

YAMAGUCHI Group

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Angiosperm leaves generally develop as bifacial structures with distinct adaxial and abaxial identities. However, several monocot species, such as iris and leek, develop “unifacial leaves”, in which leaf blades have only an abaxial identity (Figure 1). We are focusing on unifacial leaf development and evolution to understand genetic mechanisms behind diversity and evolution of organismal morphology.

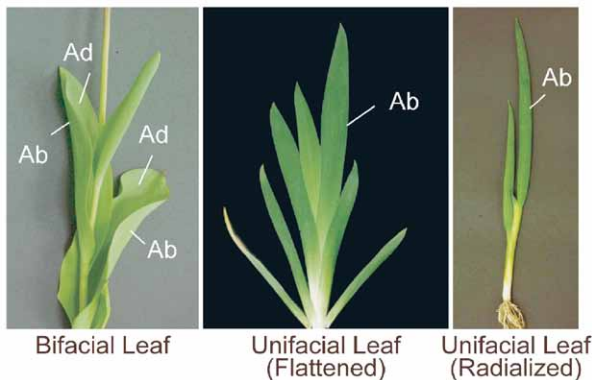


Figure 1. Bifacial and unifacial leaf structures. Ad, Adaxial side; Ab, Abaxial side.

I. Abaxialization of unifacial leaves

The development and evolution of unifacial leaves have long been matters of debate. However, nothing has been studied at the molecular genetic level. We focused on the genus *Juncus* as a model to study the evolution and development of unifacial leaves. *Juncus* contains species with a wide variety of leaf forms and is amenable to molecular genetic studies (Yamaguchi and Tsukaya, 2010). We first characterized unifacial leaf development by investigating gene expression patterns of adaxial and abaxial determinants. As a result, we demonstrated that the unifacial leaf blade is abaxialized at the gene expression level and revealed that dominant abaxial activity leads to the unifacial leaf development (Yamaguchi et al., 2010).

II. Flattening of unifacial leaves

In bifacial leaves, adaxial–abaxial polarity is required for leaf blade flattening, whereas many unifacial leaves become flattened although their leaf blades are abaxialized (Figure 1). This indicates independent mechanisms underlying flattened leaf blade formation in bifacial and unifacial leaves.

Using two closely related *Juncus* species, *J. prismatocarpus*, with flattened unifacial leaves, and *J. wallichianus*, with radialized unifacial leaves, we revealed that *DL* expression levels and patterns correlate with the degree of laminar outgrowth. Genetic and expression studies

using interspecific hybrids of the two species revealed that the *DL* locus from *J. prismatocarpus* flattens the unifacial leaf blade and expresses higher amounts of *DL* transcripts. Thus, *DL* is a key gene that flattens the unifacial leaf blade. Interestingly, *DL* plays a distinct role in promoting midrib formation during bifacial leaf development. We suggest that morphological convergence of flattened leaf blades in unifacial leaves has occurred via the recruitment of *DL* function, which plays a similar cellular but distinct phenotypic role in monocot bifacial leaves (Figure 2, Yamaguchi et al., 2010).

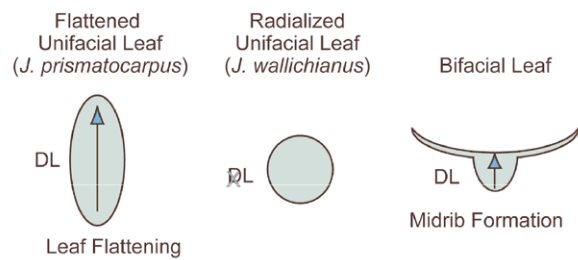


Figure 2. Mechanism of leaf blade flattening in unifacial leaves.

Publication List

[Original papers]

- Nakayama, H., Yamaguchi, T., and Tsukaya, H. (2010). Expression patterns of *AaDL*, a *CRABS CLAW* ortholog in *Asparagus asparagoides* (Asparagaceae), demonstrate a stepwise evolution of *CRC/DL* subfamily *YABBY* genes. *Amer. J. Bot.* 97, 591–600.
- Nelissen, H., De Groeve, S., Fleury, D., Neyt, P., Bruno, L., Bitonti, M.B., Vandenbussche, F., Van Der Straeten, D., Yamaguchi, T., Tsukaya, H., Witters, E., De Jaeger, G., Houben, A., and Van Lijsebettens, M. (2010). Plant Elongator regulates auxin-related genes during RNA polymerase II transcription elongation. *Proc. Natl. Acad. Sci. USA* 107, 1678–1683.
- Toriba, T., Suzaki, T., Yamaguchi, T., Ohmori, Y., Tsukaya, H., and Hirano, H. (2010). Distinct regulation of adaxial-abaxial polarity in anther patterning in rice. *Plant Cell* 22, 1452–1462.
- Yamaguchi, T., Yano, S., and Tsukaya, H. (2010). Genetic framework for flattened leaf blade formation in unifacial leaves of *Juncus prismatocarpus*. *Plant Cell* 22, 2141–2155.

[Original paper (E-publication ahead of print)]

- Ikeuchi, M., Yamaguchi, T., Kazama, T., Ito, T., Horiguchi, G., and Tsukaya, H. *ROTUNDIFOLIA4* regulates cell proliferation along the body axis in *Arabidopsis* shoot. *Plant Cell Physiol.* 2010 Sep 8.

[Review article]

- Yamaguchi, T., and Tsukaya, H. (2010). Evolutionary and developmental studies of unifacial leaves in monocots: *Juncus* as a model system. *J. Plant Research.* 123, 35–41.