

## Disease Reports

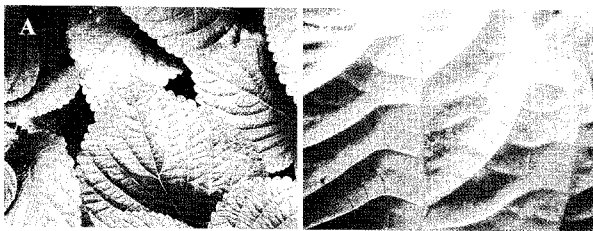
# Downy Mildew of Perilla Caused by *Peronospora perillae* in Korea

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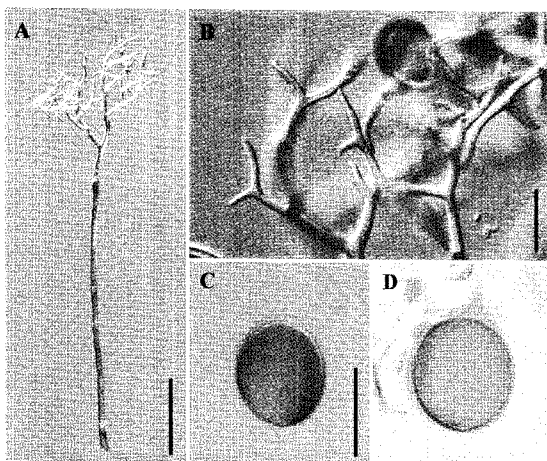
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*Perilla* (*Perilla frutescens* (L.) Britton var. *frutescens*) is extensively cultivated and used in East Asia. In Korea, the plant is one of the most important oil crops with sesame (*Sesamum indicum* L.), and its leaves are used as a leafy vegetable. Recently, accompanied with increased meat consumption and development of various cooking methods of fresh leaves, cultivation area of the crop is becoming wider. Downy mildew disease on the crop has previously occurred in China and Japan (Farr and Rossman, 2008), but not yet in Korea.



**Fig. 1.** Downy mildew symptom on *Perilla frutescens*. A: Leaves infected with *Peronospora perillae*, B: Sporulation of *Peronospora perillae* on the lower leaf surface.

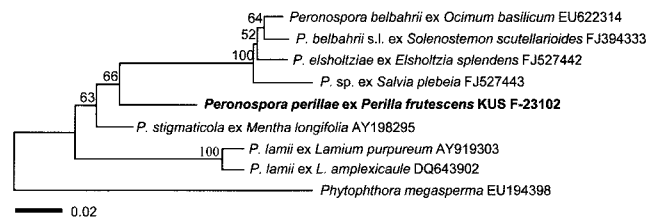
In October 2007, plants showing typical symptoms of downy mildew were found in a greenhouse in Hwaseong, Korea. Infection resulted in yellow or pale green spot on upper leaf surfaces, with a greyish fungal growth developing on lower surfaces. The lesions are angular, clearly delimited by leaf veins (Fig. 1A & B). A sample was deposited at the Mycological Herbarium of the Korea University, Seoul, Korea (KUS F-23102). Conidiophores (320-650×7-11 μm) are hyaline, tree-like, branched 4-6 times (Fig. 2A). Ultimate branchlets were slightly curved to substraight, 8-17(-30) μm long (Fig. 2B). Conidia are subglobose, brown to pale brown, and measured 20-25.3×17.5-22.5 μm (length/width ratio=1.06-1.25) (Figs. 2C & D). Morphological observation showed this fungus is well concordant with previously known characteristics of *P. perillae* (Yu et al., 1998). By morphology of conidia and ultimate branchlets, it differed from



**Fig. 2.** *Peronospora perillae* on *Perilla frutescens*. A: Conidiophore, B: Ultimate branchlets, C & D: Conidia. Bars=100 μm for A, 20 μm for B-D.

*P. lamii*, which was often regarded as the causal agent in a few previous studies.

The amplification and sequencing of the complete ITS region of rDNA were performed with procedures outlined by Cooke et al. (2000), and the sequence of the region was deposited in GenBank (Acc.No. EU513600). For comparison, seven sequences of *Peronospora* species parasitic to the family Lamiaceae were obtained from GenBank. Molecular phylogenetic reconstructions were done using MEGA4, version 4.0 (Tamura et al., 2007), for neighbour-joining (using Tajima-Nei distances). To test the reproducibility of results, 1000 bootstrap replicates were performed. In ITS-based tree (Fig. 3), the KUS F-23102 occupied an independent branch, and was clearly distinguished from *P. lamii* (DQ643902) with sequence dissimilarity of 10.3%, which was a well-known pathogen on many plants of the Lamiaceae, including perilla. Since this was the first sequence submitted for *P. perillae*, comparable data were not available. The present phylogenetic analysis with the morphological result supported that the causal agent is indeed *P. perillae*.



**Fig. 3.** Phylogenetic relationship between *Peronospora perillae* on *Perilla frutescens* and other *Peronospora* species parasitic to the Lamiaceae, inferred by ITS rDNA region. Numbers above the branches represent the bootstrap values. Bar=Number of nucleotide substitutions per site.

Based on morphological and molecular approaches, the assumed pathogen was identified as *Peronospora perillae*. Though this fungus has been previously recorded in China and Japan (Farr and Rossman, 2008), phytopathological importance has never been considered. This is the first report on the occurrence of the downy mildew in commercial production of perilla. Since most of perilla plants are cultivated for producing leaves and most of leaves are consumed as salads in Korea, the downy mildew poses a serious threat to safe production of perilla leaves.

## References

- Cooke, D. E. L., Drenth, A., Duncan, J. M., Wagels, G. and Brasier, C. M. 2000. A molecular phylogeny of *Phytophthora* and related Oomycetes. *Fungal Genet. Biol.* 30:17-32.
- Farr, D. F. and Rossman, A. Y. 2008. Fungal Databases, Systematic Mycology and Microbiology Laboratory, ARS, USDA. Retrieved December 15, 2008, from [http://nt.ars-grin.gov/fungal\\_databases/](http://nt.ars-grin.gov/fungal_databases/)
- Tamura, K., Dudley, J., Nei, M. and Kumar, S. 2007. MEGA4: Molecular Evolutionary Genetics Analysis (MEGA) software version 4.0. *Mol. Biol. Evol.* 24:1596-1599.
- Yu, Y.-N., Zhung, W.-Y., Liu, X.-J., Ma, G.-Z., Li, J.-L., Yin, G.-Y., Yang, Z.-S., Tao, J.-F., Shen, Y.-Z., Wang, Y.-X. and Liu, Y.-L. 1998. *Flora Fungorum Sinicorum. Vol. 6. Peronosporales*. Science Press, Beijing, 530 pp.

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