The Nakanishi Symposium

on Natural Products & Bioorganic Chemistry

Nagoya University

March 27, 2014

Sponsored by
The Chemical Society of Japan
&
The American Chemical Society

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Jerrold Meinwald
Professor Emeritus, Cornell University

■Department Appointments

Chemistry and Chemical Biology (CHEM)

■Graduate Fields

Chemistry and Chemical Biology

■Other Affiliations

American Academy of Arts & Sciences, Secretary

■Keywords

Biosynthesis of biologically active natural products, chemical ecology

■Research

Isolation and identification of biologically active compounds from insect and other arthropod sources

Pheromone and chemical defensive systems of arthropods

Identification of the messenger molecules involved and the understanding of the underlying signal transduction pathways

■Selected Publications

1. Eisner, T.; Meinwald, J. Alkaloid-Derived Pheromones and Sexual Selection in Lepidoptera. Pheromone Biochemistry and Molecular Biology, G. J. Blomquist and R. C. Vogt, Eds., Elsevier Academic Press, London, 2003, pp. 341–368.
2. Taggi, A.E.; Meinwald, J.; Schroeder, F. A New Approach to Natural Products Discovery Exemplified by the Identification of Sulfated Nucleosides in Spider Venom. J. Am. Chem. Soc, 2004, 126 (33), 10364.
3. Schroeder, F.C.; Weibel, D.B.; Meinwald, J. Chiral Silylation Reagents: Determining Configuration via NMR-Spectroscopic Coanalysis. Organic Letters, 2004, 6, 3019.
4. Meinwald, J. Personal Reflections on Receiving the Roger Adams Award in Organic Chemistry. JOC , 2005, 70, 4903.
5. Gronquist, M.; Meinwald, J.; Eisner, T.; Schroeder, F. Exploring Uncharted Terrain in Nature's Structure Space Using Capillary NMR Spectroscopy: 13 Steroids from 50 Fireflies. JACS 2005, 127 (31), 10810.

■Awards and Distinctions

- ❖ American Chemical Society Ernest Guenther Award;
- ❖ Arthur C. Cope Scholar
- ❖ Tyler Prize for Environmental Achievement (with Thomas Eisner)

- International Society of Chemical Ecology Silver Medal
- Gustavus John Esselen Award for Chemistry in the Public Interest(with Thomas Eisner)
- Czech Academy of Sciences Heyrovsky Medal
- 2005 American Chemical Society Roger Adams Award in Organic Chemistry
- 2006 Grand Prix, la Maison de la Chimie (with Thomas Eisner)
- 2013 Benjamin Franklin Medal in Chemistry

Nakanishi Symposium 2014

Organized by：Nakanishi Symposium Organizing Committee
Co-organized by: Chemical Society of Japan,
Division of Natural Products Chemistry & Biological Science

Date　March 27th, 2014, 13:30–17:30

Venue　Nagoya University (Higashiyama Campus)

Program

■13:30–14:00 Award Ceremony of the Nakanishi Prize 2014

Chair　Prof. Kazuo Tachibana (The University of Tokyo)

Prize Winner of the Nakanishi Prize 2014:

Prof. Jerrold Meinwald (Cornell University)

■14:00–17:30 Nakanishi Symposium

Chair　Prof. Michio Murata (Osaka University)

◆14:00–

"*Chemistry and Biology of Nyctinastic Plant Movement*"

Prof. Minoru Ueda (Tohoku University)

◆14:35–

"*Toward an Ideal Synthesis of Bioactive Molecules through Direct Arene Assembling*"

Prof. Jun'ichiro Yamagushi (Nagoya University)

Chair　Prof. Minoru Ueda (Tohoku University)

◆15:10–

"*Exploration of New Juvenile Hormone of Heteropteran Insects*"

Prof. Tetsuro Shinada (Osaka City University)

◆15:45–

"*Chemical Ecology of Insect–Plant Interactions*
— *Ecological Roles of Phytochemicals*"

Prof. Ritsuo Nishida (Kyoto University)

Chair　Prof. Kazuo Tachibana (The University of Tokyo)

◆16:20–　Award Lecture

"*Exploring the Chemistry of Biotic Interactions*"

Prof. Jerrold Meinwald　(Cornell University)

Chemistry and Biology of Plant Leaf-movement

Minoru Ueda

Department of Chemistry, Tohoku University

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"The movements of plant" is historic research field in biology. It is well known that Charles Darwin is a pioneer of this field. We have been engaged in the bioorganic studies on this intriguing plant behavior.

We identified 12-*O*-*β*-D-glucopyranosyljasmonic acid (JAG)[1] as the bioactive metabolite inducing nyctinastic leaf-folding of Samanea saman.[2, 3] JAG was completely inactive with respect to activation of typical JA responses and triggers leaf-folding through COI1-dependent mechanism.[3] The addition of JAG mediates the generation of second messenger in the extensor motor cell and induce the activation of outward-rectifying potassium channel. Additionally, JAG have identified as a trap-closing endogenous factor of Venus's Flytrap.[4] This movement is also known to be classified in an ion-channel regulated behavior of plant. We found unique function of JAG as an endogenous mediator of "plant movements".

References:

1. *Tetrahedron*, **56**, 8101–8105 (2000).
2. *Angew. Chem. Int. Ed.*, **47**, 7289–7292 (2008).
3. *Plant Physiology*, **155**, 1226–1236 (2011).
4. *ChemBioChem*, **11**, 2378–2383 (2010).

Toward an Ideal Synthesis of Bioactive Molecules Through Direct Arene Assembling

Junichiro Yamaguchi
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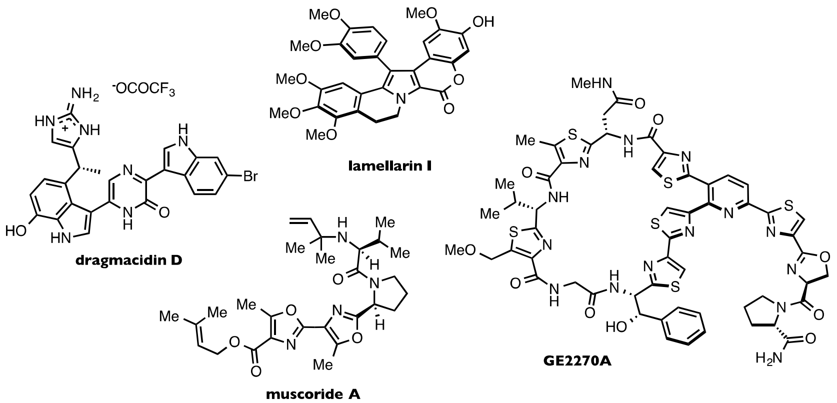
Graduate School of Science, Nagoya University
junichiro@chem.nagoya-u.ac.jp

Biaryls and heterobiaryls are ubiquitous motifs in pharmaceuticals, natural products, and organic materials alike, and therefore, the construction of these scaffolds has been a topic of great importance in chemistry. Recently, C–H coupling of aromatic compounds using transition metal catalysts has garnered much attention from the synthetic chemistry community as a next-generation coupling method for constructing (hetero)biaryl motifs.[1] Although the development of new reactions and catalysts continues to evolve at a rapid pace, successful applications of this method to the synthesis of natural products and pharmaceuticals are still rare.[2] Thus, our research program has focused on synthesis-oriented methodology development in catalytic C–H coupling (direct arene–assembling reactions). As a result, more than ten new C–H coupling reactions of heteroarenes such as 1,3-azoles, indoles, pyrroles, azines, and thiophenes have been developed and utilized for the rapid synthesis of bioactive molecules such as natural products and pharmaceutical candidates. Furthermore, the method of late-stage C–H coupling can be highly relevant for medicinal chemistry. In this symposium, I would like to talk our recent progress of toward an ideal synthesis of bioactive molecules through direct arene assembling.



References:

1. Yamaguchi, J.; Itami, K. “Biaryl Synthesis through Metal-Catalyzed C–H Arylation”, *Metal-Catalyzed Cross-Coupling and More*, Wiley–VCH, **2014**, 1315

2. Yamaguchi, J.; Yamaguchi, A. D; Itami, K. *Angew. Chem. Int. Ed.* **2012**, 51, 8960.

Exploration of New Juvenile Hormone of Heteropteran Insects

Tetsuro Shinada

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The insect juvenile hormone (JH) is an acyclic terpenoid that regulates many aspects of insect physiology, such as metamorphosis, reproduction, diapause, and polyphenisms (Fig. 1).[1] The presence of JH was first discovered by Wigglesworth in 1934 in the blood-sucking bug, Rhodnius prolixus (suborder Heteroptera, order Hemiptera) as a humoral factor that prevents metamorphosis of the final instar nymph into an adult.[2] The structure of JH I (**1**) in the cecropia moth was first elucidated in 1967.[3] Since then, several JHs **2-6** have been reported.[1]

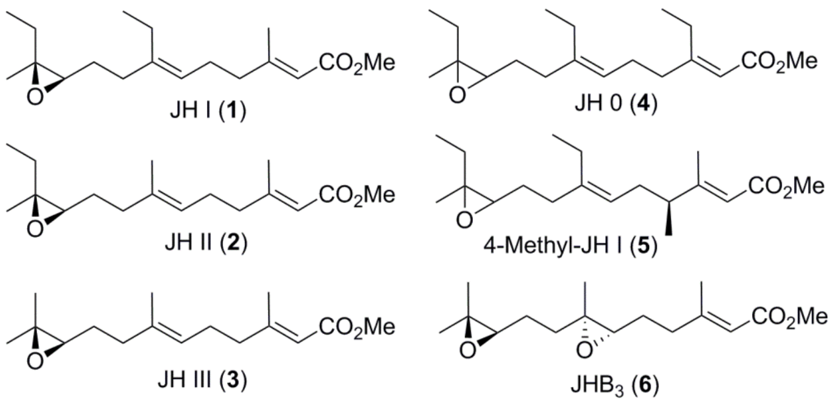

Fig. 1 Structure of JH

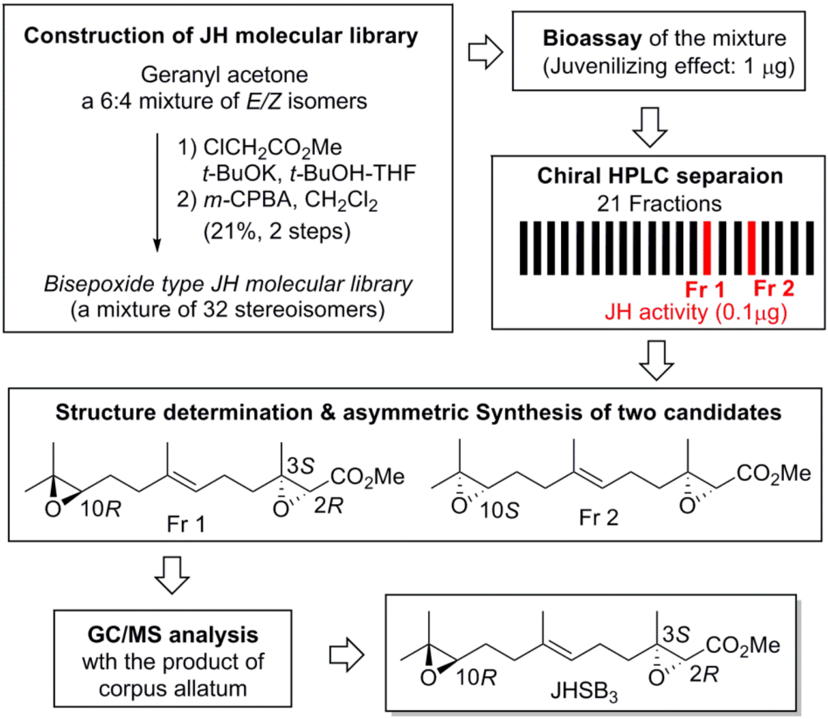

Fig. 2 Structure determination of $JHSB_3$

Heteropteran insects are a major insect group including ca. 40,000 species. In this group, several serious pests of crops and gardens, and vectors of the Chagas parasite are included. Although the physiological study of heteropterans is one of the important subjects in this research area, the structure of heteropteran JH has remained unsolved. We tackled this challenge and solved the structure of a new JH, JHSB,[3] in a stink bug, *Plautia stali* by a new chemical library approach (Fig. 2).[4] In this presentation, the details of new chemical library approach and its application to the exploration of $JHSB_3$ in other heteropteran insects will be described.

References:

1. Morgan, E. D.; Wilson, I. D.; Mori, K. “Comprehensive Natural Products Chemistry”;Barton, D. H. R., Nakanishi, K., Eds. Miscellaneous Natural Products Including Marine Natural Products, Pheromones, Plant Hormones, and Aspects of Ecology; Pergamon: Oxford, 1999; Vol. 8, pp 263–369.
2. Wigglesworth, V. B. *Q. J. Microsc. Sci.* **1934**, *77*, 191–222.
3. Röller, H.; Dahm, K. H.; Sweely, C. C.; Trost, B. M. *Angew. Chem. Int. Ed. Engl.* **1967**, *6*, 179–180.
4. (a) Kotaki, T.; Shinada, T.; Kaihara, K.; Ohfune, Y.; Numata, H. *Org. Lett.* **2009**, *11*, 5234-5237. (b) Kotaki, T.; Shinada, T.; Kaihara, K.; Ohfune, Y.; Numata, H. *J. Insect Physiol.* **2011**, *57*, 147–152.

Chemical Ecology of Insect–Plant Interactions – Ecological Roles of Phytochemicals

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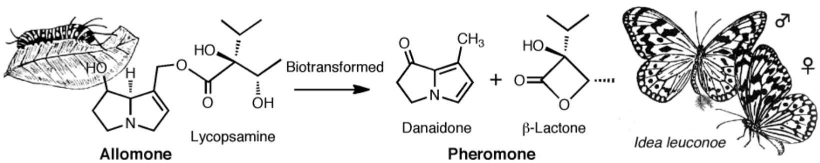
Plants produce a diverse array of secondary metabolites as chemical barriers against herbivores. Phytophagous insects are highly adapted to these allelochemicals and may use such unique substances as specific host-finding cues, defensive substances of their own (allomones), and even as sex pheromones or their precursors by selectively sensing, incorporating and/or processing these phytochemicals.

Caterpillars of a giant danaine butterfly, *Idea leuconoe*, selectively feed on *Parsonsia laevigata* (Apocynaceae), by sensing specific metabolites in the host plant, and sequester a series of poisonous pyrrolizidine alkaloids to protect themselves from predators. The males biotransform alkaloids to danaidone and a unique β-1actone, and emit a bouquet of volatiles from "hairpencils" to arrest a female (see below). The female can verify a male's defensive quality via the pheromonal ingredients. This exemplifies an ecological adaptation mechanism via plant secondary metabolites in the highly diverse interactions between insects and plants.



References:

R. Nishida, *Biosci. Biotech. Biochem*. **78** (1) (2014).

Exploring the Chemistry of Biotic Interactions

Jerrold Meinwald
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The study of the chemistry of “natural products” has led to the rich development of much of what we know about organic chemistry. However, it was not until the mid-20th century that the *significance of natural products from the viewpoint of the producing organisms* became a subject of interest to chemists. Some examples of our studies of arthropod defensive chemistry will be presented, and the relationship between plant defensive chemistry and insect chemical signaling will be discussed. Based on this and other examples, a plausible mechanism for the evolution of pheromones will be presented. The study of chemical ecology is still in its infancy, and it will be important to preserve the earth’s biodiversity so as to learn about chemical interactions of potential importance to medicine, agriculture, and everyday life.

Minoru Ueda: born in Nagoya, 1965 and graduated from Konan University (B 1989), earned his PhD (1994, Nagoya Unversity, Prof. Minoru Isobe), and became Assistant Professor, Department of Chemistry, Keio University (1994–1999), Lecturer, Department of Chemistry, Keio University (1999–2001), Associate Professor, Department of Chemistry, Keio University (2001–2004), and Professor, Department of Chemistry, Tohoku University (2004–). He received awards including Japan Chemical Society Awards for Young Chemists (2000), The Tokyo Techno Forum Gold Medal (2003), and The Japanese Society for Chemical Regulation of Plants Awards (2013).

Junichiro Yamaguchi: born in 1979 and graduated from Tokyo University of Science (B. 2002), PhD, Tokyo University of Science (Prof. Yujiro Hayashi) 2007, Postdoctoral fellow, The Scripps Research Institute (2007–2008, Prof. Baran), Assistant Professor, Faculty of Science, Nagoya University (2008–2012), Associate Professor, Faculty of Science, Nagoya University (2012–). Young Scientist's Research Award in Natural Product Chemistry, Japan (2011), The Chemical Society of Japan Award for Young Chemists (2013), Banyu Chemist Award (2013), and Thieme Chemistry Journal Award (2014).

Tetsuro Shinada: born in Hyogo, 1965 and graduate from Setsunan University (B. 1987), Kobe Pharmaceutical University (PhD, 1992, Prof. Ichiya Ninomiya). Postdoctoral fellow: Texas A & M University (1992–1994, Prof. D. H. R. Barton), Suntory Institute for Bioorganic Research (1994–1996, Prof. T. Nakajima). Academic position: Lecturer, Department of Material Science, Osaka City University (1996–2003, Prof. Y. Ohfune Lab.), Associate Professor, Graduate School of Material Science, Osaka City University (2004–2010), Professor, Graduate School of Material Science, Osaka City University (2010–). Award of Kansai Branch, The Society of Synthetic Organic Chemistry, Japan (2008).

Ritsuo Nishida: born in Mie, 1949 and graduated from Mie University (1972). PhD, Kyoto University (Prof. Hiroshi Fukami) 1977. Research Associate, NY State Agricultural Experiment Station, Cornell University (1977–1979, Prof. W. S. Bowers; 1979–1980, Prof. W. L. Roelofs). Assistant Professor of Faculty of Agriculture, Kyoto University (1980–1992), Associate Professor (1992–2003), Professor of Graduate School of Agriculture, Kyoto University (2003–). Awards: Research Award by Japanese Society of Applied Entomology and Zoology, 1996. The Japan Bioscience, Biotechnology and Agrochemistry Society Senior Scientist Award, 2013.

The Recipients of the Prize hereto are:

1996	Yoshimasa Hirata*	2006	Takeshi Yasumoto*
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1999	Jeremy R. Knowles	2009	JoAnne Stubbe
2000	Satoshi Omura*	2010	Shosuke Yamamura*
2001	John D. Roberts	2011	C. Dale Poulter
2002	Sir Jack Baldwin*	2012	Daisuke Uemura*
2003	A. Ian Scott	2013	Arthur G. Palmer, III
2004	Isao Kitagawa*	2014	Jerrold Meinwald*
2005	Stephen J. Benkovic		

*Selection and presentation made by the Chemical Society of Japan.

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