FAST BREAKING PAPERS - 2008

August 2008

PDF

Claus Wasternack talks with *ScienceWatch.com* and answers a few questions about this month's Fast Breaking Paper in the field of Plant & Animal Science. The author has also sent along images of their work.

Article Title: Jasmonates: An update on biosynthesis, signal transduction and action in plant stress response, growth and development
Authors: Wasternack, C
Journal: ANN BOT
Volume: 100
Issue: 4
Page: 681-697
Year: OCT 2007
* Leibniz Inst Plant Biochem, Dept Nat Prod Biotechnol, Weinberg 3, D-06120 Halle, Saale, Germany.
(addresses have been truncated)

SW: Why do you think your paper is highly cited?

This is an invited review on recent aspects of biosynthesis, signal transduction, and the action of jasmonates (JAs) in plant stress responses, growth, and development. JAs became an exponentially growing interest during the last decade due to their role as important signal in plant responses to biotic and abiotic stress, and also in hormone regulating developmental processes such as root growth, tuber formation, and flower development.

There is a large scientific community interested in news related to the field of JAs, which regulate plant root growth, pollen fertility, wounding and healing, and defense against pathogens and insects. Due to a remarkable crosstalk between signaling pathways of JAs and other plant hormones such as ethylene, salicylate, or abscisic acid, readers need to have a concise update on biosynthesis and the action of JAs.

Furthermore, after appearance of the review in *Annals of Botany,* a breakthrough in JA research was published on a new protein family active in a protein complex with the F-box protein COI1 showing putative JA receptor function. This breakthrough was published by several groups worldwide and all of them took the review mentioned above as the most recent overview.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

The review gives a concise overview on JAs. Although distinct aspects of Jas are frequently reviewed, the *Annals of Botany* review summarizes news on the lipoxygenase pathways where JA biosynthesis is one branch, on JA

biosynthesis including regulation and crystal structure of enzymes, on the metabolic fate of JAs, on structure-activity relationships, and on action of Jas (as novel anti-cancer agents, as signal in biotic and abiotic stress, in tuber formation, in tendril coiling and touch, in flower development, and in senescence). Obviously, this type of synthesis of knowledge, supported by adequate schemes and pictures, came out at the right time.

Figure 1: +detials

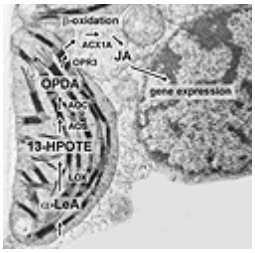
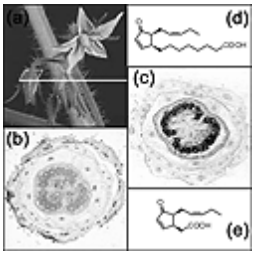


Figure 2:



SW: Would you summarize the significance of your paper in layman's terms?

The paper is an overview on recent discoveries in biosynthesis and the action of Jas. These compounds occur exclusively and ubiquitously in plants and are signaling compounds in defense reactions of plants in response to stress such as wounding by herbivores. Additionally, they are essential for proper plant development, e.g., fertility of flowers.

SW: How did you become involved in this research, and were there any problems along the way?

Eighteen years ago, I became familiar with the work on Jas. At that time, the director of the Institute of Plant Biochemistry (IPB) Halle, Prof. Benno Parthier, asked me to lead the JA research at the IPB. Within the IPB, in parallel to Junichi Ueda's group at Osaka Prefecture University in Japan, the first physiological effects were observed in the early '80s, and, at the end of this decade, the first JA-induced alteration of gene expression was observed by B. Parthier's group with barley leaves showing so-called JA-induced proteins (JIPs) as abundant proteins upon JA treatment.

Later, Clarence A. Ryan's group at Washington State University in Pullman, WA, showed that synthesis of proteinase inhibitors upon herbivore attack on tomato leaves was mediated by an airborne signal, the jasmonic acid methyl ester. From that time on, JAs were identified as signals in many plant stress responses.

Our own research at IPB Halle was, and is, characterized by a combined use of molecular genetic, cell-biological, and analytical techniques. This broad expertise and the unique advance in GC-MS analysis of Jas from the '80s led to the broad interest of many groups from around the world in collaborating with the Halle group.

SW: Where do you see your research leading in the future?

Since I retired last month, my own active research will be finished by the end of 2008. But the expertise on JAs, for which the IPB Halle is known worldwide over the past two decades, will be ongoing in terms of tools, GC-MS analysis of JAs, and new projects by Dr. Bettina Hause (Department of Secondary Metabolism) and the new head of the Department of Natural Product Biotechnology, who is currently under nomination.

SW: Do you foresee any social or political implications for your research?

While there are no apparent social and political implications of my research on JAs, there is an increasing interest worldwide in taking advantage of JA action in plant-insect interaction for agricultural applications.

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Keywords: biosynthesis, signal transduction, jasmonates, JAs, plant stress responses, biotic, abiotic stress, root growth, tuber formation, flower development, plant root growth, pollen fertility, JA-induced proteins, JIPs, plant-insect interaction.

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Figures and descriptions:

Figure 1:

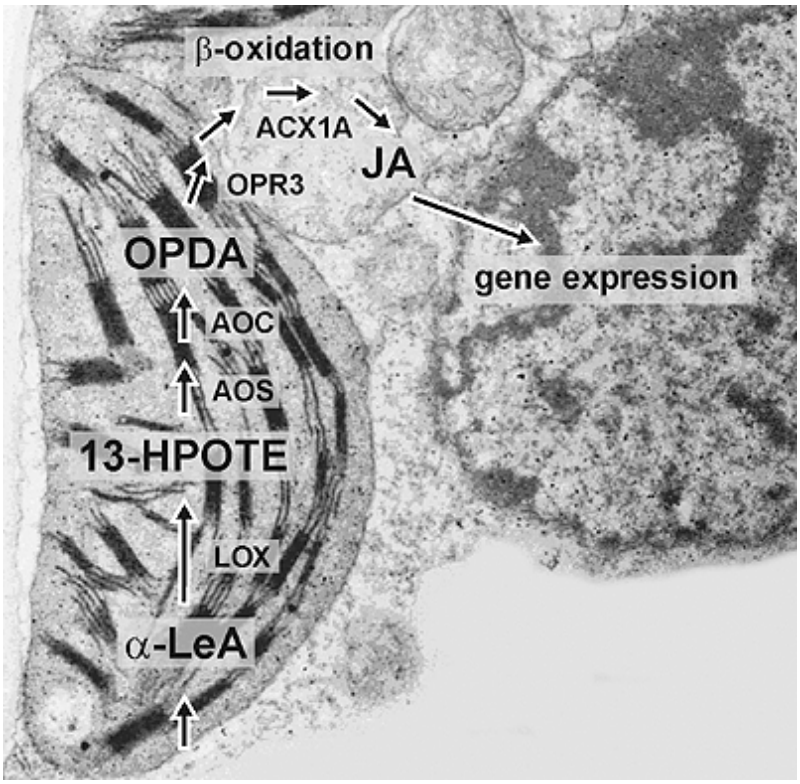

Figure 1:

Biosynthesis, intracellular location and action of jasmonate biosynthesis illustrated on a transmission electron micrograph of a barley mesophyll cell showing the associated cellular compartments, the chloroplast, the peroxisome and the nucleus (a-LeA: a-linolenic acid; LOX: lipoxygenase; 13-HPOTE: 13-hydroperoxy-octadecatrienoic acid; AOS: allene oxide synthase; AOC: allene oxide cyclase; OPDA: 12-oxophytodienoic acid; OPR3: OPDA reductase3; ACX1A: acyl CoA oxidase 1A; JA: jasmonic acid) (photo: B. Hause) (C. Wasternack, *Ann. of Bot.* **100:** 691-697, 2007).

Figure 2:

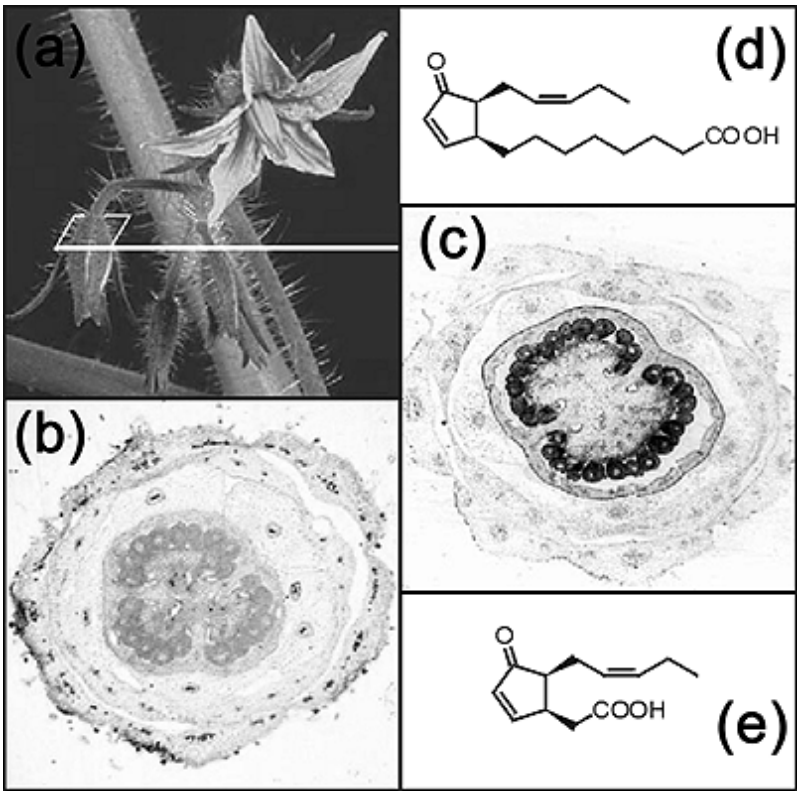

Figure 2:

Within jasmonate biosynthesis, the correct enantiomeric structure of the cyclopentanone ring of jasmonate is established by the allene oxide cyclase (AOC), which is encoded by a single copy gene in tomato. The first AOC was cloned from tomato by the Halle group in 2000. *AOC* is preferentially expressed in ovules of tomato flower buds. (a) tomato flower and tomato flower bud, (b) cross-section of a tomato flower bud showing *AOC* promoter activity by GUS staining, (c) cross-section of a tomato flower bud showing immunocytological detection of AOC protein (black staining), (d) structure of 12-oxo-phytodienoic acid, the precursor of jasmonic acid; (e) structure of jasmonic acid in the more stable (-)-form (C. Wasternack, *Ann. of Bot.* **100:** 681-697, 2007).

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