

Fellowship ID : BR220202

独立行政法人日本学術振興会理事長 殿

To: President, Japan Society for the Promotion of Science

研究活動報告書

Research Report

1. 受入研究者/ Host researcher

受入研究機関・部局・職

Name of Host Institution, Department and Title

千葉大学・大学院園芸学研究院・准教授

受入研究者氏名

Host Researcher's Name

島田 貴士

2. 外国人再招へい研究者/ Fellow

所属研究機関・部局・職

Name of Institution, Department and Title

ストラスブルグ大学・植物分子生物学研究所・グループリーダー

外国人再招へい研究者氏名

Fellow's Name

Hubert SCHALLER

3. 採用期間/ Fellowship Period

2022 年 11 月 11 日

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2022 年 12 月 1 日

4. 研究課題/ Research Theme

Plant biology – Phytosterol metabolism and biology

5. 研究活動報告/ Research Report

(1) 研究活動の概要/ Summary of Research Results

The objective of the scientific stay and workplan at Chiba University (2022-11-11 to 2022-11-21) with Dr Takashi Shimada was (i) to perform a prospective evaluation of a research program centered on the elucidation of phytosterol biology and homeostasis in model and crop plants, (ii) to outline future collaborative efforts on this common interest and research hot topic, and (iii) to identify a framework for collaborative efforts including networks and funding agencies.

Sterols are tremendously important components in cell developmental biology and biochemistry. Cholesterol metabolism and function have been quite well described in mammalian cells but still some aspects in cellular distribution and function are lacking. Plant sterol biology although sharing some common elements with mammalian cholesterol biology (especially enzymes) has its own specificities. Clearly, well-known regulatory elements known in mammalian cholesterol homeostasis as discovered by Brown and Goldstein (NP 1985) do not have homologous counterpart in plants, therefore key components of phytosterol homeostasis cannot be identified based on homology searches. This is fully justifying the forward genetic approaches developed by the Shimada [1,2] and the Schaller research groups in Chiba and Strasbourg [3]. In fact, plant-specific components implied in sterol homeostasis are just emerging thanks to the identification of a novel regulatory component called HiSE controlling the

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metabolism of phytosterols [1,2,3].

The following research questions have been defined between Drs Shimada and Schaller:

- Broad significance of the HiSE gene: the role of HiSE in other plants than in the model *Arabidopsis thaliana* is currently examined by Dr Takashi using tomato as a target crop plant and genome editing as a valuable approach. The role of HiSE in a related species from the *solanaceae* family will be examined by Dr Schaller, using tobacco (*Nicotiana tabacum*) genome edited lines currently generated (work in progress). The work on tobacco in the Strasbourg lab is linked to the genetic characterization of a tobacco variant that accumulates sterols. This program had formed the basis of a recent EU funded project (H2020-2021) on 'High phytosterol variants towards improved feedstocks and biofortification of crops'.
- Molecular mechanism of HiSE gene function on phytosterol homeostasis: one of the key questions here is to demonstrate if there is a direct or indirect interaction between HiSE and the key enzyme 3-hydroxy-3-methylglutaryl coenzyme A reductase (HMGR) implied in the mevalonate/isoprenoid/sterol pathway. The Strasbourg lab in collaboration with Dr Shimada is working on a series of gene expression experiments using distinct HMGR proteins expressed in high and low HiSE *Arabidopsis thaliana* lines.

The collaborative research program discussed by the host Dr Shimada and the JSPS BRIDGE fellow Dr Schaller will be formalized by applying to the next 2023 call for starting PI-to-PI projects funded by CNRS (grant program called *International Emerging Actions CNRS*, deadline June 2023).

The objective of the scientific stay and workplan at Osaka University (2022-11-22 to 2022-12-01) with Pr Daisaku Ohta and Dr Takashi Shimada was (i) to perform a thorough assessment of the research program centered on the biogenesis of lipid droplets in plants and especially the formation of phytosterol esters-rich lipid droplets in model and crop plants, and (ii) to identify a funding body for preparing a full research proposal (JSPS joint programs, JSPS postdoc fellowships, Human Frontiers Scientific Programs, others to be identified). A important scientific discussion on the biogenesis of lipid droplets in plants was organized by Dr Shimada and Pr Ohta at Osaka Metropolitan University with Pr Ikuko Ishimura (2022-11-29) as special guest and scientific advisor. The objective of the scientific visit in Osaka with Pr Daisaku Ohta was also to further develop a common approach on phytosterol signaling in cell division and plant development [4].

References-publications

- [1] Shimada TL, et al 2019 HIGH STEROL ESTER 1 is a key factor in plant sterol homeostasis. *Nature Plants* 5 (11), 1154-1166).
- [2] Darnet S, Schaller H (2019) Unleashed sterol production in thale cress. *Nature Plants* 5, 1112-1113.
- [3] Darnet S, Schaller H, et al Genetic analysis of isoprenoid and phytosterol pathways, submitted.
- [4] Ohta D, Schaller H, et al Subcellular dynamics of sterol methyltransferases in cell division, in preparation

(2) 研究キーワード/Keywords

Plant biology, metabolism, terpenoid and lipid homeostasis, lipid droplets, phytosterol, cholesterol.

(3) 主な研究発表 (雑誌論文、学会、集会、知的財産権等)/Main Research Publications

Including seminars

Seminars

The BRIDGE JSPS fellowship to Dr Schaller included the following seminars and scientific visits:

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Seminar – 2022-11-14 – RIKEN Brain Science Center, Wako, Saitama.

Host: Pr Yoshio Hirabayashi, Dr Peter Greimel

Title: Novel components of sterol pathways and metabolic diversity in eukaryotes

Dr Schaller had co-organized a workshop in Strasbourg September 2-4, 2019 with Dr Toshihide Kobayashi (RIKEN and Strasbourg University) entitled 1st Japan-Europe Workshop on Glycosphingolipids and Membrane Homeostasis. This was the occasion to meet colleagues from RIKEN Wako in Strasbourg, therefore the BRIDGE visit offered the possibility to further develop scientific interactions on sterol biology in the brain.

Seminar – 2022-11-18 – Chiba University, Graduate School of Horticulture

Host: Dr Takashi Shimada

Title: Genetic analysis of isoprenoid and phytosterol pathways

Seminar – 2022-11-25 – Osaka University, Department of Biotechnology

Host: Pr Toshiya Muranaka

Title: Genetic analysis of isoprenoid and phytosterol pathways

Hybrid seminar online for the JSPP (Japanese Society for Plant Physiology). The possibility to send French undergraduate students on a Takenoko JSPS program, to the Muranaka lab was discussed.

Seminar – 2022-11-28 – Osaka Prefecture University

Host: Pr Daisaku Ohta

Title: Genetic analysis of isoprenoid and phytosterol pathways

Other scientific visits and project-based discussion.

The BRIDGE JSPS visit allowed Dr Schaller to visit:

Dr Yuki Nakamura, Plant Lipid Research team, RIKEN Center for Sustainable Resource Science, Yokohama, Kanagawa.

The context of this visit is a common interest in plant lipids and activities at the International Symposium for Plant Lipids (ISPL, biannual international meeting).

Dr Tetsuo Kushiro, School of Agriculture, Meiji University, Kawasaki, Kanagawa

We are engaged with Dr Kushiro in the characterization of novel sterol conjugates (aminoacylsterols) in eukaryotes [5].

Dr Masaharu Mizutani, Kobe University

Scientific and prospective discussion on plant sterol biosynthesis in non-seed plants.

The context of the visit is a running networking program developed by CNRS called **GDR France-Japan Frontiers in Plant Biology (2021-2023)**.

A scientific conference will be organized by leaders of this program in Kyoto in October 2023, **Topics:** Plant biology, Cellular biology, Signal transduction, Genome dynamics, Development and morphogenesis, Plant stress adaptation, Photosynthesis and metabolism.

Publications

The BRIDGE JSPS fellowship and stay is supported by the current publications or manuscripts:

[1] Shimada TL, et al 2019 HIGH STEROL ESTER 1 is a key factor in plant sterol homeostasis. *Nature Plants* 5 (11), 1154-1166.

[2] Darnet S, Schaller H (2019) Unleashed sterol production in thale cress. *Nature Plants* 5, 1112-1113.

[3] Darnet S, Schaller H, et al Genetic analysis of isoprenoid and phytosterol pathways, submitted.

[4] Ohta D, Schaller H, et al Subcellular dynamics of sterol methyltransferases in cell division, in preparation

[5] Yacobov N, [..], Yokokawa D, [..], Kushiro T, [..], Schaller H, Fischer F, Becker H (2022) RNA-dependent synthesis of ergosteryl-3 β -O-glycine in ascomycota
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expands the diversity of steryl-amino acids. J Biol Chem 298(3):101657.

(4) その他/Remarks

The BRIDGE JSPS fellow Dr Hubert Schaller warmly thanks the JSPS and the host Dr Takashi Shimada, as well as Pr Daisaku Ohta, for supporting the scientific visit and fruitful stay in Japan.

受入研究機関事務担当者記入/ Filled in by Host Institution

部署・氏名		電話番号	
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※ 部局名等の名称含め、内容に誤りが無いか必ずご確認ください。

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