

2.3.4 Laboratory : Chemical Ecology

Member:	Professor	Nishida, Ritsuo, D. Agric. Sci.
	Associate Professor	Mori, Naoki, D. Agric. Sci.
	Assistant Professor	Ono Hajime, D. Agric. Sci.
	Doctor's program	2
	Master's Program	8
	Undergraduate	5

A. Research Activities (2009.4-2010.3)

A-1. Main Subjects

a) Contact pheromone perception mechanisms in cockroaches

Females of *Blattella germanica* feed on a nuptial secretion from the male's eighth tergal gland (TG-8) during courtship. The pheromonal components, oligosaccharides and 1,2-diacylphosphatidylcholine, elicited specific behavioral and electrophysiological responses specifically in females. The TG-8 extract induced specific impulses in four functionally different receptor cells: the sugar, salt and two other types of receptor cells in a single gustatory sensillum on the paraglossae in both sexes. The results suggested that the synergistic effect on 'sweetness' of oligosaccharides in the female cockroach contributes to her nuptial feeding. The female-biased gustatory sensitivity seems to ensure successful coupling during nuptial feeding. Likewise, the male tergal glandular secretions of *Periplaneta fuliginosa* was examined to characterize the sex pheromonal components.

b) Phospholipid biosynthesis in the gut of *Spodoptera litura* larvae

We investigated the biosynthesis of lysoPC in *Spodoptera litura* larvae. *S. litura* larvae were fed artificial diets enriched with [U-13C]linolenic acid for 3 h, and then phospholipids in the gut contents were analyzed by LCMS-IT-TOF. Labeled linolenic acid was incorporated into lysoPC as well as diacylPC, diacylphosphatidylethanolamine (diacylPE) and diacylphosphatidylinositol (diacylPI). Detailed investigation of the biosynthesis revealed that [U-13C]linolenic acid was incorporated into phospholipids in gut tissues, the biosynthesized phospholipids were released into the gut lumen, and then some diacylPC was hydrolyzed to lysoPC in the gut lumen. When *S. litura* larvae were fed artificial diets enriched with tannin, a significant increase in the activity to produce diacylPC in the gut tissues was observed.

Activated diacylPC production leading to an increase of lysoPC in the larvae might be an adaptive mechanism against plant tannins.

c) Distinct roles of ecdysone from 20-hydroxyecdysone in *Drosophila melanogaster*

In insects, a steroid hormone, 20-hydroxyecdysone (20E), plays important roles in the regulation of developmental transitions. Besides, its role as a precursor, ecdysone has been considered to be a relatively inactive compound. To characterize biological function of ecdysone, the expression of a biosynthetic enzyme in the prothoracic gland (PG), an ecdysteroid biosynthetic tissue, was manipulated. In this case, it is expected that 20E will be released from the PG instead of E. This manipulation leads to developmental delay and a larval lethal phenotype. Furthermore, an application of ecdysone to wild type larvae accelerates the timing of initiation of pupariation, which results in elevation of lethality during metamorphosis. These results indicate that ecdysone and not just 20E is essential for molting and metamorphosis to occur with correct timing in *Drosophila melanogaster*.

A-2.Publications and presentations

a) Publications

Books

- Nishida, R. 2009. Coadaptation between insects and plants via floral fragrances "Innovative food and environmental studies pioneered by entomomimetic sciences" pp.191 -220 (Fujisaki, K., Nishida, R. and Sakuma, M. eds) Kyoto University press, Kyoto
- Katsumata, A., R. Nishida 2009. Chemical sensors of insects. "Innovative food and environmental studies pioneered by entomomimetic sciences" pp.191 -220 (Fujisaki, K., Nishida, R. and Sakuma, M. eds) Kyoto University press, Kyoto
- Mori, N., N. Yoshinaga, T. Aboshi (Writing division) 2009. Herbivore adaptations to plant defense systems, "Innovative food and environmental studies pioneered by entomomimetic sciences" pp. 165-189 (Fujisaki, K., Nishida, R. and Sakuma, M. eds) Kyoto University press, Kyoto
- Mori, N., Y. Kuwahara (Writing division) 2009. Oribatid mites as a major dietary source for alkaloids in poison frogs, "Innovative food and environmental studies pioneered by entomomimetic sciences" pp. 246-251 (Fujisaki, K., Nishida, R. and Sakuma, M. eds) Kyoto University press, Kyoto
- Mori, N., Y. Kuwahara (Writing division) 2009. Induction of allergic contact dermatitis by astigmatid mite-derived monoterpene, α -acaridial. "Innovative food and environmental studies pioneered by entomomimetic sciences" pp. 468-471 (Fujisaki,

K., Nishida, R. and Sakuma, M. eds) Kyoto University press, Kyoto

Original Papers

- Aboshi, T., N. Yoshinaga, R. Nishida and N. Mori: Phospholipid biosynthesis in the gut of *Spodoptera litura* larvae and effects of tannic acid ingestion. *Insect Biochem. Mol. Biol.* 40; 325-330, 2010
- Yoshinaga, N., H.T. Alborn, T. Nakanishi, D.M. Suckling, R. Nishida, J.H. Tumlinson and N. Mori: Fatty acid-amino acid conjugates diversification in lepidopteran caterpillars. *J. Chem. Ecol.* 36; 319-325, 2010
- Nishida, R., H. Enomoto, T. E.. Shelly and T. Ishida: Sequestration of 3-oxygenated α -Ionone derivatives in the male rectal gland of the solanaceous fruit fly, *Bactrocera latifrons*. *Entomol. Exp. Appl.* 131; 85–92, 2009
- Wada-Katsumata, A., M. Ozaki, F. Yokohari, M. Nishikawa and R. Nishida: Behavioral and electrophysiological study on the sexually biased synergism between oligosaccharides and phospholipids in gustatory perception of nuptial secretion by the German cockroach. *J. Insect Physiol.* 55; 742-750, 2009
- Shimizu, N., K. Miwa, K. Noge, R. Yakumaru, N. Mori and Y. Kuwahara: Stereochemistry of female-specific normonoterpenes, sex pheromone candidates from the acarid mite, *Tyrophagus* sp. (Astigmata: Acaridae). *Biosci. Biotechnol. Biochem.* 73; 2332-2334, 2009
- Ishikawa, C., N. Yoshinaga, T. Aboshi, R. Nishida and N. Mori: Efficient incorporation of free oxygen into volicitin in common cutworm *Spodoptera litura* larvae. *Biosci. Biotechnol. Biochem.* 73; 1883-1885, 2009
- Sasai, H., M. Ishida, K. Murakami, N. Tadokoro, A. Ishihara, R. Nishida and N. Mori: Species specific glucosylation of DIMBOA in larvae of the rice armyworm. *Biosci., Biotechnol. Biochem.* 73; 1333-1338, 2009

b) Conference and seminar papers presented

- The 5th Asia-Pacific Conference on Chemical Ecology, Honolulu, Hawaii, USA: 4 papers
- The 26th ISCE Annual Meeting: 2 papers
- Japan Society for Bioscience, Biotechnology, and Agrochemistry (2009): 4 papers
- The 80th Zoological Society of Japan (2009): 1 件
- The Insect Workshop (2009): 1 件

A-3.Off-campus activities

Membership in academic societies

- Nishida, Ritsuo, D. Agric.Sci. : Japanese Society of Applied Entomology and Zoology (councilor)
- Naoki Mori : Union of Japanese Societies for Insect Sciences (Committee), Japanese Society of Applied Entomology and Zoology (Editor), Japanese Society of Environmental Entomology and Zoology (Councilor), The Acarological Society of Japan (Executive Committee, Editorial Board)

Research grants

1. Grants-in-aid for Scientific Research(KAKENHI)

- Scientific Research (B) (2) : Nishida, Ritsuo, D. Agric.Sci. : Molecular chemical ecological approach for coevolutionary process between insects and plants
- Scientific Research (C) (2) : Naoki Mori, D. Agric. Sci. : Insect herbivore-produced elicitors of plant defense reactions
- Young Scientists (B) : Ono, Hajime, D. Agric.Sci. : Analysis of signaling cascades of insect hormones by manipulation of hormonal secretion

2.Other Research Grants

- JST in Research for Promoting Technological Seeds:Nishida, R., D. Agric Sci. : Production of tephritid fruit fly pheromones via biotechnology using Drosophila melanogaster
- The Asahi Glass Foundation: Ono, Hajime, D. Agric.Sci. : Elucidation of developmental mechanism regulated by levels of steroid hormone in insects

A-4.International cooperation and overseas activities

Membership in academic societies

- Nishida, Ritsuo, D. Agric.Sci.: Asia-Pacific Association of Chemical Ecologists (President), Biochemical Systematics and Ecology (Editorial advisory board), Chemoecology (Editorial advisory board)

International meetings(country,roles)

- Nishida, Ritsuo, D. Agric.Sci. : The 5th Asia-Pacific Conference on Chemical Ecology (USA, Organizing committee)
- Naoki Mori : The 5th Asia-Pacific Conference on Chemical Ecology (USA, Symposium organizer)

International joint research, overseas research surveys

- Chemical ecology on fruit fly attractants, Nishida, R., Malaysia, Thailand, Papua New

Guinea, USA

- Chemical ecology of turnip sawflies, Nishida, R., Germany
- Pheromonal study in cockroaches, Nishida, R., Germany, Russia, USA, Malaysia
- Biosynthesis of insect-produced elicitors, Mori, N., Penn State University, USDA ARS CMAVE, The New Zealand Institute for Plant and Food Research Limited

B.Educational Activities(2009.4-2010.3)

B-1.On-campus teaching

a) Courses given

- Undergraduate level: Bioorganic Chemistry III (Nishida and Mori), Organic Reaction Mechanisms I (Mori), Structure Analyses of Organic Compounds (Nishida), Laboratory Course in Bioorganic Chemistry (Mori and Ono).
- Graduate level: Chemical Ecology (Advanced Course) (Nishida and Mori), Laboratory Course in Chemical Ecology (Nishida, Mori and Ono), Chemical Ecology Seminar (Nishida, Mori and Ono)

B-2.Off-campus teaching etc.

Part-time lecturer

- Nishida, R.: Faculty of Education, Kyoto University of Education (Natural Product Chemistry)