Laboratory of Biological Diversity

MANO Group

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Plant cells can induce, degenerate and differentiate their organelles to adapt to environmental changes. This flexibility of plant organelles is the basis of the strategy for environmental adaptation in plants.

The aims of our research group are to clarify the molecular mechanisms underlying the induction, differentiation, and interaction of organelles, and to understand the integrated functions of individual plants through organelle dynamics.

I. Molecular mechanisms of peroxisome biogenesis and functions in plant cells

Peroxisomes are single-membrane bounded organelles, which are ubiquitously present in eukaryotic cells, and they are involved in various biological processes such as lipid metabolism and photorespiration. To understand peroxisome biogenesis and functions, we have been analyzing a number of Arabidopsis mutants having aberrant peroxisome morphology (*apem* mutants) and peroxisome unusual poisoning (*peup* mutants). To date, *APEM1*, *2*, *3*, *4*, *9* and *10*, and *PEUP1*, *2* and *4* genes were identified, and based on the characterization using their gene-products a part of the mechanism of division, protein transport and degradation of peroxisomes, were revealed.

Recently, we found that peroxisome functions and biogenesis are involved in the reproductive process. Therefore, peroxisomes in gametes and gametophytes were visualized, and their dynamics are currently under investigation (Figure 1).

II. Accumulation mechanism of seed storage proteins

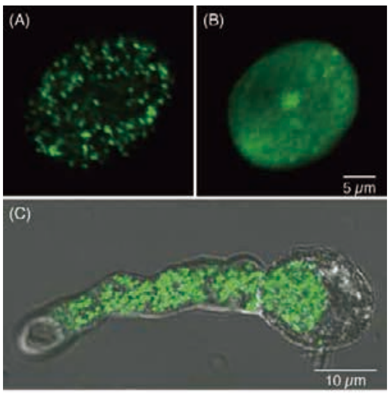

Figure 1. Visualization of peroxisomes in pollen and pollen tube. The fusion gene of GFP with peroxisome targeting signal 1 is expressed in the wild-type (A) and *apem2*/*pex13* plants (B). (C) Peroxisomes move toward the tip region during pollen tube growth.

Plant seeds accumulate huge amounts of storage reserves such as oils, carbohydrates and proteins. Humans use these storage reserves as foods, feed, and industrial materials. Storage reserves are different among different plant seeds. Wheat, maize and rice seeds mainly accumulate starch, whereas rapeseed, pumpkin and sesame contain large amounts of oils. Soybean contains proteins as a major reserve. We are analyzing Arabidopsis mutants showing different patterns of oil/protein ratios to elucidate the mechanisms controlling oil and protein contents in seeds.

III. Construction of The Plant Organelles Database 3 (PODB3)

PODB3 was built to promote a comprehensive understanding of organelle dynamics. PODB3 consists of six individual units: the electron micrograph database, the perceptive organelles database, the organelles movie database, the organellome database, the functional analysis database, and external links. Through these databases, users can obtain information on plant organelles' responses to environmental stimuli of various tissues of several plant species, at different developmental stages. We expect that PODB3 will enhance the understanding of plant organelles among researchers.

Publication List

〔Original papers〕

- Goto-Yamada, S., Mano, S., Nakamori, C., Kondo, M., Yamawaki, R., Kato, A., and Nishimura, M. (2014). Chaperone and protease functions of LON protease 2 modulate the peroxisomal transition and degradation with autophagy. Plant Cell Physiol. *55*, 482-496.
- Mano, S., Nakamura, T., Kondo, M., Miwa, T., Nishikawa, S., Mimura, T., Nagatani, A., and Nishimura, M. (2014). The Plant Organelles Database 3 (PODB3) update 2014: integrating electron micrographs and new options for plant organelle research. Plant Cell Physiol. *55*, e1.
- Shibata, M., Oikawa, K., Mano, S., and Nishimura, M. (2014). Measurement of the number of peroxisomes. Bio-Protoc. *4*, e1284.

〔Original paper (E-publication ahead of print)〕

- Motomura, K., Le, Q.T.N., Hamada, T., Kutsuna, N., Mano, S., Nishimura, M., and Watanabe, Y. Diffuse DCP2 accumulates in DCP1 foci under heat stress in *Arabidopsis thaliana*. Plant Cell Physiol. 2014 Oct 22.

〔Review articles〕

- Goto-Yamada, S., Mano, S., and Nishimura, M. (2014). Interaction between chaperone and protease functions of LON2, and autophagy during the functional transition of peroxisomes. Plant Signal. Behav. *9*, e28838.
- Goto-Yamada, S., Mano, S., Oikawa, K., Shibata, M., and Nishimura, M. (2014). The role of peroxisomes in plant reproductive processes. In Sexual reproduction in animals and plants. – Edited by Sawada, H., Inoue, N., and Iwano, M. Springer Japan, pp. 419-429.
- Shibata, M., Oikawa, K., Yoshimoto, K., Goto-Yamada, S., Mano, S., Yamada, K., Kondo, M., Hayashi, M., Sakamoto, W., Ohsumi Y., and Nishimura, M. (2014). Plant autophagy is responsible for peroxisomal transition and plays an important role in the maintenance of peroxisomal quality. Autophagy *10*, 936-937.