Department of Environmental Bioscience

Laboratory of Plant Physiology and Function

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TEACHING	Biological Chemistry Plant Nutrition Plant Functional Science Advanced Plant Environmental Physiology (MC)	Plant Biochemistry Plant Physiology Advanced Plant Environmental Physiology (MC)

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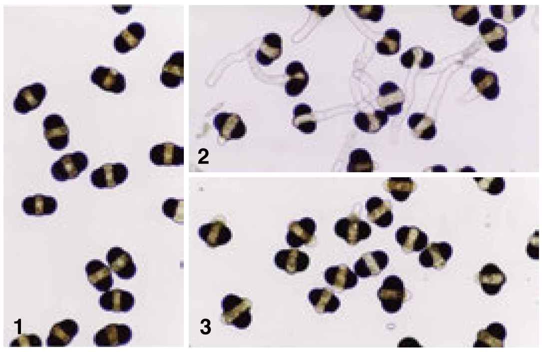
Research

Elucidation of the environmental adaptation mechanisms in plants

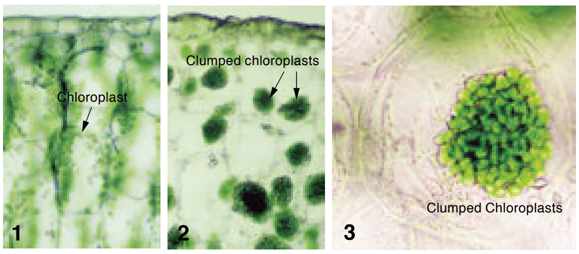
Response mechanism of plant male gametophyte to nutrient stress

Pollen, plant male gametophyte, plays an important role in bridging life from the past to the future on earth. Mature pollen released from anthers is extremely dry, and in a state of dormancy. However, when pollen absorbs water, it germinates and subsequently elongates the pollen-tube for fertilization.

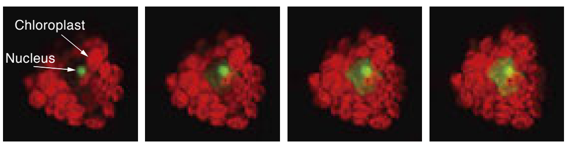
Mature pollen (photo 1) from Pinus thunbergyi germinates in about 20 h on agar medium and then significantly elongates the pollen-tube after 48 h-cultivation (photo 2). We found an interesting phenomenon that the pollen-tube growth is strongly suppressed even after 48h-cultivation with the addition of a natural substance to this medium (photo 3). Currently, to clarify the regulatory mechanism of pollen-tube elongation of pinus pollen, we have biochemically attempted to elucidate the inhibition mechanism of pollen-tube elongation by the natural substance.



Effects of a natural substance on pollen germination and pollen-tube elongation of Pinus thunbergyii
1. mature pollen (without cultivation), 2. pollen after 48 h-cultivation (control),
3. pollen after 48 h-cultivation with a natural substance (inhibitor).



Comparison of chloroplast arrangement during light period in leaves of succulent plants with adequate water (1) and water stress (2, 3).



3D analysis of the clumped chloroplasts by use of confocal microscope.
Chloroplasts clumped around the nuclei.

HPLC

Data analyzed by use of HPLC

Active oxygen scavenging mechanism in plants

When plants encounter a stressful environment, active oxygen is generated in their cells. Since the strong oxidizing power of active oxygen may cause various obstacles to living cells, it is thought that the plant uses the defense and response mechanism using antioxidants.

In our laboratory, it was found that the clumping of chloroplast was caused by both factors of light and water stress in several sorts of succulent plants (photo 1, control; photos 2, 3, water stress). The optical transmittance of the leaf increased 3-fold compared with the control by forming the clumping of chloroplasts. The results suggested that such a phenomenon plays an important role as one of the evasion mechanisms of the optical obstacle resulting from water stress. Further analysis is required to know more about the relationship between the clumping phenomenon of chloroplasts and active oxygen scavenging enzyme systems including ascorbic acid peroxidase.

Carbon metabolism mechanism of CAM plants

CAM (Crassulacean Acid Metabolism) represents one of the three major photosynthetic carbon metabolisms, together with C3 and C4 pathways. CAM plants have drought tolerance that enables plants to survive in arid areas. Therefore, the features of CAM plants have been attracting for use in preservation of greenery and prevent desertification. Recent studies reveal that the intracellular localization of a key enzyme in carbon metabolism, pyruvate, Pi dikinase (PPDK) in mesophyll cells of CAM plants varies among species, and connected with that, the pathways in decarboxylation of malic acid are also different. These findings show that CAM system is more diverse than previously thought. Further detailed analysis is necessary to know the behavior of intermediate on responses to environmental stress. Our goal is to clarify the metabolic pathway and its regulation in CAM to apply the useful features of CAM plants to crop production under water deficit conditions.

Some CAM plants. (Pineapple, Zygocactus, Kalanchoe showed from the left.)

Recent publications:
- Kondo A., Murakami H. Y. and Funaguma T. (2010) Induction of CAM by salt stress in the common purple ice plant, *Lampranthus spectabilis*. *J. Res. Inst. Meijo Univ.*, 9:11-17
- Kondo A, Shibata K, Sakurai T, Tawata M, Funaguma T. (2006) Intracellular positioning of nucleus and mitochondria with clumping of chloroplasts in the succulent CAM plant *Kalanchoë blossfeldiana*: an investigation using fluorescence microscopy. *Plant Morphology*, 18: 69-73
- Kondo A, Kaikawa J, Funaguma T, Ueno O. (2004) Clumping and dispersal of chloroplasts in succulent plants. *Planta*, 219: 500-506
- Kondo A, Nose A, Ueno O. (2001) Coordinated accumulation of the chloroplastic and cytosolic pyruvate, Pi dikinases with enhanced expression of CAM in *Kalanchoë blossfeldiana*. *Physiol. Plant.*, 111: 116-122
- Funaguma T, Okabayashi T, Horii T, Hara A. (1999) A glycosidase with β - D - glucosidase and β - D - fucosidase from pollen of *Typha latifolia*. *Jpn. J. Palynol.*, 45: 159-163