fine-scale structure is important to maintenance of an upwind course, with encounters of pheromone filaments at rates >5 Hz promoting a more upwind heading. In the case of female mosquitoes orienting upwind along a plume of odor from prospective host, plume structure also influences orientation, but compared to the moth's signal, a plume from a vertebrate host is generally much larger and more complex in its spatial structure and chemical composition. Female Aedes aegypti, a highly anthropophilic mosquito, head upwind following a brief encounter with a single filament of carbon dioxide and continued upwind navigation along the plume is promoted by fluctuations in the intensity of carbon dioxide. Human skin odor also induces upwind flight, but a homogeneous rather than an intermittent plume structure is most apt to promote high levels of source location.

Key Words: Orientation, pheromone, odor, plume, moth, mosquito

J-1

More than Three Decades After the First Mating Disruption Registration: Major Successes with Reservoir Dispensers and Lessons Learned for Future Growth.

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Abstract: The potential of using sex pheromones to control insect pests was first demonstrated over 40 years ago. The first registration of a pheromone-mediated mating disruption product for control of an insect pest Pectinophora gossypiella occurred over 30 years ago. At the time, control with conventional insecticides was difficult and mating disruption became a successful alternative control. Now more than 30 years later, mating disruption technology is used worldwide to control many insect pests in both agriculture and forestry. The use of mating disruption technology to control Grapholita molesta and Cydia pomonella in fruit growing regions around the world are other acknowledged success stories and examples will be presented. The adoption of mating disruption technology has often been precipitated by crises, for example the loss of pest control due to resistance or the restrictions on insecticides. The incorporation of mating disruption technology into pest management systems especially when used in area-wide programs, was instrumental in end-users being able to re-establish control, harvest marketable crops and improve profitability. With the re-establishment of control, growers sometimes returned to a reliance on conventional insecticide control programs. However, environmental concerns and consumer preferences have led to increased regulatory and export restrictions resulting in the phase-out of many insecticides. Although new chemistries have been registered, these products are more expensive, difficult to use and often result in the outbreak of secondary pests. Together these factors have led to mating disruption technology becoming a standard practice in pest management systems around the world. The incorporation of mating disruption technology into pest management systems has led to improved control, less insecticide residues and increased natural enemy populations. Shin-Etsu Chemical Co., Ltd., Tokyo, Japan was one of the first commercial producers of pheromone active ingredient and mating disruption dispensers. Shin-Etsu has been the leader in the business and technology of mating disruption for more than a quarter of a century. Shin-Etsu products are dominant in every major market in about 30 countries including the United States, Canada, European Union, Argentina and Chile, South Africa, Australia, Japan and are now expanding into other Asian countries. Shin-Etsu products are viewed as the industry standards due to their consistent quality, technical superiority and performance. As environmental awareness increases and countries become increasingly interdependent on trade, the use of mating disruption products will become increasingly important. Shin-Etsu with its technical expertise, high quality products, experience and commitment to the industry will continue to lead the world in the business of mating disruption.

Key Words: Pheromone, mating disruption, pest management

J-2

Towards multi-species mating disruption in horticulture: advantages and pitfalls

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Abstract: Pheromone-mediated mating disruption (MD) is now a major tool of sustainable, effective and environmentally-friendly Integrated Pest Management (IPM) systems in Horticulture. Review of the literature indicated that in Australian orchards, hand-applied MD dispensers have been used successfully for long-term sustainable control of oriental fruit moth (OFM), codling moth (CM) and light brown apple moth (LBAM) for over 20 years. Initially the general approach was to treat individual orchard blocks and only known host-plant with MD for individual pest species. For example, Australian growers have generally associated OFM damage with stone fruit (mostly peaches and nectarines), and CM damage with pome fruit (mostly apples and pears). However, in the last 10 years OFM damage has become a serious problem on pome fruit, especially pears in Victoria. It is known that OFM damages apples in the USA and Canada, while in Chile and Argentina CM has expanded its host range to include stone fruit. These pests have the ability to migrate, quickly invade new host-plants and growers now need to cater for both OFM and CM together in their IPM strategies. Individually CM and OFM have been controlled successfully by MD, but treatment of pome fruit with two individual hand-applied dispensers for CM and OFM could be uneconomical for growers. The results of field trials conducted over three consecutive seasons consistently demonstrated that dual-species dispensers, designed to disrupt both CM and OFM, were as effective as single-species dispensers applied individually in pears for control of CM and OFM respectively. The dual and individual-species dispensers reduced moth catches and fruit damage to a similar degree. But combined control of both pests in pears by applying dual-species dispensers at the full-recommended rate of 500 dispensers per hectare will be more economical than use of individual species dispensers, since the price and application cost of dual dispenser is about half that for individual dispensers. Further research demonstrated that disruption of both CM and OFM male orientation to pheromone traps in plots treated with a dual-species dispenser, simultaneously releasing the pheromone components of both pests, was equivalent to that obtained by treating plots with separate formulations for each species through mid-season. However, disruption efficacy of the dual-species formulation was significantly lower near the end of the season for OFM compared with the MD dispenser because of depletion of active ingredients. Effective disruption of CM and OFM was also obtained with a multi-species formulation that releases the main pheromone components of both CM and OFM and several leaf roller species. The review of results provided evidence that simultaneous disruption of several species with a single formulation will be economically advantageous in regions where control of multiple pests is needed given the need for hand application of this technology. The review of further research demonstrated that similar principles could be applied for the mixtures of microencapsulated sprayable multi-species formulations. Pitfalls of MD for multi-species will also be discussed.

Key Words: mating disruption, oriental fruit moth, codling moth, multi-species

J-3

A successful story of applied chemical ecology: Rescue ® insect traps from Sterling International, Inc.

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Abstract: Sterling International, Inc. (SII) is one of the world's leading semiochemical-based companies, manufacturing the RESCUE!® brand attractants and traps for various filth flies, yellowjackets, paper wasps, hornets, Japanese and Oriental beetles, and recently the stink bugs for home and garden settings.

SII is a family own company and was founded in 1982. It occupies 150,000 ft2 of space in Spokane Industrial Park, WA, USA, which includes 8000 ft2 of R & D facilities. Our R & D department is a fully-equipped, top-level chemical ecology research laboratory, with one gas chromatography–electroantennographic detection (GC-EAD) system, three gas chromatography–mass spectrometers (GC-MS), two GC-FIDs, one liquid chromatography (LC), a Short Path Thermal Desorption system, and a newly obtained Electroretinogram (ERG) system. We also have a strong micro and scale-up chemical synthesis capacity, BSL-2 insectaries (environmental rooms and chambers), insect flight (wind) tunnel, walking bioassay apparatus, aeration sampling systems, UV crosslink system, polymer technology and control release measurement system. SII has a full-dimensional engineering and product development department, equipped with CAD capacities (such as AUTO-CAD; Solid Works) for three-dimensional design system, Z-corp printer and the latest Fused Deposition Modeling Technology (Stratasys FDM400MC) for pre-prototype development; CNC machines for making custom molds; and four plastic injection and thermoforming machines. RESCUE!® products are available in all major retailers in the U.S., such as Home Depot, Lowe’s, Wal-Mart, Costco, Ace Hardware, True Value Hardware etc., and they are distributed throughout Europe, Middle East, Central and South America, Canada, Australia and New Zealand. Our mission at SII is: “making pest control smarter®”.

Key Words: Semiochemical, insect trap, attractant, industry

J-4

Remote Detection and Reporting of Invasive Insect Species Using Satellite and Internet Communication

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Abstract: We have developed a system in which the detection of an invasive insect species can be reported from an appropriate sensor via a satellite modem and then conveyed to an operator via simple text message or email anywhere in the world. The system has been validated using a specially designed European gypsy moth pheromone trap and lure for proof of concept. The unique address of each trap in the world is provided by its GPS location chip. False positives are avoided by using acoustic verification of any insect entering the trap and tripping the sensor mechanism. The minute-to-minute reporting capability of this sensor system allows (the heretofore useless) information about diel periodicity of sex pheromone activity of the target species to be utilized in species discrimination to further reduce the incidence of false positives that might otherwise occur due to pheromone cross-attraction or acoustic ambiguity.

Key Words: satellite modem, acoustic verification, sex pheromone trap detection, remote sensing, false positives

J-5

Technical aspects in electroantennogram, GC-EAD and single cell recording in insect olfaction

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Abstract: Electrophysiological techniques such as electroantennogram (EAG), gas-chromatograph-linked EAG (GC-EAD) and single cell recording (SCR) have been useful in insect chemical communication research. In particular, GC-EAD has been a powerful tool to identify pheromones and other semiochemicals in a number of insects. While the basic principles of EAG and SCR remain unchanged significant technical improvements have been made in recent years, which made these techniques more accessible to many researchers. The major factors that may influence on the performance of GC-EAD or SCR include antennal preparation, electrodes, electromagnetic noise, amplifier, signal processing system, stimulus delivery system, and the stability of test compounds. Although measuring EAG responses is not technically difficult in many insects that have substantial size of antennae, it can be challenging for the insects with small antennae. The SCR typically requires a high resolution microscope and the highly stable precision control of electrode positions in order to register action potentials from individual sensory neurons. Two recording techniques, the cut-tip recording and the fine-tip electrode recording, are mainly used in SCR in insects, of which main difference is the way of making electrical contact between the recording electrode and a sensillum. Each of these two techniques has merits and weaknesses that can be complimentary each other. The cut-tip recording technique shows us the exact location and type of the sensillum where the action potentials are recorded from, which is often difficult in the fine-tip electrode recording. However, the cut-tip recording is only available for the sensilla with substantial length so that the tip of the sensilla can be cut off to connect the recording electrode. The application areas of these electrophysiological recording techniques are expanding as shown in recent attempts to use the EAG technique with an array of insect antennae for detecting compounds of interests amongst various volatile compounds in confluent odor plumes.

electroantennogram

Key Words: GC-EAD, single cell recording, sensilla, olfaction, olfactory receptor neuron, semiochemical

J-6

Proactive Chemical Ecology: Strategies for Identification of Pheromones for Invasive Species

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Abstract: Modern global trade has resulted in the unintended consequence of rapid and efficient movement of invasive species to new areas of the world. As an example, on average, six new insect pests of economic importance become established in California each year, and economic losses to California from invasive species are estimated at $3 billion per year. The problem of invasive species is now global in scope. It is exacerbated by the fact that some invasive species are not problems in their native countries, and so have received little study. However, once moved to new countries that are free of the coevolved predators and parasitoids that keep the exotic insects under control in their native ranges, these new invaders can build up to large numbers and cause substantial damage.

Typically, invasive species entering the United States are only studied intensively once they are detected, that is, studies are conducted reactively rather than proactively. By the time a new exotic species is noticed, it is usually well established and has started to spread. Efforts to contain and eliminate new invaders are further hampered by the time delay in obtaining funding and resources to mount control and eradication programs, and by the fact that there are often no sensitive methods for detection of the insects, particularly when they are present at low densities in the initial stages of an invasion. Without good detection methods to determine where the invaders are, eradication efforts are almost certainly doomed to failure.

Here, we will describe a different, proactive approach to the problem of invasive species. Over the long term, it may be much more effective and cheaper to identify and prioritize insects that are likely invaders, and to identify their pheromones before they are introduced into new countries. The pheromones can then be used in pheromone-based surveillance and quarantine efforts, to detect the presence of potential invaders in incoming shipments, or at very early stages of an invasion, so that intensive eradication efforts will have the best possible chance of success. Two recent projects on pheromone identifications for exotic insects that are not yet established in the US, but which represent major threats to California agriculture, will be described. The problems and bottlenecks that were identified during these proactive chemical ecology projects, and possible solutions to these problems, will be discussed.

Key Words: Pheromone, invasive species, Lepidoptera, Diaspididae

J-7

Track3D: a new system for tracking, visualization and analysis of insect flight behavior in 3D

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Abstract: Wind tunnel systems are widely used in research on chemoreception and olfactory orientation of insects. Data collection often implies manual scoring of take-off and landing times, or video recording of flight in either the horizontal or vertical plane (2D), using a single camera. However, 3D tracking provides a more complete description and analysis of flight patterns than 2D coordinate data sets. With some species, 3D analysis is indispensable to understand their orientation in space and response to visual or olfactory stimuli.

Here we present a new video-based system for automated tracking of insects in a 3D space. The Track3D system records the flight of an insect in a test chamber or wind tunnel, visualizes the trajectory in 3D and calculates a large number of movement parameters. The system consists of tightly integrated hardware and software components. Insect flight is recorded using two synchronized video cameras and stored in high-resolution digital video files, using Media Recorder software running on a Windows 7 computer. From these files, the insect's movement is acquired by EthoVision XT video tracking software. The program records the 2D coordinates of the moving insect in each individual video image. Subsequently, the Track3D program – after 3D calibration using a specially designed calibration frame – converts the 2D coordinates from each camera view into one set of 3D coordinates. This track can be visualized in 3D, played back, rotated, and zoomed in/out. The software also calculates a large number of flight parameters, including distance moved, tortuosity, velocity (absolute and ground speed), heading and turn angles (relative to wind speed and different planes) for user-defined zones (odor plume and sectors of the wind tunnel).

The Track3D system has been validated in research on the behavior of the nocturnal malaria mosquito *Anopheles gambiae*. Responses to different human host cues involved in the foraging behavior of mosquitoes were studied by quantifying flight track characteristics in a wind tunnel. The insects were tracked while navigating through a plume of host-emitted cues under nocturnal conditions. Because of the low light intensity, infrared lighting and IR-sensitive CCD cameras were used. In the absence of host stimuli, flight paths were relatively short and flight speed remained nearly constant over the entire track. In contrast, exposure to human odor caused highly convoluted flights. Flight speed was greatest when mosquitoes were exposed to odor + heat. With these stimuli, flight speed decreased when the insects arrived near the source. This quantitative analysis of nocturnal host-seeking mosquitoes is a new step in the development of effective monitoring and preventive techniques for the control of malaria. The data show that a considerable proportion of flights take place in the vertical plane, demonstrating the value of 3D analysis of insect flight behavior.

Key Words: video tracking, wind tunnel, mosquito, flight behavior, EthoVision, Track3D

J-8

Competitive trapping and straight flying may explain the edge effect common under mating disruption.

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Abstract: Pheromone-mediated mating disruption has been used as a control technique against lepidopteran pests in orchards for several decades. It has generally been recommended that mating disruption works best in large (>3ha) square shaped orchard blocks. Several theories were put forward to explain why higher levels of damage or greater captures of moths in traps occurred at the edges rather than the interior of the blocks. Wind assisted dilution of pheromone concentration; immigration of mated female moths from neighbouring areas not treated with pheromone; and movement of moths away from high concentrations of pheromone have been cited as possible explanations.

Here we describe results from two computer simulations that suggest that the edge effect may be a result of either reduced competition between traps and pheromone dispensers, the propensity of straight-flying moths to accumulate at the orchard boundaries, or a combination of both.

When circles depicting the hypothetical space from which male moths can originate and move towards a pheromone dispenser are drawn centred on each tree in an orchard the result is a complex pattern of overlapping circles. The weave density of the pattern is directly proportional to the competition intensity. The weave was less dense around the crop edges, suggesting that competition is lowest here and more male moths would be expected to find a trap and be captured.

When computer simulated moth dispersal flights based on random diffusion with a strong bias towards straight locomotion were effected by restricting the circular standard deviation for movers decrementally from 15 to 1 degree from the heading of the previous step, and movers had to turn around at the crop boundaries, movers tended to accumulate at the crop edges.

In an orchard treated with mating disruption dispensers any monitoring traps placed inside near the edges of the orchard would therefore be expected to catch more moths than traps in the centre because (i) the moth population at the edges would be higher due to the accumulation of straight-fliers, and (ii) there is less competition between traps and dispensers at the crop edges.

Key Words: competitive attraction, mating disruption, edge effect

J-9

Models for monitoring invasive insect species

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Abstract: The effective attraction radius (EAR) describes the monitoring power of a semiochemical lure with regard to blend and release rate as well as the responding insect species. A specific EAR is a spherical radius that would intercept the same number of insects as that actually caught by a particular semiochemical-baited trap. The pink bollworm, Pectinophora gossypiella, has been largely eradicated from Arizona using a combination of pheromone monitoring traps, release of sterile males, and growing BT (Bacillus thuringiensis toxin) cotton. Eradication continued in Arizona by means of releasing sterile male moths from small airplanes over cotton fields three days a week throughout the summer of 2011 (USDA APHIS). The male PBW were grown on diets that caused their bodies to become reddish-pink. Thus, identification of the small moths caught by sticky traps was easily done. We determined the EAR of synthetic sex pheromone lures in the field by counting numbers caught on baited and unbaited traps. The EAR for a lure was calculated to be about 1.1 m. Six clear sticky cylinders baited with PBW lures were placed on 3-m poles to determine the mean flight height (0.80 m) and SD (0.26 m) that are used to calculate an effective flight layer (FL) of 0.66 m. The FL is used to convert the EAR into a circular EARc (2.93 m) that that can be used to model two-dimensional encounters of rare insects with monitoring traps over large areas. The models can indicate which population densities and distributions of monitoring traps would likely detect invading moths or residual populations in non-BT cotton in Arizona.

Key Words: pink bollworm, Pectinophora gossypiella, monitoring, computer simulation model, effective attraction radius, effective flight layer, mean flight height, detection

J-10

Novel mating disruption technologies and strategies for managing fruit pests

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Abstract: Recent efforts to develop new mating disruption formulations have been guided by studies examining the mechanisms by which mating disruption is achieved. Dosage-response profiles for reservoir dispensers revealed that competition between pheromone dispensers and females initiates communicational disruption in the field. Additional disruption mechanisms come into play subsequent to initial attraction. Disruption profiles indicated that one exposure to a reservoir dispenser rendered codling moth males incapable of normal sexual response for the remainder of a diel cycle, but males recovered and oriented to pheromone sources the following evening. Superior disruption was achieved when the initial attraction to a dispenser resulted in the complete elimination of subsequent male orientations, i.e., males were killed following attraction. Disruption profiles generated for an attract-and-remove dispenser revealed that this approach provided disruption 4-5 times greater than that achieved using reservoir dispensers. The high cost of mating disruption is often cited as a major impediment to broader adoption of the tactic. The economics of reservoir dispensers could be improved through more efficient use of the precious active ingredient. Very similar disruption profiles and impacts were generated using dispensers that released pheromone at much lower rates than the standard dispenser. ShinEtsu (Tokyo, Japan) has produced Isomate Flex dispensers that have substantially lower release rates than the standard Isomate dispenser. Equivalent levels of disruption have been achieved using low-releasing Flex dispensers and standard dispensers in both small-plot and on-farm experiments. The greatest efficacy of reservoir dispensers should occur when numerous point sources are distributed uniformly within the orchard. Reservoir dispensers that are amenable to mechanical application should facilitate achieving this. A new pheromone delivery system, called the Tangler®, consists of a two-piece pheromone module connected by string that is launched from a compressed gas applicator. As a result of the bola design, the propelled modules readily become tangled in the tree branches. The Tangler® showed promise in field tests conducted over the past three years. A single application provided codling moth control equal to commercially available hand-applied dispensers. Moreover, automated deployment of the modules was nearly 4x faster than hand application of dispensers. Sprayable microencapsulated formulations appear to operate by camouflage. Their major limitations are that capsules only hold enough pheromone to last a few weeks and capsules are dislodged by heavy rainfall. A solid-set system that delivered a small dose of pheromone-filled nanocapsules each evening was tested in 0.25 ac apple plots. The 'pherogation' system provided orientation disruption superior to that achieved through airblast sprayer application.

Key Words: Cydia pomonella, codling moth, mating disruption, pheromone, Isomate

J-11

A new insight for development of attract-and-remove against codling moths, Cydia pomonella

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Abstract: In attract-and-remove technique, insect pests are attracted by semiochemicals such as sex pheromone or kairomones. Removal can be achieved either by use of a toxicant such as insecticides, sterilants, insect pathogens or by permanently ensaring the insect. Most attract and kill formulations use droplets of paste or gel incorporated both insecticides and attractants together. One of critical factor for success of attract and kill depends on adequate dosing with the insecticide before insect pests leaving the attractant. The failure of attract-and-kill formulations developed to date appears to rest in the inability of moths to consistently make contact with the formulation. Here we used codling moths to demonstrate if the attractant was not allowed for moths to contact directly, the time that codling moths spent to look for the attractant was 5 times longer than that moths allowed touching the attractant. Overall, results suggest that an effective attracticidal formulation should include an attractant source that maximizes getting moths close to the source and some structure that maximizes moth landing. The toxicant or trapping surface will most likely be located on the structure where moths will first land and not the attractant source (lure). Another strategy for attract-and-remove to be successful would be to ensnare codling moths at their first contact. Several attract-and-remove devices provided substantial levels of CM disruption in field tests.

Key Words: codling moths, attract-and-remove, pheromone

J-12

Study on the Taxis of Tea Leafhopper Empoasca vitis (Gothe) to Plant Volatile Oils

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Abstract: False eye green leafhopper Empoasca. vitis (Gohte) is the most important tea pest in China. In traditional tea plantation, the control of this pest is largely relied on synthetic pesticides which cause very serious residues. In this paper, the taxis of E. vitis to volatile oils from 6 non-host plant species was tested by a four-armed olfactometer. The influence of olfactory response of these oils to adult of E. vitis was evaluated by the comparison of finally choice, time spend and number of entrance in treated area and control. The oils were extracted from Wedelia chinensis (Osb.) Merr., Synedrella nodiflora L. Gaertn, Mikania micrantha H.B.K., Eupatorium catarium Velda. & K., Eucalyptus citriodora Hook.F. and Lantana camara L. The result showed that all six volatiles had repellency effect on adult of E. vitis. Among them, volatile oils from W. chinensis and S. nodiflora were more sensitive. Female and male didn't showed different taxis to these volatile oils.

The volatiles compounds of S. nodiflora and W.chinensis were analyzed by FIinnigan TRACE GC-MS respectively. Twenty five compounds were checked out in S. nodiflora, the main contents were (2S,3S)–(+)–2,3-Butanediol,meso–2,3- Butanediol, Isopropyl myristate, Dibutyl phthalate and Hexadecanoic acid. Thirty eight compounds were checked out in W.chinensis, among them the main contents were Benzene, Methyl(1-methylethyl) - (CAS) ， Trans-Isolimonene, 2-β-Pinene and (-)-Caryophyllene oxide.

This study demonstrated that the behavioral effect of volatile oils from non-host plants on E. vitis was common. This effect might be use in integrated E. vitis management.

Key Words: plant volatile oil, Empoasca vitis (Gothe), olfactory response, repellency effect

J-13

Assessment of Allelopathic potential of rice on barnyardgrass by inhibitory ring under greenhouse conditions

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Abstract: Rice allelopathy and its application are considered as an ecological security way of restraining paddy weeds in the 21st century. The fundamental rice allelopathy research is to establish a reasonable method of the evalution of rice allelopathic potential. The results in the continuous three years all showed that the inhibitory rate of allelopathic rice PI312777 on co-cultured barnyard grass was > 50% within 10 cm, and its range was defined as allelopathic activity zone. Furthermore, the bioassay results of different leaf stages indicated that allelopathic rice PI312777 has a strongest capacity to inhibite barnyardgrass under five leaf stage. Simultaneously, the results from bioassay of inhibitory ring and RSA demonstrated that PI312777 and Taichung Native1 both have a strong inhibited barnyardgrass, but the reverse was true in Azucena and Iguape Cateto, whose inhibitory effect were both lower than 20%. The findings reveal that the characteristic of its inhibitory ring is low-expand, easy operation, short period, result objectivity, and it could be used repeatedly.

Key Words: Rice (oryza sativa L.), Allelopathy, Inhibitory ring

J-14

Functional determination of chemosensory proteins, LmigCSPI, LmigCSPII and LmigCSPIII in Locusta migratoira

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Abstract: Insect chemosensory systems detect a wide range of volatile and soluble chemicals and are important for locating and assessing the quality of food sources, in addition to identifying mates and oviposition sites. Several kinds of molecules including chemosensory proteins (CSPs), odorant binding proteins (OBPs), odorant receptors (Ors) and sensory neuron membrane proteins (SNMPs) are involved in this process. CSP is a superfamily of acidic soluble proteins widely expressed in insects. Structural analysis demonstrates that they are globule-shaped with a binding pocket and have binding ability toward semiochemicals. In view of its high concentration in chemosensilla lymph and many results of experiments, a lot of hypothesis has proposed that CSPs may play a vital role in chemoreception.

Locust is notorious worldwide pests causing tremendous damage to agriculture in history. Dozens of genes encoded chemosensory proteins have been identified in *L. migratoria*. Two classes of these CSPs have been identified. The expression profile and binding property of *Lmig*CSPs have been extensively characterized, but no research has been carried out to elucidate their function.

We have first identified a novel CSP in locust, and phylogenetic analysis classified this CSP into the third subfamilies, *Lmig*CSPIII according sequence similarity. To determine the function of these three subfamilies of locust CSPs we performed the genes silencing by micro-injection of dsRNA of these genes and detected the behavior.

Silencing effect was detected by real-time PCR. We found that 3ds after injection, the expression of *Lmig*CSPI/II in mouthparts of dsRNA injected locusts is completely suppressed compared to the H_2O injected and no injection controls. The interfering effect sustains till more than 10ds. In contrast, there is scarcely any difference of CSPs expression in tarsi or wings between RNAi mutants and wild-types.

The mutants, *Lmig*CSPI/II deficient locusts feed significantly less than wild-types on both the 3 days and 5 days after injection. In contrast, the inhibition of *Lmig*CSPIII expression does not cause any variation for feeding amount and weight increasing rate. Although we didn't observe any variations of age duration after *Lmig*CSPI/II was suppressed, the weight increasing rate greatly decreased for *Lmig*CSPI/II deficient locusts on the 7 days after injection. The results indicated that different CSP in a specific insect species may exert different function.

Competitive binding assay was used to assess the binding specificity of *Lmig*CSPII and *Lmig*CSPIII to semiochemicals. And the results demonstrated that the two types of CSP displayed similar binding property although their sequences divergence is significant. Aromatic compounds, such as α-Amylcinnamaldehyde and 1-Aminoanthracene, showed the strongest binding affinity, while linear aliphatic alkanes couldn't effectively replace the reporter from the binding pocket.

Behavioral assays showed that Ethyl dodecaoate and α-Amylcinnamaldehyde were effective antifeedants toward wild-type locusts, by contrast, their antifeeding effects on *Lmig*CSPI, *Lmig*CSPII and *Lmig*CSPIII deficient locusts were significantly decreased.

Together, our results demonstrated that these three classes LmigCSPs function variously, LmigCSPI and LmigCSPIIs may mediate the sensitivity of locust to food, while LmigCSPIII seems to perform a transporting function.

Key words: *Locusta migratoria,* Chemosensory proteins, RNA interference, Competitive binding assay, Semiochemicals

J-15

Application of a newly developed computer tracking program to locomotion analyses of a small population of Argentine ant, Linepithema humile

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Abstract: Ants living in a society called colony cooperatively behave in a population. Individual behavior was therefore influenced by the presence of their nestmates or non-nestmates. Until now, evaluation of their behaviors have relied on observation by eye even with the help of a video recorder, hence the results might often biased. Although some more quantitative evaluation of the animal behaviors at a video rate has been required, tracking analysis in a population is not easy as that of an isolated animal.

Here, we developed a computer tracking program, and applied it to locomotion analysis of Argentine ant, Linepithema humile. This program has an advantage of accurate tracking of multiple individuals in an arena. Even if they were randomly walking and crossing, the program can keep correct identification of multiple individuals and follow each trajectory during experiments.

Argentine ant is an invasive species migrating in many countries. Here in Japan, it was settled in Kobe, Port Island, which is our study field. Previous studies suggested that there are genetically separate 4 populations; we call two of the four populations A and B.

For the trial of our computer program application, five workers from the population A were previously put in an arena as resident individuals and later one worker either from the population A or B was released to the same arena as an invader. Totally six ants were then recorded at the same time with a video recorder for 10 min, and locomotion of each individual was continually analyzed.

In the present paper, we show a couple of data on the walking distances along the trajectory of each ant per 10 sec for 10 min recording period. If the invader ant was genetically separated from the residents, its walking distance was decreased shorter than that of the resident ants. In this case, observing the actual movies, we found that the invader was decreased in its locomotion activity. This may be reasonably reflected on the result of our video rate computer analysis as a reduced walking distance that the invader shows.

Key Words: Argentine ant, computer tracking program, locomotion analyses

P-1-B

Prediction of the range of host plants using single cell recording technique

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Abstract: Olfaction is a major sensory modality in a number of phytophagous insects that use the olfactory information for locating their host plants, although other sensory modalities such as contact chemoreception may be involved in the final decision for host selection. Naturally, phytophagous insects have species-specific sets of olfactory receptor neurons (ORNs) for detecting their host plants. Our recent studies on three moth species, Cydia pomonella, C. succedana and Uraba lugens, indicate that the phytophagous insects have not only ORNs specialized for their host-specific volatiles but also separate ORNs specialized for the non-host specific volatiles. Our study clearly shows 1) each moth species has species-specific sets of ORN types each of which is specialized for a narrow range of plant volatiles, 2) a major proportion of these ORN types are used as agonist detecting host-specific volatile compounds, 3) another set of ORN populations are used as antagonist for detecting volatiles from non-host plants, and 4) plants release species-specific sets of volatile compounds. Our research up to present indicates that the species-specific profiles of ORN types are correlated with the volatile emanations of host and non-host plant volatiles, and here we hypothesize that ORN profiles can be used to distinguish between potential host plants and potential non-host plants by comparing the ORN profiles with the volatile emanations from these plants.

Key words: single cell recording, olfactory receptor neuron, host range, Cydia pomonella, Cydia succedana, Uraba lugens, plant volatile

P-2-B

Electrophysiological responses of the diamondback moth, Plutella xylostella (L.) to nine crucifer volatiles

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Abstract: Electroantennogram (EAG) was employed to record the electrophysiological responses of the diamondback moth （DBM） adult to crucifer of nine volatiles. The results showed higher EAG responses of DBM to six carbon alcohol and aldehyde were displayed, such as 1-hexanol, hexanal, trans-2-hexen-1-al. However, the weaker EAG responses of DBM to terpenes such as (1R)-(+)-α-pinene, α-terpinene, (+)-3-carene, 1,8-cineole and d-limonene were displayed. The EAG responses were enhanced with the increase in concentration,of 1-hexanol, hexanal, trans-2-hexen-1-al, heptanal, α-terpinene and d-limonene respectively. The EAG response to (1R)-(+)-α-pinene, (+)-3-carene and 1,8-cineole were decreased at first and then increased to the maximum with increasing concentrations. The highest EAG response in female was to trans-2-hexen-1-al and the EAG relative value was approximately 331%, and that in male was to 1-hexanol and the EAG relative value was approximately 298%. The maximal differences of EAG relative values of DBM responding to the same concentration of volatiles were no more than two fold.

Key Words: Plutella xylostella, electroantennogram (EAG), crucifer volatiles

P-3-C

Pheromone diversity in Japanese hawkmoths

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In reproductive isolation of Lepidopteran insects, sex pheromones are very important. A diversity of sex pheromones plays a role to maintain various species. Sphingidae is a large group in Bombciodae with ca.1,200 species. The sex pheromones of sphingids are less studied than the noctuid and pyralid species. A few species are attracted to Bombykal (E10,Z12)-10,12-hexadecadienal and its isomers as sex pheromones or sexual attractants. Chemical identification and field tests on these sex pheromones are essential for understanding the diversity and evolution of sex pheromones in Sphingidae species.

In this study, 14 species, Ambulyx schauffelbergeri (As), Cephonodes hylas (Ch), Daphnis nerii (Dn), Deilephila elpenor lewisii (De), Dolbina tancrei (Dt), Hemaris affinis (Ha), Langia zenzeroides nawai (Lz), Marumba gaschkewitschii echephron (Mg), Mimas christophi (Mc), Neogurelca himachala sangaica (Nh), Smerinthus planus planus (Sp), S. tokyonis (St), Theratra japonica (Tj) and T. oldenlandiae (To) were used for identification of sex pheromones. The larvae were collected from the campus of University of Tsukuba or Tottori University and reared on host plants. After emergence, pheromone glands were excised from 3 - 4 d old females, and extracted with hexane for 20 min. The extracts were subjected to GC-EAD, GC-MS and GC analyses. Sets of one to three EAD-active components were detected in the GC-EAD. Chemical structures were determined by GC-MS and their DMDS or MTAD derivatives. 11-Hexadecacal, 10,12-hexadecadienal and 9,11-pentadecadienal were identified from EAD-active components. Then geometrical isomers, (E)-, (Z)-11-hexadecadienal, (E,Z)-, (Z,Z)-, (E,E)-10,12-hexadecadienal and (E,Z)-, (Z,Z)-9,11-pentadecadienal were determined by comparison of the Rt of synthetics and naturals. Active components were finally confirmed by field traps baited with synthetic compounds. Hawkmoths were attracted to natural mixture lures, but not attracted to different isomers or mixtures in unnatural ratios. This suggests rigorous species specificity in pheromone systems.

Sex pheromone systems of 14 species were categorized into 2 groups. Group A is a system using hexadecadienal analogs (Bombykal family) and Group B, a system using pentadecadienal isomers (Dt) (Non-bombykal family). Group A was further categorized into 3 groups based on components. Group A1,is a system using hexadecenal and hexadecadienal (Ch, Dn, De, Ha, Mc, Nh, Tj, To), Group A2 a system using isomers of hexadecadienal (Lz, Mg, Sp) and Group A3 a system using hexadecadienyl acetate and hexadecadienal (As, St). Hexadecadienol (Bombykol family) was not found in these sphindidae species. Comparing these results with a phylogenetic tree, sex pheromone groups and subfamily classification appear to be related. Here we show that the sex pheromones of hawkmoths are diverse as is the number of species.

Key Words: sex pheromone, hawkmoth, biodiversity

P-4-C

Trapping effect of 7 chemical lures on Ips nitidus Eggers and the natural enemy

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Abstract: In order to find out the leading components which are attractive to Ips nitidus based on Ips typographus（IT）lure, trapping experiments of lures of chemical Ipsenol, Ipsdienol and cis-Verbenol and the 4 combination lures were carried out in spruce forest. Results showed that 7 chemicals all trapped some beetles and the natural enemy Thanasimus sp., but only the combinations lure of Ipsenol and cis-Verbenol had attractive ability to Ips nitidus comparing to the IT ecolure, but not significant in Thanasimus sp.. Either single chemical of Ipsenol or cis-Verbenol was not attractive, but the combinations trapped 44 individuals per lure, similar to 56 individuals per lure of IT lure. Any combination of the 7 lures with Ipsdienol were not effective in trapping the beetle, so that Ipsdienol is an inhibiting component to I. nitidus beetle lure. But lure of Ipsdienol and Ipsenol and cis-Verbenol had better trapping ability than the combination lure of Ipsenol and cis-Verbenol or IT ecolure.

Key Words: Ips nitidus Eggers, Ipsenol, Ipsdienol, cis-Verbenol

P-5-C

Trapping effect of 6 kinds of Ips typographus (IT) lures on Ips nitidus

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Abstract: Studies on the field trapping effects of 6 kinds of Ips typographus lures on Ips nitidus were carried out in natural spruce forest in three different altitude grads. Results showed that The six IT-Ecolures had certain trapping abilities to Ips nitidus, which were Mountaintype-A > IT-3 > IT-2 > IT-T > IT-1 > Mountaintype-B according to average beetles captured per lure. IT-3 and Mountaintype-A were the strongest as a whole. Respectively, In altitude 2800- 2900m, trapping abilities were: Mountaintype-A > IT-3 > IT-2 > Mountaintype-B > IT-T > IT-1; In altitude 2900- 3000m: IT-3 > Mountaintype-A > IT-2 > Mountaintype-B > IT-1 > IT-T; beyond 3000m: Mountaintype-A > IT-3 > IT-T > IT-2 > IT-1 > Mountaintype-B. These results showed that the IT lures had trapping abilities on Ips nitidus and can be applied in routine monitoring in forest.

Key Words: Ips typographus (IT) lures, Ips nitidus, altitude grads, routine monitoring

P-6-C

Testing olfactory responses of a parasitoid, Dastarcus helophoroides, to differ their different populations

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Abstract: Different populations of insect might have different olfactory response to the same odor from the host. This different behavior might separate them as different "biotypes". Insect natural enemies play an important role on traditional biological control. They may also have different populations demonstrating different olfactory response to the chemical signal from the host or the host plant. Dastarcus helophoroides (Fairmaire) (Coleoptera: Bothrideridae) is an important natural enemy of longhorned beetles (Coleoptera: Cerambycidae). It is distributed throughout most provinces in China. The author investigated whether there were differences among D. helophoroides populations collected from different hosts in different geographic locations. Results showed that different D. helophoroides populations displayed different olfactory responses to larval frass from different longhorned beetle species. All populations were significantly attracted to the frass of their original hosts. Parasitism rates of different populations also varied when supplied with host larvae of the same longhorned beetle species. These results indicate that the three D. helophoroides populations tested differed in host-related behaviors. Therefore, the population of D. helophoroides must be taken into consideration when implementing biological control programs for different species of longhorned beetle.

Key Word: Population differences; Anoplophora glabripennis; Monochamus alternatus; Massicus raddei; Wood borer; Tritrophic interactions

P-7-C

Close range mate location behavior of Massicus raddei

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Abstract: Masssicus raddei (Blessig) (Coleoptera: Cerambycidae) is an important wood borer of oak trees which caused serious damage to Quercus mongolicus Fisch. ex. Turcz. and Quercus wutaishanica Mayr. in northern China since 1990s. It is a large body cerambycid and the body lengths of adults are 5-7 cm. The length of individual antenna is about 6.0-9.1 cm for male and 4.1-5.5 cm for female respectively. The adults are nocturnally active. The observed result showed that when two sexes of adults walked or run on the surface of tree trunk, their antennas rapidly and circularly waved as radar detection, so there are high frequencies for individuals encounter on the host trees.

In order to explore how the male adult locate and recognize the female in a close rage, the author investigated their mating behavior in the observation box (1.2m×0.6m×0.6m) made by white clothe curtain. All the experiments were conducted from 19:00 to 22:00 at night. When the eyes of either sex were blinded by paint, both sexes can find each other and complete the mating behavior. If the male antennal flagella (nine segments) were cut one segment by segment to test adult's locating and mating ability, it indicated that the mating frequencies would decreased after the fifth segment were cut, and that the whole flagellum of male was cut would stop their mating behavior. However, cutting the whole flagellum of female would not stop their mating behavior. Females still could be pursued by healthy male. Therefore, based on observation both in field and laboratory, in a close range, we can conclude that contacting female body with antenna are major cues males use for mate location and recognition. The vision has no obvious effect on mate location. Male antennae, particularly the terminal five segments, are critical for males to detect and recognize females. Removal of male palpi has no effect on mate location and recognition by males.

Key Words: Massicus raddei; longhorned beetle; mate location; mate behavior

P-8-C

The circadian rhythm of adult eclosion and female calling behavior of Omphisa plagialis (Lepidoptera: Pyralidae)

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Abstract: The circadian rhythm of adult eclosion and female calling behavior of Omphisa plagialis Wileman (Lepidoptera: Pyralidae), a branch borer of Catalpa bungei in eastern Asia, was studied at laboratory. The percentage of spring generation O. plagialis Wileman moths emerging during 10:00-13:00, 13:00-16:00, 16:00-19:00, 19:00-22:00 and 22:00-24:00 was 1.11%, 11.11%, 45.55%, 34.44% and 4.44% respectively. The percentage of summer generation O. plagialis Wileman moths emerging during 10:00-13:00, 13:00-16:00, 16:00-19:00, 19:00-22:00 and 22:00-24:00 was 3.57%, 10.71%, 46.82%, 33.15% and 5.61% respectively.

The percentage of calling female moths on the eclosion day under 25±1℃, 14L:10D condition at 20:00, 21:00, 22:00, 23:00, 24:00, 1:00, 2:00, 3:00, 4:00 and 5:00 was 33.3%, 53.3%, 63.5%, 74.4%, 83.6%, 61.0%, 52.8%, 47.2%, 42.0% and 30.6%. The circadian rhythm of calling female moths on the second, third, fourth day was similar as that on the eclosion day, while the percentage of calling female moths was decreasing day by day. The circadian rhythm of adult eclosion and female calling behavior both showed a “∩” type, while the peak of female calling was 6-8 hour later. The results would help to identify the sex pheromone of this borer belonging to insect Omphisa, a genus on which few chemical ecological works was reported.

Key Words: circadian rhythm, adult eclosion, calling behavior, Omphisa plagialis

P-9-C

Sex pheromone of an Inner Mongolian population of the Spruce Seed Moth, *Cydia strobilella* L. (Lepidoptera: Tortricidae)

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Abstract: The sex pheromone of Swedish populations of the Spruce Seed Moth *Cydia strobilella* was previously identified as a 6:4 mixture of (8*E*,10*E*)-dodecadienyl acetate and (8*E*,10*Z*)-dodecadienyl acetate [1], whereas Canadian populations of *C. strobilella* were reported to use only (*E*)8-dodecenyl acetate as a sex pheromone [2,3]. In Inner Mongolia, *C. strobilella* is a serious pest of the endangered spruce species *Picea mongolica*, endemic to the sandy forest-steppe ecotone. We investigated the female-produced pheromone of this moth population by gas chromatography with electroantennographic detection (GC-EAD), coupled gas chromatography-mass spectrometry (GC-MS) and field trials. The pheromone was identified as a mixture of (8*E*,10*E*)-dodecadienyl acetate and (8*E*,10*Z*)-dodecadienyl acetate, *i.e.* the same blend as was previously reported for the Swedish populations. Trapping experiments in China and Sweden, using various ratios of the acetates, revealed a similar broad male response profile in both areas. In GC-EAD screening, using possible additional pheromone components as stimuli, antennae of both Chinese and Swedish males responded strongly also to the corresponding alcohols,(8*E*,10*E*)-dodecadienol and (8*E*,10*Z*)-dodecadienol, but no effect on attraction of males was observed when adding these alcohols to the acetate blend. Although Brown and Miller [4] synonymized the North American (formerly *C. youngana*) and European *C. strobilella* based on characters of the genitalia, it is tempting to suggest that based on the marked difference in their sex pheromone composition the two populations are indeed different species. Our data show that the Chinese population is similar to the Swedish population, and that the same two-component blend can be used for monitoring and control of populations in both Europe and Asia.

Keywords: Sex pheromone, *Cydia strobilella*, Tortricidae, Lepidoptera, *Picea mongolica*

P-10-C

The communication between healthy and pest-fed Pinus massoniana

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Abstract: In order to investigating whether gymnosperm have the similar behaviours that like angiosperm tomato to perceive chemical compound as pre-warning signals from adjacent neighbors, Pinus massoniana was selected as a kind of typical material, which was fed seriously by Dendrolimus punctatus in south of China every year. First, insect-damaged P. massoniana and healthy ones were placed in one transparent closed glass box. After treated for 10h, the dynamic change of endogenous jasmonic acid (JA), abscisic acid (ABA), salicylic acid (SA), lipoxygenase (LOX) and VOCs from healthy needles had been studied. The results showed that the content of JAs increased immediately and reached twice times as control after treatment, then it was keeping in a higher level than control until another peak come again at 48h. LOX is a key enzyme in the synthesis of JA, its activity was increased at first and then trend down, the change trend was consistent with that of JA. SA in measured points was always higher than controls, and reached its peak in 12h. Although in most points ABA higher than the control, the analysis of variance was not significant. Furthermore, compared with control, no new compounds produced emitted from adjacent no-feeding P. massoniana needles, but most of their relative percentages like Tricyclene, α-Pinene, β-Phellandrene promoted and reached the peak between 24-36h. In addition, to explore what kinds of chemicals can be the potential elicitor, the blend of gases in the glass cube were collected and analyzed, apart from the common VOCs from P. massoniana, ethylene (ETH) was detected and was keeping stable content about 5μg/L among the treating points. The reported volatile MeJAs was not found. The date indicates that the neighboring plants make evident response to the received information and initiated the rapid resistance reaction, plant-to-plant communication indeed exists between damaged and undamaged P. massoniana. The variational VOCs from damaged trees are the dominant excitaton sources. Meanwhile, ETH may play an independent effect in the proceeding of communication. Besides, in the inspired signal conduction pathway, JA, SA and ETH showed synergy effect in the regulation of volatiles.

Key Words: Pinus massoniana, interplant communication, volatile chemical compounds, endogenous hormones, LOX

P-11-C

Antifungal properties of low polar extracts from Taxodium distichum cones

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Abstract: Cones are important parts for the self-propagation of coniferous species and known to contain characteristic self-defensive constituents. We have been reported antitermitic activities against subterranean termite and antifungal activities against two wood decay fungi of abietane-type diterpenoids isolated from Taxodium distichum cones [1,2]. In this study, eight fungal strains from four classes were used for antifungal tests of T. distichum cones' successive extractions to compare the difference of chemical defense. Furthermore, the relationship between quantity and quality of isolated constituents were considered from the results of our previous antifungal tests [2] mixed with the other study which connected diterpenoids in the order of oxidation [3].

The freeze-dried T. distichum fallen cones were extracted at room temperature for 7 days by the successive extraction with n-C6H14, EtOAc, and MeOH two times each. Eight fungal strains from four classes were used for evaluating the antifungal properties of extracts; Trametes versicolor and Lenzites betulina as white rot fungi, Fomitopsis palustris and Gloeophyllum trabeum as brown rot fungi, Trichoderma virens and Myrothecium verrucaria as soft rot fungi, and Penicillium citrinum and Rhizopus oryzae as mold fungi.

All extracts showed strong antifungal properties against brown-rot fungi, F. palustris and G. trabeum, much stronger than white-rot fungi, T. versicolor and L. betulina. The low polar extracts, n-C6H14 and EtOAc especially showed potent activities against F. palustris and also showed some activities against soft-rot fungi T. virens. Low polar extracts chiefly showed the activities against wood rot fungi. The yield of n-C6H14 extract was three times higher than that of EtOAc extract; thus, it was suggested the low polar components in T. distichum cones mainly related to their chemical defense. The n-C6H14 extract was mainly composed of abietane-type diterpenoids. Antifungal properties against T. versicolor and F. palustris were evaluated due to the oxidation degree of ten isolated constituents. The minor components, ferruginol oxides, showed potent antifungal properties much higher than major components according to the increasing the number of functional group such as ketone and hydroxyl groups.

The low polar extract of T. distichum cones showed potent antifungal properties against wood rot fungi. In addition, the abietane-type diterpenoids constitute ferruginol as a main compound together with its oxides showed certain activities. The quantity of constituents was not the only factor influencing the antifungal properties of T. distichum cones, but that there is also an effect of oxidized abietane-type compounds. This illustrates that it is important to investigate the antifungal properties of both major and minor constituents and their oxidative relations when evaluating the plant self-defenses against forest pests.

Key Words: Taxodium distichum, Cone, Wood rot fungi, Abietane-type, Diterpenoid, Oxidation

P-12-C

The aggregation pheromone of Ips duplicatus (Sahlb.)

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Abstract: The double-spines spruce bark engraver, Ips duplicatus (sahlb.) is a spruce (Picea spp.) pest insect in Europe and North –East Asia. Continuous outbreaks under attacking P. mongolica since the 1950s in Baiyinaobao National Nature Reserve, Inner Mongolia, China, as well as its status as a vector of phytopathogenic fungi, pose a serious threat to the spruce forest in the region. Therefore, the development of efficient and environmentally sound control measures such as mass trapping with aggregation pheromone is needed to combat the outbreaks of this species.

Field trapping experiments were carried out to confirm the optimal response components and ratios of aggregation pheromone of I. duplicatus on the pheromone analysis and identification base and evaluate effective trap characteristics for maximizing I. duplicatus catches in the pheromone-baited traps and apply the pheromone-baited traps to population monitoring and mass trapping in Inner Mongolia, China.

The optimal response components and ratios of aggregation pheromone of I. duplicatus is 1:1:0.1(20mg:20mg:2mg) of Ipsdienol(Id), E-myrcenol(EM) and Amitinol(At) , while Id combined with EM at a high dose (200mg for each component)displayed the best trapping efficiency. We suggest 40mg:20mg or 20mg:20mg of Id:EM should be used for the practice application economically.

Window slot and cross barrier traps showed significantly higher trap catches than the Lindgren funnel traps; comparison made after correcting their trap surface area differences revealed the same pattern.

Trap color showed a significant effect on I. duplicatus catches in the window slot traps, with the dark colors (black and red) being more effective than the light colors, especially the white and yellow.

Numbers of I. duplicatus beetles caught were greatest in traps at 1.5-2.0 m level, which were significantly higher than those at either ground or 3.5-4.0 m levels.

I. duplicatus beetles can be attracted to the pheromone-baited traps over a distance of at least 100 m from the forest edge (i.e. the source of overwintered beetles) in an open field, with an estimated maximum catching (or sampling) distance being ca. 135 m.

I. duplicatus beetles showed a strong diurnal pattern of flight activity. Its flight response to the pheromone-baited traps occurred during the day-time in both early and late summer each with one big/broad peak occurring around mid-late afternoon. The seasonal flight activity of I. duplicatus was also monitored by the pheromone-baited traps during 2007-2008. The results indicated three main flight peaks occurring in early June, late June-early July and late July, respectively, which suggests the existence of a potential (at least) partial 2nd generation.

These optimal trap characteristics will improve the performance of pheromone-baited traps as a critical monitoring or mass-trapping tool to combat the outbreaks of this pest in Inner Mongolia, China.

During three years of mass trpping from 2007 to 2009, tree mortality was down from 5.11 trees/hm2 to 1.26 trees/ hm2, from 3.80 trees/ hm2 to 0.72 trees/ hm2 and from 1.25 trees/ hm2 to 0.29 trees/ hm2, respectively and tree mortality percent reduced 77.58%. The effect on the mass trapping was significant.

Key Words: Ips duplicatus, aggregation pheromone, trap, monitoring, mass-trapping

P-13-C

Electrophysiological Responses of Carpenterworm Moths, *Holcocerus Vicarius* Walker to the Female Sex Pheromone Gland Extracts and Standard Compounds

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Abstract: The carpenterworm moths, Holcocerus vicarius Walker (Lepidoptera: Cossidae), a destructive forest pest, is widely distributed throughout China, including Inner Mongolia Autonomous Region, Ningxia Autonomous Region, Shanxi, Shaanxi, Gansu, and Liaoning provinces and so on. The larvae inflict seriously damages broad-leaved trees and fruit trees by tunneling into their trunks. The trunks of damaged trees are full of wounds and holes that eventually can cause the death of entire tree. The primary host of H. vicarius is Ulmus pumila L., besides other alternative hosts including Quercus acutissima Carruth, Robinia pseudoacacia L., Salix babylonica, Populus etc. (Xiao，1992). It was one of forestry harmful biology risk listed (Managing Office of Preventing Exotic Forest Pests of the National Forestry Bureau in 2003). Chemical insecticides are ineffective due to the cryptic nature of H. vicarius. In addition, the indiscriminate use of insecticides can certainly pollute the environment. Thus, insect pheromones produced by target species have been effectively used to control H. vicarius.

Collection of sex pheromone from calling female: 24hr observation of female moths revealed that the moths began calling and mating. The pheromone glands of 2-day-old were extruded by gently pressing the abdominal tips at 17: 00, 19: 00, 21: 00, 21: 30, 22: 00, 22: 30, 23: 00, 23: 30, 0: 00, 1: 00, 2: 00, and 1 to 5-day-old were extruded at 21: 30. Then the abdominal tips were excised with a small scissors and immersed in hexane for 40~60 min. The remaining extract was transferred into a clean conical glass vial and kept at −20 ℃ for additional analysis. Chemical synthesis of standard compounds: The corresponding compounds were synthesized via Wittig reaction routes (Horiike et al., 1980) and acetylene routes (Henrick, 1977). Electroantennograms: Dissected antennae from 1- to 3-d-old males were used for EAG measurements. Previously described methods (Zhang and Meng, 2000) were used for determining EAG responses to a series of monounsaturated 14-carbon alcohols and acetates. The results showed the amount of pheromone in the gland was relatively low on the first night after the eclosion, peaked on the second night and then decreased gradually when they aged. The amount of pheromone of 2-day-old virgin females began to increase gradually since 17:00, with the peak at 21:30 to 22:00, and then decreased gradually since 22:00. EAG response was the greatest at 22:30. The peak of sex pheromone production and release of H. vicarius occurred between 21:30 and 23:00.

Among 12 standard compounds and sex pheromone gland extracts, Z7－14:Ac elicited the strongest EAG response (4.95 mV), followed by E3－14: Ac(4.01 mV), Z3E5－14: Ac(3.89 mV), E3E5－14: Ac(3.34 mV), Z3－14: Ac(3.25 mV), sex pheromone gland extracts (2.85 mV) and E7－14: Ac(2.42 mV). The EAG values of these synthetic acetate compounds were very high and significantly different from corresponding alcohols（$P < 0.01$). It revealed that sex pheromone components were similar to Z7－14:Ac, E3－14: Ac, Z3E5－14: Ac, E3E5－14: Ac and Z3－14: Ac probably existed in the pheromone of H. vicarius. In field trials, traps baited with Z7-14:Ac caught several male moths, while E3－14: Ac, Z3E5－14: Ac, E3E5－14: Ac and Z3－14: Ac or solvent baited traps caught no males. E3–14: Ac and Z3E5–14: Ac could highly enhance the attractive activity when they were added to Z7–14: Ac. We conclude that the sex attractant of H. vicarius is composed of Z7-14:Ac, E3–14: Ac and Z3E5–14: Ac.

The study could establish a kind of sex attractant which had strong attractive activity, and could provide a theoretical foundation and scientific basis for establishing efficient, nontoxic, pollution-free and environment-friendly new methods and new technology to control H. vicarius

Key words: Holcocerus vicarius Walker; electroantennographic; chemical synthesis; sex pheromone extracts; standard compounds.

P-14-C

Physiological characteristics related to chemical communication system of *Zeuzera leuconotum* Butler (Lepidoptera: Cossidae)

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Abstract： Zeuzera leuconotum Butler(Lepidoptera: Cossidae), one of the serious trunks-tunneling pests of broad-leaved forest, is widely distributed in Tianjin, Shandong, Henan, Gansu and Shanxi provinces in China. It was listed in the contents of forestry harmful biology risk (Management office of the National Forestry Bureau of Preventing Exotic Forest Pests in 2006). A generation of Z. leuconotum may last one year, whose larvae cause serious damage by tunneling into tree trunks. There are dozens of hosts of Z. leuconotum, including Fraxinus chinensis Roxb, Platanus acerifolia(Air.) Willd, Sophora japonica Linn, Zizyphus jujube, Juglans, etc. Z. leuconotum is commonly controlled by cutting off damaged branches, but no significant results appear. Consequently, their distribution and population have been enlarging recently. Furthermore, it has been considered the major pest species of these types of above trees. One of compatible management strategies and methods of Z. leuconotum control is to manipulate its reproductive behavior, which suppresses phenomenal communications by way of trapping and interfering mating. Therefore, it is very important to study the physiological characteristics related to chemical communication system, such as adult reproductive behavior and characters, sexual gland and circadian rhythm.

First of all, adult reproductive behavior and characters were investigated at (19～32) ℃ and 75%～85% RH under 14L∶10D(lights on at 5:30 and off at 19:30). The results showed that the emergence period lasted 60 days, from the last half of May to the first half of July. In the last 10 days of June, the pests attained the peak of emergence quantities in a year. The daily emergence peak occurred from 17 : 00 to 18 : 00， and accounted 55.4% to the emergence quantities in a day. The ratio of quantities of female to male was 1:1.03. A few adults became sexual maturity on the same day of emergence. When paired with the same old virgin females and males, both female and male mated only once in their whole life span. The mating behavior can only be seen during the scotophase. The peak of mating behavior occurred after entering scotophase 5 to 7 hours. The female age influenced mating behavior as well: the ratio of mating raised as the age increase, and reached the peak when females are 2 or 3 days old, then decreased gradually. As the age of female increased, the onset time of mating (time after light switched off) would start earlier, which ranged from 6.83 h to 5.96 h, but the duration of mating prolonged. On average, a copulated female can averagely lay 378 eggs in its whole life, and the ratio of egg fertility was about 80%, while a virgin female can lay 426 eggs, which had not activity for the absence of mating. The lifespan of the virgin female and unmated male was 5.56 and 3.83 days, but that of the copulated female and male was 5.66 and 2.41 days respectively. This indicates that mating can shorten the lifespan of male, but no more influence on that of female.

The sexual tendency of Z. leuconotum was researched in detail by wind tunnel techniques and field tests. The virgin female and male moth of 2-day-old was laid at the uptake of wind tunnel to determine the sexual tendency respectively. The results showed that the virgin female attracted male before mating among the same species and there was no gathering among the same gender. In the field test, the delta-traps baited with a virgin female can catch the males. In addition, the effect of female age on the amount of catching male moths was studied and it was found that the number of males attracted by 2-day-old virgin females was the most, which was significant to the other-day-old females($P<0.05$).

Secondly, the location and modality of the sexual gland of female Z. leuconotum was studied in detail by

transmission electron microscopy (SEM) and scanning electron microscopy (SEM). It was showed that the sexual gland situates ventrally in the modified inter-segmental membrane between the eighth and ninth abdominal segments. There are many plump cones on the surface of the gland, and the glandular cells are arranged in one layer, and evident conjugation between cells and more involutions at the basal membrane of each cell. As examined by TEM, Microvilli are distributed on the cytoplasmic membrane and link with endocuticle on which there are many layers of chitin. These cells contain empty bubbles, mitochondria, lipid granule and smooth endoplasmic reticulum. The results could help to gain the basic knowledge of histology and morphology of chemical communication system.

Thirdly, the circadian rhythm of sex pheromone production and release was studied by the electroantennograms(EAG) and gas chromatography(GC). Response to compounds extracted from sex glands were recorded by the EAGs from the antennae of Z. leuconotum. The sex pheromone content of female moths at different time was determined by gas chromatographic analysis. The results showed that the average amount (area of the separated peak) of sex pheromone in a gland of the 2-day-old virgin females was maximum, and the EAG response(mV) to crude extract of the 2-day-old virgin female gland was the significantly greater than that of the other-day-old ($P<0.05$). As the age of female increased, the amount of pheromone decreased. In addition, in a day, the amount of pheromone increased gradually from 20：00 to 0：00, then decreased gradually until 5：00. The peak of sex pheromone production and release of Z. leuconotum occurred between 23：00 and 1：00. The production and the release of sex pheromone were not in synchronization. Actually, the production was earlier than the release of sex pheromone.

Lastly, the female sex pheromone gland extract of Z. leuconotum was separated by gas chromatography (GC), and comparative analysis with the standard compound. Preliminary results indicated that the sex pheromone may include Z/E8-12Ac, Z/E7-12Ac and so on. This will help to identify the sex pheromone of Z. leuconotum.

Key Word： Zeuzera leuconotum Butler, reproductive behavior, sex pheromone, sexual tendency, sexual gland, circadian rhythm, physiological characteristics

P-15-C

Volatile Components in Plants of Two Coniferous Species and Damage of Blastesthia sp

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Abstract: The volatile components from the cones and branches of Abies georgei var. smithii, and the cones of Sabina recurva var. coxii were examined and analyzed. Thirteen kinds of volatiles were detected in cones of Abiesgeorgei var. smithii, consisting of 10 kinds of monoterpaniliposoluble constituents, 1 kind of hydroxybenzene and 2 kinds of alcohols α-pinene, β-myrcene, β-pinene and β-phellandrene were dominants components. The content of β-phellandrene was the highest and it was not been found in other two plantmaterials. The volatiles of branches of Abies georgei var. smithii was consisted of 6 monoterpaniliposoluble constituents and 1 kind of hydroxybenzene, and the content of the hydroxybenzene was the highest among all the components detected. 5 kinds of monoterpaniliposoluble constituents were detected from the cones of Sabina recurva var. coxii, the dominant components were sabinene and limonene, and limonene was not found in cones of Abies georgei var. smithii. It can be deduced that the Blastesthia sp. was attracted by the big amount of β-phellandrenea, and the limonene in other two plantmaterials had drive action for this pest species.

Key Words: Abies georgei var. smithii; Sabina recurva var. coxii; volatile; Blastesthia sp.

P-16-C

Relationship between outbreak of pine caterpillar (*Dendrolimus punctatus*) and volatiles of Masson pine (*Pinus massoniana*) under drought conditions

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Abstract: The pine caterpillar Dendrolimus punctatus is one of the major forest defoliators in Central and South China, causing great economical damage. The main host of D. Punctatus is the masson pine (Pinus massoniana). The role of host volatiles in host selection and forming the spatial-temporal pattern and fluctuation of pest population in large scale drought conditions is uncovered.

The experiment were conducted in Guangxi, China, after a severe drought were broke out in the spring of 2010, with two years consecutive survey on the volatiles releasing and drought related factors in fixed sample plots discriminated by pest populations in year 2010.

The results showed that monoterpenes had the largest quantity among the 4 different chemical classes in the volatiles compounds. In the draught year 2010, the content of α-pinene ($P<0.01$), β-pinene ($P<0.01$) and 3-carene ($P<0.05$) were significantly different among the plots. There was positive correlation between the content of α-pinene, soils nitrogen, and the pest population, while negative correlation between the pest population and the content of needles carbon, needles moisture, myrcene, β-pinene and soil moisture. In the ordinary year 2011, the main components were α-pinene(64.15%), β-pinene (9.76%) 3-carene (12.43%) and limonene(11.01%), with myrcene barely been tested. A very significantly decrease of α-pinene($P<0.01$) and increase of 3-carene were found.

It can be conclude that higher content of α-pinene and lower content of 3-carene release might may cause the outbreak of pine caterpillar. And a few of myrcene may promote the process.

Key Words: *Dendrolimus punctatus*, masson pine, volatiles, drought, GC-MS

P-17-C

Exogenous Methyl jasmonate induce changes of substance in Populus deltoids leaves and its effect on Clostera anastomosis

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Abstract: Exogenous signal chemicals can induce plant to produce various defense responses, such as changing in the composition of volatiles and contents of other secondary metabolites, which in turn will affect the behavior of phytophagous insects. In this study, 10^{-5} mol/L Methyl jasmonate(MeJA) solution were sprayed on one-year-old *Populus deltoides* 895 leave which as treated leave, unsprayed leaves on the same plant as lateral leave in order to access the systemic effects of the MeJA treatments, and control leave were treated with carrier solution. Different leaves were harvested at 0、4、12、24、48、72h respectively, and the contents of chemical, the activity of enzyme of different treated leaves were assayed. The results showed that the content of soluble sugar of treated leaves decreased significantly from 12h to 72h, the free amino acids of treated leaves increased significantly from 4h to 24h, the soluble protein of treated leaves at 24, 72h increased significantly. The content of tannins of treated leaves and lateral leaves at 4, 12, 48h increase significantly, the content of phenolic acids of the treated leaves at 24, 48h increased significantly. and reaced the peak at 48h, the same changed in lateral leaves. The content of flavonoids of treated leaves increased significantly from 4h to 24h, but lateral leaves increased slightly at 4h. 2,6-Octadien-1-ol, Pentadecane, Cyclopentane were detected in the volatiles of treated leaves, while the content of Hexadecane1, 2-Benzenediol, 2-hydroxy-Benzaldehyde in treated leaves increased to some extent. The polyphenol oxidase activity of treated leaves increased and reached the highest at 12h and then decreased, the lateral leaves increased was not obvious. The lipoxygenase activity of treated leaves increased significantly at 12, 24, 72h, as well as that of lateral leaves increased significantly at 24, 72h. The trypsin inhibitor activity of treated and lateral leaves increased significantly from 12h to 72h, and the chymotrypsin inhibitor activity of treated leaves only increase significantly at 4h.

The nutrition metabolism and development duration of larvae of *Clostera anastomosis* feeding on treated leaves and control were evaluated. The results indicated that when feeding on the treated leaves, the POD activity of larvae of *C. anastomosis* increased obviously at 4, 24, 36h. CAT activity increased only significantly at 12h, and then decreased at 36h with lower than control obviously at 36, 48h. SOD activity increased significantly at 36, 48h and reached the hightest at 48h. GarE activity increased obviously at 4, 24, 36h and decrease at 48h, but the difference was not significant. MFO activity increased from 4h to 24h and the difference was significant at 12h, and then decreased at 36h with lower than control at 48h. GST activity increased obviously at 4, 12h, the rate of increased is smaller at 48h and the activity was similar to the level of control. The relative growth rate(RGR), relative consumption rate(RCQ) and efficiency of conversion of digested food(ECD) of larvae of *C. anastomosis* reduced significantly when feeding on treated leaves, while the efficiency of ingested food(ECI) and approximate digestibility(AD) increased although no significant difference between treated leaves and controls. The development duration of larvae and pupae prolonged, and pupae weight declined, emergency rate and numbe of egg-laying of adults decreased.

Keys words: Methyl Jasmonate; *Populus deltotoids*; *Clostera anastomosis*; induced resistance; nutrition metabolism; growing and development

P-18-D

Mating Behavior, Contact Pheromone and Acoustic Signals of the Predatory Stink Bug, Eocanthecona furcellatta

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Abstract: Mating behavior of the predatory stink bug, Eocanthecona furcellatta (Walker) and the role of the sternal gland of the male bugs in the mating behavior was studied. During courting, the male grabs the antennae of the female bug rubbing the stenal gland of the male. This behavior often makes the female bugs engaged in the mating position. However, the amount of the compounds found in the sternal gland is not positively correlated to the success of the courtship of the male bugs toward the females, i. e. the female will mate with a male with or without the secretion from the sternal gland. The acoustic communication between the male and female bugs may play a role.

During mating, the male will rub the stern of the female with the tarsus of the hind appendages quickly for about 1.5 min with intervals of about 30 min. The possible purpose of this rubbing behavior was proposed and studied.

Key Words: Predatory Stink Bug, Mating behavior, Contact Pheromone, Acoustic Signals

P-19-D

Synthesis and field evaluation of 3-oxo-alpha-ionone derivatives as male attractants for the solanaceous fruit fly, Bactrocera latifrons (Hendel) (Diptera: Tephritidae)

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Abstract: A series of 3-oxygenated derivatives of alpha-ionone and alpha-ionol have been characterized as highly specific male attractants for the solanaceous fruit fly, Bactrocera latifrons. However, the relative attractiveness of those compounds was less compared to that of other well-known tephritid male attractants, such as methyl eugenol for the Oriental fruit fly, B. dorsalis. Recently, certain 3-oxygenated alpha-ionones/ionols have been found to strongly attract flies in indoor cage assays (Ishida et al., 2008; Enomoto et al., 2010) though their long-distance attraction appeared low due to their relatively low volatility. Thus, in order to evaluate the field captures using those compounds, an efficient synthesis of 3-oxo-7,8-dihydro-alpha-ionone (P3) and 3-oxo-4,5,7,8-tetrahydro-alpha-ionone (P5) using preparative scale was developed. 3-Oxo-alpha-ionone (P1) was obtained as a crystalline solid by selective oxidation of alpha-ionone at the 3-position using tert-butyl hydroperoxide and sodium hypochlorite (yield: 59 %). P1 was then subjected to a partial hydrogenation with palladium (10 wt %)/carbon catalyst to yield P3 (85 %). Further hydrogenation produced P5. Field test was subsequently conducted in Yonaguni Island, Okinawa, where a large number of sterile B. latifrons were released as part of the fruit fly eradication program. A fan-shaped gauze (double layered, 75 mm radius) which was impregnated with a mixture of either P3 or P5 (200 mg) together with an insecticide (diazinone, 40%, 0.18 ml) was placed in a Steiner trap. The traps were positioned in the agricultural area for approx. one month. Although captures were very low, both P3 and P5 traps caught a number of sterile B. latifrons males.

Key Words: Solanaceous fruit fly, Bactrocera latifrons, 3-oxo-7,8-dihydro-alpha-ionone, attractant Synthesis

P-20-D

Pheromonal cross-attraction of two allied species, Nezara viridula and N. antennata (Heteroptera: Pentatomidae)

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Abstract: The southern green stink bug, Nezara viridula (L.) (Heteroptera: Pentatomidae) is a serious agricultural pest throughout the world. In recent years, N. viridula has been expanding its range northward in Japan, probably due to the global warming. To develop the monitoring system of N. viridula, we investigated the attractiveness of both live males and its synthetic pheromone, and also compared the attractiveness with its allied congener, the oriental green stink bug, Nezara antennata Scott, which is widely distributed in Japan. Water-pan traps were used to evaluate the attractiveness of the males or the synthetic pheromone. Adult males of N. viridula attracted not only conspecific adults, but also N. antennata adults. In addition, adult males of N. antennata attracted conspecific adults, as well as N. viridula adults. The synthetic N. viridula pheromone (1: 1: 1 mixture of (Z)-a -bisabolene, cis-1,2-epoxy-(Z)-a -bisabolene, and trans-1,2-epoxy-(Z)-a -bisabolene; 50 mg) attracted both N. viridula and N. antennata adults. Previous reports have demonstrated that N. antennata males possess same chemical components of N. viridula pheromone (Aldrich et al., 1993). These results strongly indicate that both Nezara species utilize the same pheromone components as their each pheromone system.

Key Words: pheromone, cross-attraction, Nezara viridula, Nezara antennata, soybean

P-21-D

Evidence of Wax Secreted by Female Adult as a Source of Aggregation Pheromone in Crawler of the Spiraling Whitefly *Aleurodicus dispersus*

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weijwu@scau.edu.cn**Abstract** Female spiraling whitefly *Aleurodicus dispersus* deposit eggs in a spiral pattern and each egg is covered by white wax. The egg spirals appear as white irregularly spirals on the undersides of host leaves. Laboratory bioassays were conducted to determine whether female adult of *A. dispersus*, produce attractant compounds to tiny mobile crawlers. Wax was found to astrict crawlers within the egg spirals. GC-MS analysis of silken wax revealed the main components including long-chain saturated hydrocarbons and aromatic esters, together with several other acid and phenol. Crawlers were significantly attracted to dibutyl phthalate and 3,5-bis(1,1-dimethylethyl)-4-hydroxy-benzenepropanoic acid methyl ester compared with distilled water or liquid paraffin control in a dual choice olfactometer. Crawler's mobile behavior and attractancy responses in laboratory studies suggest that a female-produced aggregation pheromone maybe the prevalent mechanism of chemical communication among whiteflies. This study is the first report of such an aggregation pheromone system in whiteflies.

Keywords *Aleurodicus dispersus* Russell, Crawler, Wax, Aggregation pheromone

P-22-D

Comparative studies on nestmate recognition in supercolony forming ants, Argentine ant and Formica yessensis

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Abstract: Many ant species can discriminate nestmate from non-nestmate, and aggressively reject the latter, which ensures that altruism is directed toward relatives. Cuticular hydrocarbons (CHCs) have been studied enthusiastically as chemical cues for ant and nestmate recognition in ants.
The supercolony forming ants possese social system characterized by the absence of internest aggression. They can expand networks where individuals move fleery among geographically distant nests. Argentine ant (Linepithema humile) and Formica yessensis.
Using two ant species, F. yessensis, japanese native species and L. humile introduced population into Japan, we compared their nestmate recognition with each other. We observed the ant behavioural responses toward another ant ("Ant vs Ant" experiments), or toward glassbeads treated with purified CHCs ("Ant vs Glassbead" experiments).
Materials and Methods
For "Ant vs Ant" experiments on Argentine ant, ants of object nest were contacted with subject ants, (nestmate, non-nestmate inside supercolony, non-nestmate outside supercolony or heterospecific) at small glass vial (diameter: 2.5 cm, height: 4 cm) for argentine ant, at circular plastic arena (diameter: 6 cm, height: 3cm) for F. yessensis. We recorded the behaviors, which occurred between two ants.
For "Ant vs Glassbead" experiments, the purified CHCs were from ants as same categories as subject ant in "Ant vs Ant" experiments. We recorded behaviors toward grassbeads (diameter of bead: ab. 2 mm for Argentine ant 4 mm for F. yessensis) treated with CHCs.
Results
As for the result, toward nestmate, F. yessensis showed prolonged antennation and ignore, and Argentine ant showed mainly ignore in both "Ant vs Ant", and "Ant vs Glassbead" experiments. Toward non-nestmate conspecific, F. yessensis mainly showed prolonged antennation, and biting in both "Ant vs Ant", and "Ant vs Glassbead" experiments. On the otherhand, Argentine ant showed biting intensively in "Ant vs Ant" experiment but showed ignore and escape toward "Ant vs Glassbeads" experiment. Toward heterospecific, F. yessensis almost always biting intensively in both "Ant vs Ant", "Ant vs Glassbeads" experiments. Argentine ant shows biting intensively, some of them even end up dead, in "Ant vs Ant" experiment, but shows almost all escape in "Ant vs Glassbead" experiment.

Key Words: Argentine ant(Linepithema fumile), Cuticular hydrocarbons, Formica yessensis, nestmate recognition, supercolony forming ant

P-23-F

Relative importance of olfactory and visual cues in perception of Coccinella septempunctata to Myzus persicae and the effect of sensational impairment on functional response

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Abstract: In this paper, the author firstly studied the relative importance of olfactory and visual cues in the perception of Coccinella septempunctata to Myzus persicae. The result shows that olfactory played a primary role while visual cues did not involve in this process. Then the author studied the effect of sensational impairment on functional response of Coccinella septempunctata on Myzus persicae. Eight impairments were set as follows: normal (N), one antenna impairment (A1), two antennae impairment (A2), one compound eye blacked (E1), two compound eyes blacked (E2), two antennae and two compound eyes impairment (A2E2), one antenna and one compound eye being impaired at the same side of the body (A1＝E1), one antenna and one compound eye being cross-bodily impaired (A1×E1), male and female beetles were observed separately in all the treatments mentioned above. The result shows that sensational impairment and Myzus persicae density extremely affected aphid consumption, but they did not interact. Aphid consumptions were not significant difference between the male and female beetles, sex and aphid density did not interact, neither did the tri-interactions among beetle sex, aphid density, and aphid density. The aphid consumptions of E2 and N were the highest and almost equal, but they had extremely significant difference compared with other treatments. Antennal impairments, regardless of one or two, could result in significant reduction of aphid consumption, suggesting that olfactory played a primary role in functional response of Coccinella septempunctata. Additionally, the olfactory would be more sensitive at the absence of visual organs; aphid consumption of A1＝E1 was slightly lower than that of A1 × E1, indicating that some symmetric compensatory mechanism might present in these two type sensory organs. In terms of the comparison of instantaneous detection rates, the mean instantaneous detection rates of E2 and E1 were 0.0452 and 0.0380, respectively, when the data of males and females were combined, being higher than that of N; however, the handling times of E2 and E1 were 0.06 and 0.12, respectively, being longer than that of other treatments. One other of this dramatic result might possibly be the movement range enhancement caused by compound eyes being blacked, the other reason might be bodily injury of antennal impairment was more serious than that of compound eyes being blacked, resulting in the beetles eagered to compensatory nutrition. In comparison of these two reasons, the former was dominant.

Key Words: Coccinella septempunctata, Myzus persicae, functional response, impairment, vision, olfactory

P-24-F

Tarsal gustatory sense in coleopteran insects

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Abstract: It is well known that some insects, such as those from Orthoptera, Diptera, and Lepidoptera, use tarsi as chemosensory organs in feeding and oviposition. However, the role of the tarsus as a chemosensory organ in feeding and/or oviposition is still unclear in insects from Coleoptera, which is the largest order among living organisms. Gustatory discrimination by tarsi in coleopteran insects has yet to be proven directly in ethological experiments, although the electrophysiological and morphological properties of the tarsus have been investigated in a few coleopteran insects such as Chrysomelidae. Firstly, we investigated the existence of tarsal chemosensilla in 50 coleopteran species with a scanning electron microscope. In Chrysomelidae, all genera (species) except cassidine beetles (tortoise beetles) possessed gustatory sensilla (sensilla chaetica) on their tarsi. In Cerambycidae, gustatory sensilla were observed on the tarsi in 6 of 10 species examined. None of species belonging to the other beetle families had tarsal gustatory sensilla. Secondly, we investigated behavioral responses on tarsal gustation using Galerucella grisescens, which possess tarsal chemosensilla, and Henosepilachna vigintioctomaculata, which possess no tarsal chemosensilla, in order to elucidate the role of tarsi as chemosensory organs in Coleoptera. G. grisescens without maxillary palpi, labial palpi, and antennae could discriminate sucrose in choice tests, but H. vigintioctomaculata could not. That is, G. grisescens could discriminate sucrose by only their tarsi. The findings are as follows: 1. In Coleoptera, tarsal gustatory sensilla may develop in only a few groups such as Chrysomeloidea, especially Chrysomelidae. 2. Chrysomelid beetles may use their tarsi as gustatory organs to discriminate their host plants.

key Words: tarsus, Coleoptera, Chrysomelidae, gustatory organs, chemosensilla, food discrimination

P-25-F

New aphid repellents discovery based on affinities to odorant-binding protein

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Abstract: Aphids are one of the major pests in agriculture, responsible for causing direct damage to the plants and for spreading plant virus infections. Aphids control is difficult owing to the great number of species, fast breeding and their ability to develop resistance to chemical insecticides. However, their chemical communication systems are exceptionally simple, both with respect to the semiochemicals and to the proteins involved in their detection. In order to find new strategy for aphids population control, we have focused our research on odorant-binding proteins (OBPs), soluble proteins secreted in the lymph of chemosensilla, and (E)- β-farnesene, the alarm pheromone for most of aphids that is released in the presence of danger and induces other individuals of the same as well as of other species to immediately abandon the place.

Here we report on a novel series of (E)-β-farnesene analogues biorationally designed for the first time by taking ApisOBP3 as the potential target and (E)-β-farnesene as the reference compound. The binding properties of several analogues with six recombinant OBPs and their repellent activity have also been measured. The data show good correlation between repellency and specific binding to two of the six OBPs examined, indicating such proteins as those specifically involved in the recognition of the alarm pheromone. These results also suggest a new strategy for discovering and selecting new aphid repellents, based on simple and inexpensive binding assays, rather than time-consuming behaviour measurements.

Odorant-binding protein,

Key Words: (E)-B-farnesene, Analogues design, ligand-binding, behaviour

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P-26-G

Synthesis of the sex-pheromones of *Omphisa plagialis Wileman*

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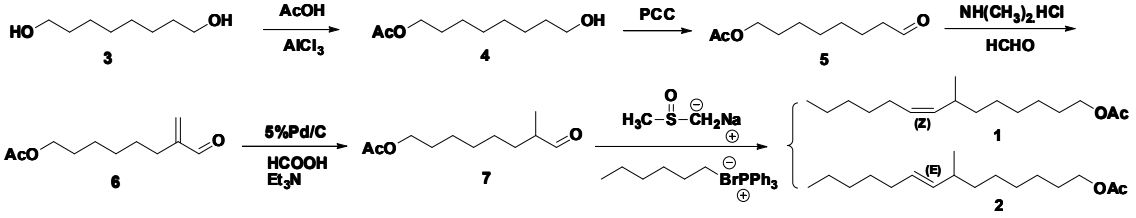
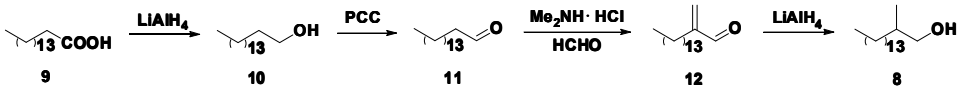
Abstract: The sex-pheromones of *Omphisa plagialis Wileman*(*SPOPW*), a branch borer of *Catalpa bungei* in eastern Asia[1], were isolated by Gao-Ping Wang *et al* from *Omphisa plagialis Wileman* in Henan Agricultural University of china in 2010. The results of GC-MS analysis indicated the main components of the *SPOPW* might be (Z)-7-methyltetradec-8-enyl acetate (**1**) and 2-methylhexadecan-1-ol (**8**). In order to confirm and apply the *SPOPW* components, we report herein the synthesis of the two sex-pheromones of *Omphisa plagialis Wileman*.



Scheme 1



Scheme 2

The major component (**1**) was synthesized in an overall yield of 17.0 % with the cheap industrial starting material 1,8-octanediol through the key reactions of mono-esterification, Mannich and Wittig reactions (**Scheme 1**), the ratio of *Z/E* was confirmed to be 80:20 by GC analysis. At the same time, the second component (**8**) was achieved in a 4-step reaction using the commercially available palmitic acid. The key step was Mannich reaction (**Scheme 2**) and the overall yield of the component was 46.3 %.

All the structures of target and intermediate compounds were confirmed by ^{1}H NMR, ^{13}NMR, IR and MS. The biological role of the two compounds (**1**) and (**8**) will be investigated. The preliminary research is significant viewing from both the natural products chemistry and chemical ecology.

Key Words: sex-pheromones, Omphisa plagialis Wileman, components.

P-27-G

Attraction of *M. falcana* (Lepidoptera: Tortricidae) by virgin females of a congeneric species, *M. phaseoli* in field trapping, and indistinct reproductive isolation

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Abstract: *Matsumuraeses phaseoli* and *M. falcana*, which both species feed on leguminous plants including soybean, red bean and mungbean, are indistinguishable in the external morphology. The two species, however, are distinguishable in the mitochondrial DNA sequence of cytochrome oxidase I and the sex pheromone composition, despite of sharing the same 3 compounds. Although it has been reported that the morphology of male genitalia is an identification key for the two species, the identification trial for the field-trapped males, based on the morphology, has failed in getting the high rate of correct answer. In a laboratory test, postzygotic reproductive isolation was not clear because the hybridization between the two species produced fertile offsprings successfully in part. In this study, therefore, we conducted a trapping test of species-specific attraction for the prezygotic reproductive isolation between the two species. In the results, most of males caught in the sex pheromone and the virgin female traps of *M. falcana* were *M. falcana*, with a small catch of *M. phaseoli*. However, a larger proportion in males caught in the traps of *M. phaseoli* was occupied by *M. falcana*, not by *M. phaseoli*. The results suggested that the prezygotic reproductive isolation barrier between the two species is not clear, too.

Key Words: Matsumuraeses phaseoli, M. falcana, virgin female, attraction ,reproductive isolation

P-28-G

A yeast cell factory for moth pheromone production: Substrate specificity of a plant-derived Acetyl-transferase

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Abstract: Moth pheromone precursors and pheromone components can be produced in yeast by heterologous expression of insect pheromone-production genes. Various desaturases produce unsaturated pheromone precursors from saturated acids and fatty acid reductases can be used to reduce fatty acid precursors to pheromone component alcohols. Acetyl transferases that catalyze the formation of acetate ester from alcohols by transfer of the acetate group from the acetyl-CoA to the fatty alcohol have been postulated in pheromone biosynthesis. However, so far no fatty alcohol acetyltransferases responsible for production of acetate pheromone components in insects have been characterized. Recently, Durrett et al. using a next generation sequencing approach found an acetyl-CoA diacylglycerol acetyltransferase (EaDAcT) in seeds of burning bushes (Euonymus alatus), which catalyzes the formation of 3-acetyl-1,2-diacyl-sn-glycerols (acTAGs). In the present study, we expressed EaDAcT in a yeast system, to investigate if EaDAcT could be used to convert moth pheromone alcohols into acetates commonly occurring as pheromone components in moths. EaDAcT was able to transform fatty alcohols with chain lengths from 10 to 18 carbons and with double bonds at varying positions, into their corresponding acetate esters. EaDAcT prefers shorter chain lengths over longer, and unsaturated substrates over the saturated ones. The yeast cells secreted the acetate ester into the medium, which may prove convenient when trying to purify the product for practical applications.

Key Words: Acetyltransferase, moth pheromone, fatty alcohol, acetate ester, yeast expression

P-29-G

Sex pheromone of fall armyworm Spodoptera frugiperda in Brazilian populations

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Abstract: The fall armyworm, Spodoptera frugiperda (J.E. Smith) (Lepidoptera: Noctuidae) is a cosmopolitan pest of maize crops. In Brazil, the use of commercial synthetic sex pheromone to S. frugiperda for monitoring has been failed, possibly due the fact that this pheromone was originally identified in populations outside the country. Thus, the current study aimed to evaluate the chemical composition of the sex pheromone from different Brazilian populations of S. frugiperda to obtain a new pheromone to be incorporated into the management of this pest. Preliminary results involving genetic variability within and between populations revealed the presence of at least two distinct races (maize and rice), and the different haplotypes have been characterized. These results provide a basis for the analysis of the pheromone of S. frugiperda as well as variation in pheromonal composition among Brazilian populations.

Key Words: Fall armyworm, Sex pheromone, Genetic diversity, Lepidoptera, Noctuidae

P-30-G

Isolation and Characterization of a rice jasmonic acid carboxyl methyltransferase gene

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Abstract: Methyl jasmonate (MeJA), which is produced by methylation of jasmonic acid (JA), is a volatilizable component of jasmonates. Since the JA signaling pathway is of central importance for plant defense response, MeJA may also be involved in this response by influencing the jasmonate pool. Here we cloned a rice jasmonic acid carboxyl methyltransferase gene *OsJMT1*, which has a 1122bp ORF, encoding a protein of 373 amino acids and localizes in cytosol. Enzymatic assay showed that the *Escherichia coli*-expressed recombinant protein could catalyze JA to yield MeJA. Transcript levels of *OsJMT1* were up-regulated in response to feeding by rice striped stem borer (SSB) *Chilo suppressalis* as well as rice brown planthopper (BPH) *Nilaparvata lugens*, mechanical wounding and treatment with JA, while were down-regulated by treatment with salicylic acid (SA). Over-expressing *OsJMT1* in rice (OE-OsJMT1) obviously decreased SSB-induced levels of JA and trypsin protease inhibitors (TrypPIs). The role of MeJA in mediating tritrophic interactions will be further studied.

Key words: Methyl jasmonate**,** *OsJMT1*, jasmonic acid, herbivore resistance, rice, *Nilaparvata lugens*, *Chilo suppressalis*

P-31-G

A WRKY transcription factor regulates plant signaling and defense responses in rice

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Abstract: Plant WRKY transcription factors function as versatile messengers in mediating responses to hormones, abiotic and biotic stresses and a variety of developmental cues. Here we cloned a gene of rice, *OsHI-WRKY*, whose expression levels were rapidly and strongly enhanced when plants were wounded, infested by rice brown planthopper (BPH) *Nilaparvata lugens* or rice striped stem borer (SSB) *Chilo suppressalis* or treated with jasmonic acid (JA). Silencing *OsHI-WRKY* enhanced the herbivore-induced levels of jasmonic acid (JA) and trypsin protease inhibitor (TrypPI) but decreased salicylic acid (SA) levels. BPH female adults preferred to feed and oviposit on transgenic lines over wild-type (WT) plants, and nymphs had higher survival rates on transgenic lines than on WT plants. In contrast, SSB, a kind of chewing herbivore, gained less mass when fed on mutants. Taken together, these results indicate that *OsHI-WRKY* is an important transcription factor, which controls rice herbivore resistance by regulating JA and SA signaling pathways.

Keywords: rice, WRKY, transcription factor, resistance, *Nilaparvata lugens*, *Chilo suppressalis*

P-32-H

Ecological niche differenciation in the pitcher plant Nepenthes rafflesiana: the role of volatile compounds

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Abstract: While trapping mechanisms in *Nepenthes* carnivorous plants received most of the attention, their system of attraction was largely overlooked. This study investigates the adaptive significance of the Volatile Organic Compounds (VOCs) emitted by two varieties of *Nepenthes rafflesiana* and their implication in the differentiation of their ecological niches.

As all *Nepenthes*, *Nepenthes rafflesiana* is specialized in dwelling in nitrogen-poor habitats. However, the varieties *typica* and *elongata* differ in their nitrogen sources: insect prey for *typica* and insect prey combined with bat feces for *elongata.* Their VOCs were collected by dynamic headspace adsorption and analyzed using gas chromatography-mass spectrometry. We also compared the pitcher attractiveness on insects using olfactometers as well as the prey spectra of both varieties.

The two varieties differ drastically in both the quantity and quality of emitted VOCs. The variety *typica* produced scent in quantities far greater than the variety *elongata.* The two varieties used different chemical pathways to attract prey: a blend of benzenoids, terpenoids and fatty acid derivatives for the *typica* form and mainly fatty acid derivatives for the *elongata* form. Interestingly, the volatiles released by the variety *typica* are highly attractive for flower-visiting insects and commonly found in the odor bouquet of generalist-pollinated flowers.

Both varieties also differ in their attractive power on insects. In contrast with *elongata* pitchers, the scent of the *typica* pitcher alone was sufficient to attract insects. Moreover, while the *typica* variety trapped a large diversity of insect species including flower-visiting insects, the *elongata* variety captured mainly ants and bugs albeit in far fewer quantities.

The use of different chemical cues might explain the exploitation of two distinct ecological niches by the two varieties and indicate an on-going speciation process. Thus, chemical ecology constitutes a useful tool to better understand the diversification of the species-rich genus of *Nepenthes.*

Key words: Carnivorous plant, pitcher plant, insect attraction, *Nepenthes rafflesiana*, volatile compounds, floral scent, ecological niche, prey spectra, insect diversity.

P-33-H

The role of host odours in the biology of a quarantine pest, the mango seed weevil

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Abstract: The mango seed weevil (Sternochetus mangiferae) is a widespread pest of mango orchards around the world including Australia, Oceania, Asia, Africa and the Caribbean. In Australia the pest is found in Queensland and the Northern Territory. Larvae enter the fruit by burrowing through the flesh into the seeds, where they feed until pupation, destroying the seed. Fruit infestation is very difficult to detect, since the only external sign of infestation is an inconspicuous egg-laying scar. Feeding activity in the seed remains undetected. Weevils leave the fruit when it is ripe or after it has fallen and decayed. Thus, yield is usually not significantly affected. Weevil feeding reduces the germination capacity of seeds

Mango seed weevil is considered a minor pest as it does not cause economic damage to fruit. However, its presence in seeds acts as a barrier to trade, as quarantine restrictions prevent movement of fruit from infected areas into weevil-free locations. All the evidence suggests that weevils spread into clean areas through the movement of infested fruit for propagation and consumption

I have been conducting infochemical research to identify a monitoring or control tool for the pest. To date I have found that volatile odours surrounding weevils, frass and mango leaves were chemically distinguishable by GC-MS. Furthermore, the compounds identified in weevil odour are of mango origin, but their relative abundance is different to either of the other odour sources, suggesting sequestration by the weevils, and a possible role in chemical communication.

Behavioural experiments demonstrated that weevils are attracted to other weevils, possibly through an actively released aggregation pheromone. The response of weevils to odours from other weevils, mango flowers and different aged fruit has been examined using an olfactometer and results of these trials will be discussed.

Key Words: Horticultural pest, Sternochetus mangiferae, Olfactometry, GC-MS

P-34-H

Elevated ozone reduces the activities of *Helicoverpa armigera* midgut proteinases by altering the induced defense of the tomato plant

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Abstract: In addition to altering the plant phenotype, elevated ozone (O_3) alters the chemical components in plant tissue, which in turn affects the performance of insect herbivores. This study examined the feeding by the cotton bollworm, *Helicoverpa armigera*, on two genotypes of tomato plants, a wild-type (WT) and a jasmonic acid (JA) pathway mutant, under elevated O_3. In the WT, with or without *H. armigera* herbivory, elevated O_3 simultaneously increased the JA and salicylic acid (SA) levels in the tomato leaves and enhanced the JA defense pathway, including the up-regulation of the activities of proteinase inhibitors and lipoxidase. In the prosystemin-mediated responses2 (*spr2*) mutant plants, elevated O_3 increased the free SA levels and the LOX activities but did not affect the JA levels and the protease inhibitors (PIs) activity. Furthermore, elevated O_3 reduced the activities of the active alkaline trysin-like enzyme (AATLE) and the chymotrypsin-like enzyme (CLE) in *H. armigera* when fed on the WT plants instead of the *spr2* tomato plants. The results indicate that elevated O_3 reduced the activities of mid-gut enzymes in *H. armigera* by enhanced JA pathway defense in the WT plants; this was not seen in the *spr2* plants. Our results suggest that future increases in O_3 would increase the JA signaling pathway and reduce the activities of the mid-gut enzymes in *H. armigera*, thereby enhancing plant resistance to herbivores.

Key words: elevated O_3; jasmonic acid; salicylic acid; *Helicoverpa armigera*; mid-gut proteinase.

P-35-H

Effect of *Ferula assafoetida* essential oil on some life parameters of the carob moth, *Ectomyelois ceratoniae* under laboratory conditions.

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Abstract: Plant essential oils have been suggested as alternative sources for insect control products because some are selective, biodegradable, and have few effects on non-target organisms and the environment. Carob moth is a polyphagus insect pest worldwide. It is the key pest of pomegranate orchards in Iran. In the present work effect of *F. assafoetida* essential oil on some life parameters of the carob moth, *E. ceratoniae* (Lep.: Pyralidae), were studied. Results showed that natural reproductive rate (r_m) of the females reduced by essential oil ($P<0.001$). In addition, comparison of different stages of males and females showed that larval and pupal stages period and females' longevity were increased in the presence of essential oil ($P<0.001$) but it didn't affect males' longevity. Width and thickness of larval head capsule was affected and decreased by the oil: it showed that more exposing larvae to the essential oil, the less growth they have in comparison to control. Oral toxicity of the essential oil for the larvae was calculated ($LC_{50} = 0.076$).

The essential oil of F. assafoetida could be an environmentally friendly product to use in IPM of the carob moth.

Key Words: essential oil, management, parasitoids

P-36-H

Performance of Spodoptera litura reared on maize sprayed with methyl jasmonic acid and relationship with defensive proteins of maize

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Abstract: Under insect chewing damage, the maize could be induced to produce some anti-insect defensive proteins and volatiles through the jasmonic acid (JA) pathway. Then, the defensive proteins can affect performance of the wounding insects. In addition, the induced volatiles may attract herbivores' natural enemy. Past studies indicated that the exogenous methyl jasmonic acid (MeJA) could induce the similar defensive responses on maize. Besides, recent researches also focused on the effect of induced volatiles on natural enemies. However, relative little is known about the relationship between induced defensive proteins of maize and their effects on performances of insects. The objectives of this study are to assess the performances of the herbivore (Spodoptera litura) fed on maize sprayed with MeJA, and the relationship between defensive proteins and growth of S. litura. Results of different instar feeding trails on 2nd day after maize sprayed with MeJA showed that the growth duration increased and growth rate decreased when S. litura fed on the MeJA-treated leaves. Moreover, results of the feeding preference test indicated that S. litura larvae preferred non-treated maize in each instar. Besides, results of the short-term feeding trail indicated that approximate digestibility (AD) and efficiency of conversion of ingested food (ECI) of 4th instar were both reduced for those fed on MeJA-treated maize. In addition, the activity of trypsin inhibitor (TI) on MeJA-treated maize was significant higher than on the control and this result suggested a negative correlation may occur between TI activity and growth performances of S. litura. Base on results, maize sprayed with MeJA might not kill the S. litura directly, but could decrease the growth efficiency of larvae.

Key Words: Spodoptera litura, maize, methyl jasmonic acid

P-37-H

Insect elicitors from different food source cause the changes of plant defense response.

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Abstract: Insect elicitors in saliva, regurgitant, and feces, play an important role as chemical signal during insect-plant interaction. For instant, when tobacco hornworm (Menduca sexta) caterpillars feed on tobacco, the glucose oxidase (GOX) in saliva may decrease the nicotine titer in plant. Another important elicitors call fatty acid and amino acid conjugates (FACs) in regurgitant, involve in plant defense signal transduction, trigger the plant defense compound synthesize and plant volatile release. Unfortunately, the quantity of these chemicals in insect saliva or regurgitant is usually low and difficult to accumulate. Most of investigators use artificial diet as a convenient food source to feed the studied insects in order to increase their sample sizes; however, the result from insect feed on artificial diets may be different to those feed on natural diets. In this study, we use Helicoverpa amigera feed on different food sources, then treat their regurgitant on tomato leaves. The results between these treatments are different, the regurgitant from caterpillar feed on tomato leaf might decrease the tomato's defense compound, but not with the regurgitant from caterpillar feed on artificial diet. This result indicates that the food source not only affect the component of insect regurgitant, but also have effect on plant's defense response.

Key Words: Feces, Helicoverpa amigera, plant's defense response, regurgitant

P-38-H

The accumulation of antidiabetic iminosugars in silkworms reared of mulberry leaves

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Abstract: 1-Deoxynojirimycin (DNJ), a constituent of mulberry (*Morus alba and M.bobysis*), is a potent α-glucosidase inhibitor. It is expected to useful in a diabetic diet due to its antihyperglycemic effect. In this study, we compared the DNJ concentrations in 5 silkworm tissues: hemolymph, skin, gut, silk gland, and gut content, and investigated changes in DNJ concentration during the growth of silkworms reared on mulberry leaves to produce DNJ-rich silkworm products. Concurrently, we also investigated 2 other iminosugars, 2-*D*-galactopyranosyl-DNJ (GAL-DNJ) and fagomine. These possess some α-glucosidase inhibitory activity or have other unique effects (e.g., insulin secretion is induced by fagomine). The highest concentrations of DNJ and fagomine were obtained from 2-day-old third-instar larvae, and the concentrations decreased with their development. GAL-DNJ concentrations were very low in all developmental stage. Hemolymph contained the highest concentrations of DNJ and fagomine of the silkworm tissues. DNJ concentration in hemolymph was extremely high and approximately 10 times that of a whole body of silkworm. On the other hand, the concentration of GAL-DNJ in the gut was the highest among silkworm tissues, but the concentration was lower than that of mulberry leaves. These results suggest that when silkworms receive iminosugars from mulberry leaves, DNJ and fagomine are absorbed in intact form into the hemolymph. However, GAL-DNJ is absorbed as a degalactosyl form (i.e., DNJ) into the hemolymph. DNJ concentration in hemolymph, as well as that in the whole body, decreased with silkworm growth. It is possible that the protein content in hemolymph increases with silkworm development. As a result, the relative content of DNJ in hemolymph decreases, which may be responsible for the reduction of DNJ concentration. This study suggests that the hemolymph of silkworms is a promising dietary supplement for effective diabetes prevention.

Keywords: 1-Deoxynojirimycin, iminosugar, mulberry, Morus spp., silkworm, diabetes prevention

P-39-H

Oviposition biology and function of host plant odor in the yellow peach moth

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Abstract: The yellow peach moth (YPM), *Conogethes punctiferalis*, is commonly a serious pest throughout the Asian and Australian regions. Approximately 250 host plants including field crops, orchard crops, spices and oil crops are recorded in the world, but YPM females preferentially lay eggs on young fruits of peach, codling and chestnut. Honda and Matsumoto (1984) reported that plant odors may be important as semiochemicals in host finding and oviposition. However, no active chemicals have been identified so far. To understand the host finding mechanism of YPM gravid females and function of plant volatiles, laboratory experiments were conducted during this study.

Test materials including fruit or leaves of host and non-host plant, were put in a pair of mesh balls wrapped with gauze as artificial oviposition substrates. Gravid moths were then allowed to lay eggs on the substrates in screened cage for 9 h of scotophase. Effect of moisture as an oviposition stimulating factor was also accessed. In the final experiments, landing and oviposition on the substrate by gravid females were also recorded to determine the dial rhythm of egg laying behavior. In dual choice tests of young peach, codling and control (empty) treatments, YPM females exclusively laid eggs on the substrates containing fruits but not on the controls. This suggests females can detect plant fruits with no direct contact, that is, host finding and oviposition responses by females can be triggered by olfactory stimuli from host plants. Moisture itself showed no oviposition stimulating activity. When host plant fruits and leaves were given to female moths in a dual choice test, they laid eggs on the substrate containing host plant leaves, but preferred fruits to leaves. This indicates that plant leaf volatiles may also be involved in host finding and oviposition behaviors of YPM females. In contrast, other factor(s) may reduce oviposition on leaves because larvae typically feed as a fruit borer. When young peach fruits were extracted with n-hexane for 6 min oviposition stimulating activity was lost, whereas codlings extracted for 1 h still showed activity. Moreover, not all landing females laid eggs on the substrates. The number of females landing was the same during two half of scotophase, but the number of moths laying eggs was significantly higher during the first half of scotophase than the later half. These results provide useful information for determining the suitable time for highly sensitive detection of YPM female responses to stimulus sources in wind tunnel and olfactometer tests.

Key words: *Conogethes punctiferalis*, yellow peach moth, host plant odor, oviposition, attraction

P-40-H

Identification and biosynthesis of fatty acid amino acid conjugates in Drosophila melanogaster larvae and adults

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Abstract: Fatty acid amino acid conjugates (FACs) are known elicitors of plant volatiles. Since the discovery of volicitin [N-(17-hydroxylinolenoyl)-L-glutamine] from oral secretions of Spodoptera exigua (1), related FACs have been identified from 28 lepidopteran species (2,3). N-Linolenoyl- and N-linoleoyl-L-glutamic acid are also identified as main FACs components in adults of two closely related cricket species (Orthoptera: Gryllidae) and in Drosophila melanogaster larvae (Diptera: Drosophilidae) with trace amounts of glutamine-type FACs (4). In this study, we demonstrate the identification of glutamic acid-type FACs in D. melanogaster adults but not in pupae and then the in vitro biosynthesis of glutamic acid-type FACs by using larval homogenates. When the homogenates were incubated with sodium linolenate and L-[α-15N] glutamic acid or L-[α-15N] glutamine, not only 15N-labeled N-linolenoyl-L-glutamic acid but N-linolenoyl-L-glutamine was detected by LCMS and LCMSMS. This clearly showed that glutamic acid was conjugated with linolenic acid directly. To our surprise, furthermore, glutamine was conjugated with the fatty acid about 20 times as much as glutamic acid, and the in vitro biosynthetic experiments with larval homogenates did not correspond to results that glutamic acid-type FACs were identified as dominant components in D. melanogaster, as shown above. To explain the glutamic acid specificity in vivo, an amino acid composition in larval gut tissues and enzymatic activities associated with decomposition of FACs in larval homogenates are investigated. Although glutamine-type FACs are suggested to play an important role in ammonia assimilation, and the glutamine uptake in Spodoptera litura larvae (5), any roles of glutamic acid-type FACs in insect physiology still remains unknown. Details on biosynthetic pathways of glutamic acid-type FACs needs to be investigated in D. melanogaster.

Key Words: FACs, plant-insect interaction, insect produced elicitor, amino acid metabolism

P-41-H

Chemicals relating host selection in rice plant for the brown planthopper, N. lugens

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Abstract: The feeding physiology of the planthoppers and leafhoppers has been clarified to consist of two phases; probing and sucking. These processes are controlled by physical and chemical factors in rice plant. However the elucidation of "the chemicals" for N. lugens is still underway. This paper, therefore, try to confirm the chemical factor in rice plant relating probing behavior by N. lugens.

Rice plant (cv. Toyonishiki) was extracted three times with 90% methanol (MeOH) for 3 days and the extract was defatted three times with hexane to get the aqueous extract. When N. lugens was fed on 2 g fresh rice plant of aqueous extract through parafilm membrane, many stylet sheaths were deposited on the parafilm. The result indicates that the extract had highly probing stimulant activities for this insect. The aqueous extract was charged on an ODS middle column and eluted in sequence with water, 20%, 40% and 100% MeOH in water to get ODS water, 20%, 40% and 100% MeOH fractions. Of these four fractions, the ODS 40% fraction was the most active. Bioassays were further conducted on the individual compounds as well as their various combinations in the ODS 40% fraction. As results in, it became clear that highest probing responses similar to that of ODS 40% fraction recovered only when at least ten compounds were combined. The structures of ten compounds, were determined as peak 2 (Neocarlinoside), peak 3 (Schaftoside), peak 4 (Isoorientin), peak 5-1 (Neoschaftoside), peak 5-2 {Isoorientin 2″-O-(6‴ -(E)-feruloyl)glucoside}, peak 5-3 {Isoorientin 2″-O-(6‴ -p-(E)-coumaroyl)glucoside}, peak 6 (Luteolin 7-O-glucoside), peak 7 {Isoscoparin 2″-O-(6‴ -(E)-feruloyl)glucoside}, peak 8-1 {Isoscoparin 2″-O-(6‴ -p-(E)-coumaroyl)glucoside}, peak 8-2 {Isovitexin 2″-O-(6‴ -(E)-feruloyl)glucoside} by using NMR and MS spectra, respectively. Polyphagous, N. cincticeps requires one common flavonoid O-glucoside as a probing stimulant. Oligophagous, S. furcifera needs one flavonoid O-glucoside and three flavonoid C-glucosides. Monophagous N. lugens like N. virescens do many special flavonoid C-glucosides as shown in this paper. Judging from these results, we considered that the probing stimulant was a host recognition substance and quality and quantities of the probing stimulant closely related with the host range by sucking insects.

Key Words: N. lugens, rice plant, probing stimulant, host range, host recognition

P-42-H

Why must the cotton aphid (Aphis gossypii) shift the host plant?

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Abstract: The cotton aphid (Aphis gossypii) is a polyphagous serious pest in the world and gives many vegetables and crops damage. This species has an intricate life cycle. In early spring, population of the cotton aphids hatched on Hibiscus syriacus which is a primary host plant, has spent on it through three or four generations and then shifts the secondary host plant, for example, cucumber, egg plant and so on in early summer. In autumn, the male and female come back to H. syriacus and fertilized-female lays egg on it.

Why must the cotton aphid shift the host plant? Why cannot the cotton aphid live on the primary host plant through four seasons?

We try to elucidate the reason in the view of the seasonal change of quality and quantity of secondary substances in primary host plant, H. syriacus.

The leaf of H. syriacus was collected in every two days or two weeks from April to November. The leaf was immediately extracted with 80%MeOH/H2O and the extract was separated on ODS column. HPLC analysis revealed that ODS water fraction only showed seasonal changes in the amount of eight secondary substances (Pks.A, D, E, F, G, H, I and J). Of these peaks, the amounts of four Pks (A, F, I and J) become the maximum before max of the population of cotton aphid on the primary host plant, H. syriacus. In contrast, the amounts of four Pks (D, E, G and H) become the maximum after max of the population on the plant. In other word, an increase of Pks.A, F, I and J has brought with it the increase of population of cotton aphid and increase of Pks.D, E, G and H dose the decrease of population of cotton aphid.

The analyses by using NMR and LC-MS revealed that Pks.A and E are uridine and fumaric acid, respectively. When uridine was artificially given to the cotton aphid through palafilm membrane, uridine made the amounts of sucking and digesting by cotton aphid and population of cotton aphid increase. In contrast, fumalic acid made the amount of excreting by cotton aphid increase and population of cotton aphid decrease though the amount of sucking by cotton aphid increase.

These results could suggest that seasonal changes in quantity of secondary substances had caused the host alternation by cotton aphid.

Key Words: cotton aphid, secondary substances, uridine, fumaric acid

P-43-H

Chemicals relating host selection in rice plant for white-backed planthopper, Sogatella furcifer

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Abstract: The feeding physiology of planthoppers and leafhoppers has been clarified to consist of two phases; probing and sucking. These processes are controlled by physical and chemical factors in rice plant. However the elucidation of “chemicals” for S. furcifera is still underway. This paper, therefore, trys to confirm the chemical factor in rice plant relating probing behavior by S. furcifera.

Japonica rice plant (cv: Toyonisiki) was extracted with 90% MeOH in water. The extract was dissolved in water and then defatted with hexane to obtain an aqueous layer. 2 g of fresh rice plant equivalent /ml of the aqueous layer coursed probing response by S. furcifera and many branched stylet sheeths were observed on the parafilm membrane. The active aqueous layer was chromatographed on ODS open column to obtain H2O, 40%MeOH/H2O, and MeOH fractions (frs.). Of these three frs., the ODS 40% MeOH/H2O fr. only showed the high probing response. Separation by HPLC and bioassay revealed that four compounds (A-D) were based on the activities. Each compound alone did not show the activities but the activity was recovered only when they are combined. By using NMR and LC-MS analyses, Compounds A, B, C and D were determined as Isoorientin 2"-O-(6"'-(E)-feruloyl)glucoside, Isoorientin 2"-O-(6"'-p-coumaroyl)glucoside, Tricin 5-O-glucoside, and Isoscoparin 2"-O-(6'-(E)-feruloyl)glucoside, respectively. The activity of the four combined compounds was almost similar to the original aqueous layer.

Polyphagous, N. cincticeps requires one common flavonoid O-glucoside as a probing stimulant and monophagous, N. lugens and N. virescens do many special flavonoid C-glucosides. Oligophagous, S. furcifera, needs one flavonoid O-glucosides and three C-glucosides as shown in this paper. Judging from these results, we considered that the probing stimulant was a host recognition substance and that quality and quantity of the probing stimulant closely related with the host range by sucking insects.

Key Words: Sogatella furcifera, host range, host recognition, probing stimulant

P-44-H

Chemicals relating host selection in rice plant for the green rice leafhopper, N. nigropictus

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Abstract: The feeding physiology of the planthoppers and leafhoppers has been clarified to consist of two phases; probing and sucking. These processes are controlled by physical and chemical factors in rice plant. However the elucidation of "the chemicals" for N. nigropictus is still underway. This paper, therefore, tried to confirm the chemical factor in rice plant relating probing behavior by N. nigropictus.

Rice plant (cv. Toyonishiki) was extracted three times with 90% methanol (MeOH) for 3 days and the extract was defatted three times with hexane to get the aqueous extract. When N. nigropictus was fed on 2 g fresh rice plant of aqueous extract through parafilm membrane, many stylet sheaths were deposited on the parafilm. The result indicates that the extract had highly probing stimulant activities for this insect. The aqueous extract was charged on an ODS middle column and eluted in sequence with water, 20%, 40% and 100% MeOH in water to get ODS water, 20%, 40% and 100% MeOH fractions. Of these four fractions, the ODS 40% fraction was the most active. Bioassays were further conducted on the individual compounds as well as their various combinations in the ODS 40% fraction. As results in, it became clear that highest probing response similar to that of ODS 40% fraction recovered only when at least four compounds were combined. The structures of four compounds, were determined as peak A (Isoorientin 2″ -O-glucoside), peak 7 {Isoscoparin 2″ -O-(6‴ -(E)-feruloyl)glucoside}, peak 8-1 {Isoscoparin 2″ -O-(6‴ -p-(E)-coumaroyl)glucoside}, peak 8-2 {Isovitexin 2″ -O-(6‴ -(E)-feruloyl)glucoside} by using NMR and MS spectra, respectively. Polyphagous, N. cincticeps requires one common flavonoid O-glucoside as a probing stimulant and Oligophagous, S. furcifera, needs one flavonoid O-glucoside and three flavonoid C-glucosides. Monophagous, N. virescens and N.lugens do many special flavonoid C-glucosides. N. nigropictus requires four flavonoid C-glucosides as shown in this paper. Judging from these results, we considered that N. nigropictus is oligophagous insect and that the probing stimulant was a host recognition substance. In addition to these conclusions, quality and quantities of the probing stimulant closely related with the host range by sucking insects.

Key Words: N. nigropictus, rice plant, probing stimulant, host range, host recognition.

P-45-H

The Attracting Effect of Odorants of Different Chemicals on Whitefly (Bemisia tabaci Gennadius)

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Abstract: Whitefly has forcefully repellent or attractant responses to different odorants. The utility of favorite materials is one significant measure to control the super pest, especially in organic farming. Four mixed odorants, such as greenery odor materials extracting from plants or inexpensive chemicals with vary proportions, has been developed for a trapping test with Y-tube olfactometer in lab and trapping trials in cucumber field. Four treatments [⑴, trans-2-hexenal: cis-3-hexen-l-ol: acetone(2: 1: 1000); ⑵, methyleugenol: ethyl acetate: acetone (100 :1 :1000); ⑶, ethyl acetate: ethyl propanoate: isopentyl acetate: isovaleric acid: β-caryophyllene (10: 10: 10: 1: 1); ⑷, soft sugar: 5% acetic acid: 59% ethanol: water (3: 4: 1: 2)] were performed for the trapping test with six reduplicates per treatment. In cucumber field, the trapper was designed with high transparent binding film adhered sticky insect glue, and a brown centrifuge tube (1.5ml) contained different trapping chemicals assembled in the center of the film. Five experimental plots including the control were laid out in a completely randomized block with three reduplicates in Hebei province in China. The results indicated that the attracting rate in Y-tube olfactometer test was significantly higher in the treatment ⑷ (59.96±7.45%,Mean±SE) than that in the treatment ⑵ (35.96±7.56%,Mean±SE) in five minutes, and kept the similar tendency (the rate of them is 63.73±10.27% and 35.61±5.25% respectively, Mean±SE) in ten minutes. The position of Y-tube chambers had no effect on the result. There was no significant difference between the different treatments and control in the field experiment, but the trend of attracting effects indicated that the number of trapped whiteflies was more in the treatment ⑷ than that in the others.

Key Words: Preference, Attractants, Choice behavior, Bemisia tabaci

P-46-H

To select vegetables as repellent against the whiteflies on cucumber

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Abstract: We choosed five species of vegetables: celery (Apium graveolens), asparagus lettuce (Lactuca psativap L. var. asparaginap Bailey), malabar spinach (Gynura cusimbua (D.Don) S. Moore), edible amaranth (Amaranthus mangostanus L.), water spinach (Ipomoea aquatica Forsk.), each of them with a relative low population of whiteflies, and we applied these five species as repellent against the whiteflies on cucumber. Chiefly, a Y-tube olfactometer was used to investigate the orientational response of the whitefly toward plant volatiles indoor; then tested the effects of these five species against the whiteflies through intercropping with cucumber in open field in summer of 2010 and in greenhouse in spring of 2011. The Y-tube olfactometer test showed that the corrselectance of whiteflies to four vegetables is less than zero, they are asparagus lettuce, malabar spinach, celery, edible amaranth. In open field or greenhouse, the population densities of whiteflies on the cucumber intercropping with the five species of vegetables were markedly lower than that of cucumber monocultured, and the densities of whiteflies on cucumber intercropping with celery or malabar spinach were significantly lower than with the others. The celery and malabar spinach showed a good effect as repellent against the whiteflies and can be applied as new ecological manipulation factor to whiteflies.

Key Words: Whiteflies, cucumber, repellent, celery, malabar spinach

P-47-H

An EAR-motif-containing ERF Transcription Factor Affects Herbivore-Induced Signaling, Defense and Resistance in Rice

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Abstract: Ethylene responsive factors (ERFs) are a large family of plant-specific transcription factors that are involved in the regulation of plant development and stress responses. However, little to nothing is known about their role in herbivore-induced defense. We discovered a nucleus-localized ERF gene in rice, OsERF3, to be rapidly up-regulated in response to feeding by the rice striped stem borer (SSB) Chilo suppressalis. Antisense and over-expression of OsERF3 revealed that it positively affects transcript levels of two mitogen-activated protein kinases (MAPKs) and two WRKY genes as well as concentrations of jasmonate (JA), salicylate (SA) and activity of trypsin protease inhibitors (TrypPIs). OsERF3 was also found to mediate rice resistance to SSB. On the other hand, OsERF3 was slightly suppressed by the rice brown planthopper (BPH) Nilaparvata lugens (Stål) and increased susceptibility against this piercing sucking insect, possibly by suppressing H2O2 biosynthesis. We propose that OsERF3 affects early components of herbivore-induced defense responses by suppressing MAPK repressors and modulating JA, SA, ethylene and H2O2 pathways as well as plant resistance. Our results also illustrate that OsERF3 acts as a central switch that gears the plant's metabolism towards an appropriate response to chewing or piercing/sucking insects.

Key Words: Rice, ERF, herbivore resistance, defense-related signaling, mitogen-activated protein kinase, WRKY

P-48-H

Antennal and behavioral response of Heortia vitessoides (Lepidoptera: Pyralidae) females to host plant volatiles from Aquilaria sinensis

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Abstract: Heortia vitessoides Moore is the most serious pest of Aquilaria sinensis (Lour.) Gilg, which is the principal source of Chinese agarwood. Like the other oligophagous herbivores, H. vitessoide has a narrow range of host plants. In southern China the larvae of H. vitessoide solely feed on the leaves of A. sinensis. In severe infestation, the insects completely denude the leaves of A. sinensis, causing severe economic losses. A. sinensis volatiles attracting the H. vitessoides were investigated. Volatiles from young and old leaves of A. sinensis were identified and quantified by gas chromatography-mass spectrometry and gas chromatography-electroantennogram detection. Both wind tunnel bioassays and field tests were carried out for attraction of synthetic blends of different maturation leaves to the adults. Consistent electroantennographic activity was obtained for 9 compounds from headspace collections of the young and old leaves of A. sinensis. Qualitative and quantitative differences were found among 2 odor profiles. In wind tunnel experiments, the nine-component mixture from young leaves was more attractive to the moths than the three-component mixture from old leaves. The further subtraction bioassays in wind tunnel showed that both the nine-component blend and a four-component blend at a fixed natural ratio elicited equivalent level responses. In a field trial with these two synthetic blends, more moths were captured by both blends than traps baited with hexane only, although the number of the catches was low. Our studies indicated that the odor blends of young leaves play an important role in H. vitessoides host recognition. The mechanisms behind host recognition and age-dependent changes in leaf chemistry were discussed.

Key Words: Heortia vitessoides, Aquilaria sinensis, host plant volatiles, GC-EAD, wind tunnel, field tests

P-49-H

Chemical Factors Affecting Food Selection by Larvae of Cotton Bollworm, Helicoverpa armigera

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Abstract: Cotton bollworm, Helicoverpa armigera and common cutworm, Spodopetera litura are serious pests for various crops such as soybean, potato and tomato. Interestingly, when these two species larvae attack their host plant, the feeding site is different. For example, in tomato, common cutworm feeds mainly on the leaves, while cotton bollworm feeds mainly on the unripe fruits. It is not clear the mechanism on feeding site preference. To clear the feeding site selection mechanism by both species larvae, we aimed at the chemical factors affecting food preference of both species larvae and conducted chemical analyses of tomato and feeding tests using the tomato extracts to cotton bollworm and common cutworm larvae.Leaves and unripe fruits of tomato were extracted with methanol respectively. These methanol extracts obtained were subjected to feeding test using a glass fiber filter paper at choice and no-choice condition for 24 hour. Sixth instar larvae were used for the test. In no-choice condition, both species larvae fed equally on the filter paper treated with the methanol extracts. This result revealed that both methanol extracts of leaves and unripe fruits have a feeding stimulant activity to both species larvae. In choice condition between filter papers treated with unripe fruits extract and leaves extract, both species larvae fed significantly on the filter paper treated with unripe fruit extract more than that treated with leaves extract. Therefore, the unripe fruits extract has higher feeding stimulant activity to both species larvae the leaves extract. The methanol extract of unripe fruits was divided into four fractions (dichloromethane, ethyl acetate, n-butanol and water soluble fractions) and each fraction was subjected to feeding test by the same manner mentioned above. Each fraction had significant feeding stimulant activity to common cutworm. Although any fraction did not show significant feeding stimulant activity to cotton bollworm, significant feeding stimulant activity was observed when the dichloromethane soluble fraction and water soluble fraction were mixed. The dichloromethane soluble fraction was further separated into eight fractions (Fr.1-Fr. 8) by silica gel column chromatography, and each fraction was subjected to the feeding test mixed with water soluble fraction. Fr. 1 had the highest feeding stimulant activity to cotton bollworm larvae among eight fractions. Fr. 1 was further chromatographed by silica gel column and two fractions (Fr. 1-1 and Fr. 1-2) were obtained. Both Fr. 1-1 and Fr. 1-2 had feeding stimulant activities to cotton bollworm. Further analysis and feeding test are now in progress.

Key Words: Helicoverpa armigera, Spodoptera litura, Tomato, Feeding stimulant activity

P-50-H

Study on Biological Activities and Application of *Lantana camara* Pentacyclic Triterpenoids against Vegetable Insect Pests

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Abtract: *Lantana camara* L. known as wild rage is a widespread plant distributed mainly over tropical or subtropical area. It is cultivated as an ornamental plant, used as folk medicine for human ailments and homemade pesticide in the field. The plant being native to tropical and subtropical America is an aggressive, obligate outbreeder weed that has invaded vast expanses of pastures, orchards and forest areas in many countries. It was listed as one of the ten most notorious weed in the world. A large number of studies on biological activities of *L. camara* crude extracts against agricultural pest have been reported. Up to now, attempts to control the plant have met with limited success but its insecticidal actions could be utilised.

Therefore, the aims of this study were (a) to evaluate biological acitivities of *L. camara* pentacyclic triterpenoids against *Plutella xylostella* and *Phyllotreta striolata*, the two most important insect pests in vegetable in south China, (b) to make up preparations used crude extracts as materials and evaluate their control efficacy on insect pests above.

The main results of the study were as follow.

1. Biological activities of crude extracts of *L. camara* against test insects

The crude extracts used as tested samples were methanol extract of leaves (ME), chloroform extract of ME (CE), crystallization material of CE (crude lantadenes) and residue of CE after crystallization (residure).

All the crude extracts had significant oviposition deterrent effect on *P. xylostella*, compared to neem based insecticide. The crude extracts reduced the eggs laid by adults on their host plant by 60.4%-87.5% at 2000 $\mu g \cdot ml^{-1}$ concentration. However, the crude extracts had no antioviposition effect on *P. stiolata* adults and did not reduce the survival rate of *P. xylostella* eggs.

All the crude extracts had feeding deterrent effect on *P. striolata* adults and *P. xylostella* larva, which reduced feeding area of adults and larva on their host plant leaves by 38.2%-69.9% and 33.4%-50.3% respectively at 2000 $\mu g \cdot ml^{-1}$ concentration. However, the extracts had no effect on survival of *P. striolata* adults and *P. xylostella* larva and had no significant activities against *Spodoptera litura* and *S. exigua.*

2. Isolation and identification of pentacyclic triterpenoids

Five pentacyclic triterpenoids were isolated from methanol extract of *L. camara.* They were lantadene A, icterogenin, ursonic acid, lantadene B and 24-hydoxy-ursonic acid. The yields of these triterpenoids in purification protocol of the study were quite different. The yields of icterogenin were higest (2.2%), while the yields of ursonic acid (0.11%) and 24-hydoxy-ursonic acid (0.11%) were less than any other one. They yields of lantadene A and B were 0.88% and 0.38% respectively. Townsville Prickly Orange (*L. camara* TPO) was the only variety of *L. camara* found to contain icterogenin. Isolation of icterogenin in Red variety (*L. camara* Red) which was used as the plant material in our investigation was reported for the first time. The isolation of 24-hydroxy-ursonic acid was conducted in *L. tiliaefolia*, another species of Lantana. *L. camara* found to contain 24-hydroxy-ursonic acid was reported here for the first time.

3. Biological activities of *L. camara* pentacyclic triterpenoids against vegetable insect pests

Lantadene A, lantadene B, icterogenin and ursonic acid had ovipostion deterrent effect on *P. xylostella*, significantly reduceing the eggs laid by adults on their host plant by 62.4%, 58.5%, 75.3% and 67.1% respectively at 1000 $\mu g \cdot ml^{-1}$ concentration. Based on OD_{50} value (Oviposition-deterrent Dose causing 50%

oviposition deterrence), lantadene A showed the highest deterrent effect, followed by ursonic acid, lantadene B and ictergenin showed less activity. The OD_{50} value of lantadene A was 206.3 μg·ml^{-1} (24 h) and 282.2 μg·ml^{-1} (48 h), ursonic acid was 206.3 μg·ml^{-1} (24 h) and 282.2 μg·ml^{-1} (48 h).The 4 triterpenoids were the active compound in crude extracts against *P. xylostella* adults. However, 24-hydroxy-ursonic acid had no effect on oviposition of adults.

The methanol extracts, lantadene A, lantadene B, icterogenin and ursonic acid had inhibitory effect on population growth of *P. xylostella* and reduced the number of next generation by 74%, 60%, 59%, 69% and 69% repectively. However, the tested samples above had no significant effect on growth and development of *P. xylostella*.

The 5 pentacyclic triterpenoids, Lantadene A, icterogenin, ursonic acid, lantadene B and 24-hydoxy-ursonic acid possess antifeedant acitivty against *P. xylostella* larva. Lantadene A and icterogenin were most acitive, followed by ursonic acid and lantadene B, while 24-hydroxy-ursonic acid showed less effect. These five triterpenoids were the active compounds in crude extracts against *P. xylostella* larva.

Among the 5 triterpenoids, only lantadene A and icterogenin had antifeedant effect on *P. striolata* adults and reduced the feeding area by 81.7% and 70.0% respectively at 1000 μg·ml^{-1} concentration after 48 h of treatement. These 2 triterpenoids were the active compounds in extracts against *P. striolata* adults.

The biological activities of ursonic acid and 24-hydroxy-ursonic acid against insects were first reported here.

4. Control efficacy of preparation made from crude extract on vegetable insect pests

Preparations (water suspensions) were made from crude extracts, which can be applied directly to the vegetable. The protocol was easy to understand so the preparations can be made up as homemade protectants. The preparations were evaluated for their control efficacy on *P. xylostell*a and *P. striolata*. The results showed that the preparations reduced eggs laid by *P. xylostella* on its host plant by 63.5%-78.2% and feeding area of *P. striolata* adults by 70.6%-84.9% at 1 day after treatment.

The preparations made from CE showed highest control efficacy among all the preparations. The control efficacy increased with the concentration of CE and concentration dependent. After 6 days of treatment, the preparations still had deterrent effect on the two insects, which reduced eggs laid by *P. xylostella* on its host plant by 48.4%-62.8% and feeding area of *P. striolata* adults by 75.6%-76.8% and showed high persistence on their control efficacy.

We applied for two patents for the preparations and their protocols above which granted patent application in 2011. The patent number was ZL 200810026195.1 and ZL 200810026198.5 respectively.

Key words: *Lantana camara,* Pentacyclic triterpenoids, Vegetable pest, Biological activity, Preparation

P-51-H

Antifeedant activitiesof podophyllotoxin, XW-2 and XW-4 against adult of stried leaf beetles, Phllotreta striolata

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Abstract: Antifeedant activities of podophyllotoxin, XW-2 and XW-4 were studied against adult of stried leaf beetles. Phyllotreta striolata. At500 μg/ml、1000 μg/ml、2000 μg/ml、3000 μg/ml、4000μg/ml for 24h podophyllotoxin showed considerable activities with antifeedant indexes 43.49%、 72.67%、 83.23%、 87.96%、 93.79%, respectively. The antifeedant activity of podophyllotoxin remained unchanged as the time extended. The indexes of XW-2 were less than 29.9%. At 500 μg/ml、1000 μg/ml、2000 μg/ml、3000 μg/ml 、 4000μg/ml , XW-4 exhibited strong bioactivities with attractive indexes of 34.70%, 65.60%, 74.20%, 86.41% and 97.73%.

Key Words: Antifeedant activities, podophyllotoxin, Phyllotreta striolata

P-52-H

Oviposition and Feeding Deterrent Effect of Plant Sterols from Xanthium sibiricum on two Insect Pests in China

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Abstract: The active components against insects were extracted from Compositae plant Xanthium sibiricum, using column chromatography and recrystallization methods. Five sterols components were purification from them. Sterols are the important secondary metabolites in plants with a variety of biological activity. Objective to reveal the behavior activity of sterols from plants on insect pests, the effect of sterol constituents from X. sibiricum on feeding behavior by feeding leaf-dishes of crucifer Brassica oleracea to Pieris rapae 4th larvae, and their oviposition deterrent and negative tropism of behavior choices on Plutella xylostella adults were investegated. The results showed that among the isolated five components , the Component V showed highest oviposition deterrent rate on P. xylostella adult with 75.76%, 85.45% and 65.85% after treated 24h, 48h and 72h, respectively. The Component IV was the second with 42.10%, 39.33% and 47.65% after treated 24h, 48h and 72h, respectively. Others showed very low or no activity. Then, Y-Tube was used to test the behavior choices tropism of P. xylostella adults, and the Component V showed the highest negative trend effect on P. xylostella adults also, with the Selevtive Index of 0.29 and 0.35 for female and male, respectively. Furthermore, behavior choice tropism of female and male of the moth was similar, and no significant difference between them. Feeding tests showed that P. rapae larvae were obviously deterrented by the Component V and the Component IV with AFC50 of 0.0147 mg/mL and 0.0229mg/mL, respectively, at 24h feeding the leaf-dishes treated by the two sterol components. Finally, chemical composition of the Component V and IV from X. sibiricum were analyzed by using gas chromatography-mass spectrum, and were found that the chemical compositions of the high activity components were similar, with primarily stigmasterol, sitosterol, and some small quantities of campesterol. But the contents of stigmasterol in Component V was a little higher than sitosterol, and Component IV was instead. This suggested that plant sterols might served as defence substances in X. sibiricum. Moreover, the contents of defferent component influenced their activities against insects.

Key Words: Xanthium sibiricum; Plutella xylostella; Pieris rapae; feeding deterrent; oviposition deterrent; negative trend effect

P-53-H

Olfactory response of *Frankliniella occidentalis* (Thysanoptera: Thripidae) and *Neoseiulus cucumeris* (Acari: Phytoseiidae) to odors of eggplants treaded with exogenous jasmonic acid

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Abstract: It was examined that the olfactory responses of *Frankliniella occidentalis* (Thysanoptera: Thripidae) and *Neoseiulus cucumeris* (Acari: Phytoseiidae) to volatiles from eggplants sprayed with different concentrations of exogenous jasmonic acid or with the same rate treated at different times in an olfactometer. The results showed that *F. occidentalis* did not respond to odors from eggplants treated with exogenous jasmonic acid (JA) at the concentrations of 0.05 mg/L, 0.1 mg/L, 0.5 mg/L, 1 mg/L, and 5 mg/L and the eggplants covered exogenous JA at the rate of 0.1 mg/L at 1 h, 3 h, 7 h, 12 h, and 24 h after treatment. However, *N. cucumeris* preferred the odors from plants sprayed at the concentration of 0.1 mg/L, 0.5 mg/L, 1 mg/L, and 5 mg/L exogenous JA to the eggplants without JA treatment, but the mites had no significant preference for eggplants sprayed at 0.05 mg/L to non-spraying JA plants. Furthermore, *N. cucumeris* significantly responded to odors of the eggplants sprayed with 0.1 mg/L JA at 7 h or earlier. As of 12 h the predatory mites had no significant difference the treated and the non-spraying eggplants.

Key words: *Frankliniella occidentalis*, *Neoseiulus cucumeris*, Exogenous Jasmonic acid, Eggplants

P-54-H

Isolation and identification of plant volatiles from three crucifer cultivars

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Abstract: The volatiles were absorbed and identified by headspace solid-phase microextraction (HS-SPME) and GC-MS from three crucifer cultivars, cabbage, Chinese cabbage and pakchoi. The result showed there were 76, 57, 60 plant volatiles absorbed by HS-SPME in the cabbage, Chinese cabbage and pakchoi respectively. Among these volatiles, saturated hydrocarbon was dominant, terpene was the second, and unsaturated hydrocarbon, aldehyde, alcohol, ketone, acid and heteroaromatic compounds existed with a small amount. (*Z*)-3-hexenyl acetate, (*Z*)-3-hexen-1-ol, benzaldehyde et al existed in all of three crucifer cultivars.

Key words: headspace solid-phase microextraction (HS-SPME); crucifer; plant volatiles.

P-55-H

Evaluation of Allelochemical Effects of Hordeum vulgare Extracts

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Abstract: There is increasing interest in the development of allelopathic crop varieties for weed suppression. The study was conducted to investigate the allelopathic potential of Hordeum vulgare varieties namely, BARI Barley-1, BARI Barley-2, BHL-3 and BL-1 that were collected from Bangladesh Agricultural Research Institute (BARI) and grown in control condition at Research Field of Tokyo University of Agriculture and Technology, Japan in 2010. The importance of allelopathy in nature and in agroecosystem has attracted researcher's attention with the main goal of using the phenomenon in biological control of weeds. Screening accessions of allelopathic crops and natural vegetation for their ability to reduce weeds is the basic approach for utilizing the phenomenon. Extracts of examined plant on annual ryegrass (Lolium rigidum L.) was investigated. Water extracts of 4 studied varieties were bioassayed on germination and seedling growth of Lolium rigidum such as, a) to test the heterotoxicity of barley on Lolium rigidum; b) to study the dynamics of allelopathic potential over three growth stages; c) to identify the most allelopathic plant part of barley; d) to indicate which variety has the highest allelopathic potentiality. Stems, roots, and leaves were extracted at three growth stage separately. Results of seedling growth bioassays demonstrated that Lolium rigidum responded differently to the allelopathic potential of H. vulgare. For L. rigidum radicle growth and germination were more depressed than coleoptile growth. The allelopathic potential of investigated plant parts was not stable over its life cycle for L. rigidum. Leaves were the most phytotoxic part of H. vulgare for L. rigidum in the all stages. The leaves extract of BHL-3 variety had the highest inhibition on radicle growth of L. rigidum. Results suggested that the response by L. rigidum varied depending on the source of allelochemicals (plant part) and the growth stage of the H. vulgare plant. The findings may be driven by the recognition that agro-ecological applications of allelopathy may provide alternatives to synthetic herbicides for weed control.

Key Words: Allelochemicals, autotoxicity, Hordeum vulgare L., Heterotoxicity, Lolium rigidum

P-56-H

Effect of Rhizoma Glycyrrhizae extract on spore germination, fungal growth and aflatoxin production by Aspergillus flavus and Aspergillus parasiticus

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Abstract: Aflatoxins (AFTs)，a group of toxic secondary metabolites are produced by species of Aspergilli, especially Aspergillus flavus and Aspergillus parasiticus. AFTs have been shown to be potent carcinogens, mutagens, and steratogens. Potentially toxigenic fungi Aspergillus flavus and Aspergillus parasiticus were isolated from licorice (Rhizoma Glycyrrhiza) root, a kind of frequently-used medicinal materials. This study was to investigate the effects of Rhizoma Glycyrrhiza aqueous extract (RGAE) and glycyrrhizic acid (GA) on the spore germination, fungal growth and aflatoxin production of Aspergillus spp. 4 isolates, non-aflatoxicogenic and aflatoxicogenic of Aspergillus parasiticus and Aspergillus flavus were tested. The productions of aflatoxin B1 and aflatoxin G1 were analyzed using high performance liquid chromatography (HPLC). The results showed that RGAE stimulated spore germination, fungal growth and aflatoxin B1 and aflatoxin G1 production of Aspergillus parasiticus and Aspergillus flavus. Non-aflatoxicogenic isolate of Aspergillus parasiticus 3.13637 was found to synthesize aflatoxin B1 and aflatoxin G1 by the action of RGAE. GA also stimulated aflatoxin B1 prodution of Aspergillus. parasiticus, but inhibited aflatoxin G1 production. These results suggested that there were some water-solubility substances in licorice root stimulated the aflatoxin B1 production of aflatoxicogenic isolates, while induced non-aflatoxicogenic isolate produced aflatoxins. Therefore, the infected medicinal materials of licorice by Aspergilli is easier to be contaminated by aflatoxins. We should pay high attention to the mildew phenomenon of Chinese medicinal materials.

Key Words: Aspergillus flavus; Aspergillus parasiticus; Rhizoma Glycyrrhiza; stimulation; aflatoxin B1 and aflatoxin G

P-57-H

Effects of inoculating arbuscular mycorrhizal fungi on Artemisia annua growth and its officinal components

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Abstract: A pot experiment was conducted to study the effects of inoculating arbuscular mycorrhizal(AM) fungi on the growth, nutrient uptake, and officinal components of Artemisia annua. Inoculation with AM fungi Glomus mosseae and G.versiforme improved the uptake of nitrogen, phosphorus, and potassium by A. annua, and increased the leaf chlorophyll content, net photosynthetic rate, stomatal conductance, and transpiration rate as well as the stem diameter and aboveground biomass of A. annua, with greater effects of inoculating G. mosseae than G. versiforme. After the colonization of G. mosseae and G. versiforme, the artemisinin content in A. annua stem, branch, and leaf was increased by 32.8%, 15.2%, and 19.6%, and 26.5% , 10.1% , and 14.9% , and the volatile oil content in leaf was increased by 45.0% and 25.0%, respectively, compared with the control. Furthermore, mycorrhizal colonization led to changes in volatile components.

Key Words: rbuscular mycorrhizal (AM) fungi; Artemisia annua; secondary metabolism; artemisinin; volatile oil

P-58-H

Silencing *OsAOS*, *OsCOI1*, *OsPAL* genes changes rice resistance to herbivorous insects

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Abstract: The role of defense signaling pathways of salicylic acid (SA) and jasmonic acid (JA) in the regulation of these induced defenses is well established in dicotyledonous plants, but little is known about it in monocotyledons. We silenced *OsAOS*, *OsCOI1* (JA pathway), *OsPAL* (SA pathway) genes in rice to determine the role of JA and SA signaling pathways in induced defense of rice against leaf folder (LF, *Cnaphalocrocis medialis*, a chewing herbivore) and brown planthopper (BPH, *Nilaparvata lugens*, a phloem-feeding insect). Transcripts of *OsAOS*, *OsCOI1*, *OsPAL* were up-regulated in wild type rice (WT) in response to feeding by LF. In response to BPH feeding, *OsPAL* transcript was up-regulated in WT. Further more, *OsBBPI* transcripts and trypsin protease inhibitor (TrypPI) level were induced by LF and BPH infestation. Antisense expression of *OsAOS* (*as-aos*), *OsCOI1* (*as-coi1*) reduced LF-induced JA, *OsBBPI* transcripts, trypsin protease inhibitor (TrypPI) level and peroxides (POD) activity, but it increased the LF larval performance. Antisense expression of *OsPAL* (*as-pal*) reduced LF-induced SA level and peroxides (POD) activity, *OsBBPI* transcripts, TrypPI level in *as-pal* plants, but it increased rice vulnerability to LF and BPH, while antisense expression of *OsAOS*, *OsCOI1* had no effect on BPH performance. These results imply that both JA and SA signal pathway involved in rice resistance to LF, while SA signaling pathway plays more important role in response to BPH attack. Trypsin protease inhibitor, POD, PPO can be regulated by both JA and SA in response to LF and BPH attack.

Keywords: Jasmonate signaling pathway, induced defense, rice, RNA interference

P-59-I

Age-related changes in olfactory response to host volatiles of a pine weevil, *Pissodes punctatus* Langor et Zhang

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Abstract: *Pissodes punctatus* is one of the most boring pest insect of *Pinus armandii* Franch, often resulting in its host death. Volatile composition of branches of the pine trees was significantly different from that released from trunks based on GC-MS analysis. There were relatively higher proportions of myrene (24.69%), limonene (26.53%), caryophyllene (9.66%) in branche volatiles, and lower α-pinene (20.20%), β-pinene (5.07%), 3-carene (undetected) in trunk volatiles. Walking *P. punctatus* in maturation feeding stage and in sexual matured stage displayed different olfactory responses toward these monoterpenes in a Y-tube olfactory test. Maturation feeding weevils displayed higher chemotaxis responses to (-)-β-pinene, myrene and limonene than sexually matured weevils; whereas (+)-carene, which was detected only in volatiles of trunk phloem, elicted more olfactory responses of sexually matured weevils than of maturation feeding weevils.

Field trap catch tests were conformed with the results in laboratory test. In 2008, trapping peak by (+)-limonene occurred in the middle and late of April, whereas trapping peak by 3-(+)-carene occurred in the early and middle of June. In 2009, the trapping peak of (+)-limonene occurred from the late of April to the late of May, and the trapping peak of 3-(+)-carene occurred from the late of June to the middle of july. Field trapping results were conformed with result in laboratory test.

We speculated that the different responses to host volatiles of the weevils in different development stages reflected the co-evolution relationship between the weevils and the pine trees. Newly emerging weevils in maturation feeding stage need to feed on tender branches to reach sexual maturity, when (+)-limonene which was mainly released from branches is a key semiochemical indicating the weevils find their appropriate food resources. On the other hand, sexually matured weevils busy in finding suitable oviposition sites for copulation and laying eggs depent on 3-(+)-carene as a key semiochemical which released mainly from trunk phloem of the trees.

Key words: *Pissodes punctatus*; age-related response; host volatiles

P-60-I

Preliminary Verification of Pheromone and Identification of Intestinal Volatile for *Pachypeltis* sp.

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Abstract: One insect species feeding Mikania micrantha was first discovered in longitude 97 ° 51'51 .3 ", latitude 24 ° 02'32 .7" during natural enemy investigation in Nov. 9, 2009. The species, identified by Prof. Liu Guo-qing of Nankai University as Pachypeltis sp. (Hemiptera: Miridae: Bryocorinae), was collected in Lianghe, Yingjiang, Longchuan, Ruili and Longling. P. sp. adults and nymphs are able to take the plant leaves juice, affect the flowering and seeding of M. micrantha, and cause plant wilt or death. P. sp. is only harmful to M. micrantha, not to major cash crops such as sugarcane, birch, pine, tea, mango, rubber, coffee, lemon, longan, corn, bamboo, teak, jackfruit, banyan and other kinds of plants like Gramineae, Cyperaceae, Asteraceae.

Mating courtship rhythm of the field survey showed that adult day behavior in the first half slow and fewer activities, more hiding in the surface of leaf and feeding the plant, causing leaf curl; or habitat in the bushes. After 16:00 pm, it is courtship and mating peak when the sun fade soft and adult become active. Courting, the plant bugs are combing the neck antennae, mouthparts, wings behavior; female adults more static volts in leaf, to lure male adult bulls arrive; male arrives, crawling around the female, male and female places touch the angle in the manner mating object; acceptable male in the female continued to crawl around for some time after the mating; other male mating success gradually leave. The same pair of adults can mate many times. After 19:00 pm, the field grass dew began to appear, P. sp. return to the plant leaf.

To verify the existence of P. sp. pheromones, explain the mechanism of chemical communication for mating behavior, the preliminary field trapping experiments were made by choosing a different color palette, with male and female adults as a living body odor. Field trials were made from Dec. 13, 2010 to Dec. 14, 2010. P. sp. respectively, 20 female adults, 20 male adults with polyethylene plastic mesh fixed on the coated plastic 30 × 40cm armyworm yellow, red, blue three kinds of polyethylene plastic sheet as a trap, trap cross hanging from the plant on top of a little shelf for supporting bamboo 1.5m. Trap spacing is not less than 10m. 5 replicates for each treatment set to not load the male and female adult sticky as the control. Male and female adult trap situation were recorded on 16:00 pm, Dec. 13, 9:00 am and 17:00 pm, Dec. 14. The results showed that the selectivity of P. sp. to red, yellow and blue three colors is not strong; selecting P. sp. male and female adults as live odor source can not be a good trap to the female adults; selecting female adults as odor source is able to trap a large number of males; Preliminary evidence showed that adult female can produce pheromone material, inducing mating with males.

In Nov. 25, 2010, selecting 100 female adults randomly, then cut intestines and related organizations (some of midgut, Malpighian tubules, and some of the fat body), put into pre-prepared sampling bottle containing 2ml cooling GC grade hexane methane; room temperature for 12h, the extract was transferred to another sample bottle, placed in -10 ℃ preservation; subsequent intestinal volatile substances by GC-MS detection, analysis to determine the main volatile female hindgut material ingredients are octadecadienoic acid, octadecadienoic acid, sixteen carbon acid, hexadecanoic acid, two octadecane, Acacia acid ester, stigmasterol -5,22 - diene -3-- alcohol, thirty alkyl 8 substances.

Key words: Pachypeltis sp.; pheromone; volatile

P-61-I

Influence of conspecific odor on the behavioral response of *Tribolium confusum* to food odor

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Abstract: *Tribolium confusum* (Coleoptera: Tenebrionidae) is a common pest of stored grains, particularly wheat flour and its products, and causes serious damage to the quality of the foods. The male insect produces an aggregation pheromone, 4,8-dimethyldecanal (DMD). In this study, the behavioral response of *T. confusum* to conspecific odors was investigated with a pitfall trap. We examined the influence of conspecific odors on the attractiveness of wheat flour odor to *T. confusum*. The odor of conspecific males or females at high density (50 or more beetles) without flour odor repelled both sexes. The odor of wheat flour that was infested by adult males or females (flour and beetles were placed together) attracted both sexes, as did the mixed odor of uninfested wheat flour and males or females (flour and beetles were located separately). However, the attractiveness of these 2 odors was less than that of uninfested flour odor without conspecific odor. In addition, the attractiveness of the flour odor gradually decreased depending on the number of days that had passed from the start of the beetle infestation. The odor of excrement dropped by 50, 100, 150, or 200 beetles for 24 h was attractive to conspecifics. The attractiveness of excrement was highest at 100 beetles; thereafter, it gradually decreased as the number of beetles increased. The odors of excrement and flour did not exert a synergistic effect on attractiveness to the beetles. *T. confusum* may regulate their density by several types of pheromones, such as aggregation pheromone, antiaggregation pheromone, and space pheromone.

Key words: *Tribolium confusum*, attraction, olfactory response, conspecific, aggregation pheromone, stored-product insect

P-62-I

Attractiveness of specific tea shoot volatiles and colored sticky plates to the tea green leafhopper, *Empoaca vitis*

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Abstract: The tea green leafhopper, *Empoasca vitis* Göthe, is one of the most serious insect pests of tea plantations in mainland China. Over the past decades, this pest has been controlled mainly by spraying pesticides. We should seek a safer biological control approach. In the present study, key components of tea shoot volatiles were identified and behaviorally tested as potential leafhopper attractants. The following thirteen volatile compounds were identified from aeration samples of tea shoots using gas chromatography-mass spectrometry (GC-MS): (*E*)-2-hexenal, (*Z*)-3-hexen-1-ol, (*Z*)-3-hexenyl acetate, 2-ethyl-1-hexanol, (*E*)-ocimene, linalool, nonanol, (Z)-butanoic acid, 3-hexenyl ester, decanal, tetradecane, *β*-caryophyllene, geraniol and hexadecane. In Y-tube olfactometer tests, the following individual compounds: (*E*)-2-hexenal, (*E*)-ocimene, (*Z*)-3-hexenyl acetate and linalool, as well as two synthetic mixtures (called blend 1 and blend 2) elicited significant taxis, with blend 2 being the most attractive. Blend 1 included linalool, (*Z*)-3-hexen-1-ol and (*E*)-2-hexenal at a 1:1:1 ratio, whereas blend 2 was a mixture of eight compounds at the same loading ratio: (*E*)-2-hexenal, (*Z*)-3-hexen-1-ol, (*Z*)-3-hexenyl acetate, 2-penten-1-ol, (*E*)-2-pentenal, pentanol, hexanol and 1-penten-3-ol. In tea fields, among ten types of coloured sticky plates the bud-green displayed the strong attractiveness to the leafhopper. The bud-green sticky board traps, baited with blend 2, captured lots of adults and nymphs of the leafhoppers. Our results indicate that the bud-green sticky traps baited with tea shoot volatiles can provide a new tool for monitoring and managing the tea leafhopper.

Key Words: tea shoot volatiles; colored sticky plates; attractiveness; Empoaca vitis; tea plantations

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P-63-J

Efficient Protocol for Seed Germination of Centella asiatica

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Abstract: The effect of several environmental factors on germination of medicinal herb Centella asiatica was investigated. Freshly harvested seeds of C. asiatica did not germinate even after gibberellic acid (GA) treatment and exposure to different treatments with light qualities, while two-three months old seeds exhibited germination (82%) without pre-treatment at warm environment (25 -30°C). GA treatment induced germination by two weeks earlier than in control. Germination was significantly ($p=0.001$) higher in red and white light than in blue and far red light. In addition, germination of C. asiatica was sensitive towards the salt stress and was significantly inhibited at 6500 ppm NaCl. The leaf leachates from invasive weeds Chromolaena odorata, Ageratum conyzoides, Parthenium hysterophorus and Xanthium strumarium showed inhibitory effects on seed germination of C. asiatica. Parthenium hysterophorus had significant effect ($p<0.001$) on seed germination. These data contribute for the establishing of an efficient protocol for C. asiatica cultivation.

Key Words: Germination, Salinity, Leaf leachate, Weeds, Gibberellic acid, Centella asiatica

P-64-J

Improving Degree Day Modelling for Oriental Fruit Moth and Codling Moth

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Abstract: Oriental fruit moth (OFM) and Codling moth (CM) are major economic pests of the Australian stone and pome fruit industries. Currently, spray prediction programs for OFM and CM are based on the first sustained catch (over two consecutive trapping periods) of the male moths in sex pheromone traps called 'biofix'. Then the 'biofix' date is used in Degree Day Models (DDM) to calculate and predict date of the first egg hatch. Unfortunately, sex pheromone traps placed in orchards treated with mating disruption (MD) produce highly variable and very low moth catches and therefore monitoring results may not be reliable for 'biofix' determination and subsequent egg hatch prediction. A current research project is assessing the accuracy of 'biofix' dates based on either male or female moth catches to predict egg hatch for OFM and CM. Sentinel egg cards from a laboratory culture were also placed in the field and used to assess the accuracy of prediction. This work will allow modifications to the DDM to develop a more accurate predictive model and a prototype decision support system.

The results to date suggested that egg hatch can be predicted to start about 86DD after a 'biofix' based on capture of female CM in pear ester baited traps in mating disruption orchards. Terpinyl acetate and brown sugar baited traps did not appear to provide reliable indication of OFM activity under MD, because head-capsule measurements of OFM larvae collected in the orchard demonstrated that egg hatch occurred before the first female moths were caught in terpinyl acetate and brown sugar baited traps.

Key Words: oriental fruit moth, codling moth, degree day modeling, kairomone traps

P-65-J

Cell-based piezoelectric biosensor for measurement of ecological environments

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Abstract: In recent years, piezoelectric quartz systems have been used in analytical chemistry because their oscillating frequencies are sensitive and have wide range. A quartz crystal microbalance (QCM), which is a nanogram mass sensing device, has been applied to determine gases, ions, and some biomolecule. These studies are based on the fact that the resonant frequency change of the quartz crystal corresponds to mass change on the crystal surface.

In this study, we have succeeded in living cell adhesion to the gold surface of the quartz crystal in our own QCM system. Although cells adhered to the surface under growth media containing serum, a stable unchanging oscillation frequency occurred. Subsequently, frequency changes were observed by trypsinization, which was remove cells from the surface. In addition, this changing process can be monitored in real time.

In the device, living cells serve as the sensing element, where cellular mass and viscoelasticity affect the frequency of the crystal. More recently, the research of these applications as cell-based biosensors has been in progress. We aim to construct the simple cell-based piezoelectric biosensor for measurement of the ecological environment (e.g., water, soil, or air pollution containing cytotoxic activity). Because the cell adhesion change can be monitored as frequency change of the quartz in the system, this biosensor will be also useful for the real time identification or screening of biologically active drugs or biological molecules that affect cell adhesion.

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Key Words: Biosensor, Quartz crystal microbalance, cultured cell

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