

4. Rice *PETER PAN SYNDROME* gene regulates juvenile-adult phase transition

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Higher plants undergo several developmental phases during the life cycle: embryogenesis, vegetative phase and reproductive phase. The vegetative phase can be further divided into two phases, juvenile phase and adult phase. This juvenile-adult phase transition is indispensable to the completion of life cycle, because only adult plants are competent to reproductive development. The juvenile phase can be characterized by several distinctive traits including absence of midrib, random vascular orientation, low photosynthetic rate, and short plastochron. In spite of its importance, regulatory mechanism of the phase transition is almost unknown. In rice, *mori* is the only heterochronic mutant that affects juvenile-adult phase transition. The *mori* plants reiterate the second-leaf stage and are unable to enter the adult phase (Asai et al. 2002). For better understanding the phase transition, other mutants that affect juvenile-adult transition in a different manner from that the *mori* did are needed. In this report, we identified a recessive mutant, *peter pan syndrome* (*pps*) that shows prolonged juvenile phase.

The remarkable feature of *pps* plants after germination is the severely suppressed growth. One month after germination, the wild-type plant was about 30 cm in height, whereas *pps* plant was only 5 cm (Fig. 1A). In *pps*, the size of leaf blade was very small, and the ratio of leaf blade length to width did not increase dramatically compared with wild type (Fig. 1B). This suggests that *pps* retains juvenile-phase-specific shape until later stages. Furthermore, the midrib was not well developed up to the sixth leaf. In wild type, almost no midrib was observed in the second leaf, and the third leaf formed midrib in around 60% of leaf blade length from the base. In the higher leaves, midrib was observed in more than 80% of leaf blade length. In *pps*, however, even the sixth leaf differentiated midrib only in less than 30% of leaf blade length (Fig. 1C, D, E). Thus, *pps* leaves shows juvenility until around sixth leaf.

Next we examined the stem structure. In wild type, node and internode are recognized in the stem upper than that where the forth leaf is inserted, while in *pps*, node was first observed where the sixth leaf is inserted. In addition, vascular orientation in *pps* was rather random compared with wild type (Fig. 2A,B). Then we observed the SAM size. The size of SAM gradually increases in wild type. However, the *pps* SAM was smaller than that of wild type at 10 days after germination (Fig. 2C, D). Again, we found prolonged juvenility of *pps* in the stem and SAM.

From the above results, we conclude that *pps* shows long juvenile phase. Interestingly *pps* showed early flowering. This suggests that *pps* shows not only long juvenile phase but also short adult phase, and that juvenile and adult phases are not independently regulated. It is considered that the function of *PPS* is the promotion of juvenile-adult phase change.

Reference

Asai K., N. Satoh, H. Sasaki, H. Satoh and Y. Nagato, 2002. A rice heterochronic mutant, *mori1*, is defective in the juvenile-adult phase change. *Development* 129: 265-273.

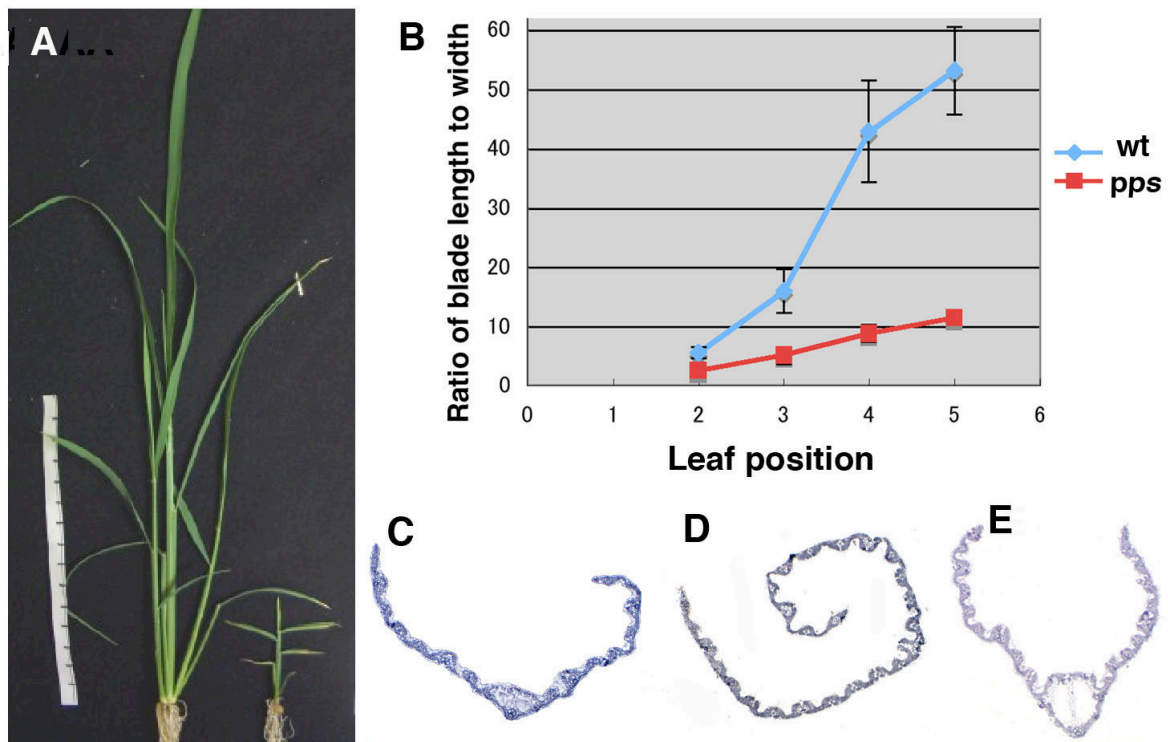


Fig. 1. Phenotypes of *pps* plant. (A) 1-month-old wild type (left) and, *pps* (right) plants. (B) Change in the ratio of leaf blade length to width during development. Vertical bars indicate standard deviation. (C) Cross section of wild type third leaf. (D) Cross section of *pps* sixth leaf. (E) Cross section of *pps* seventh leaf.

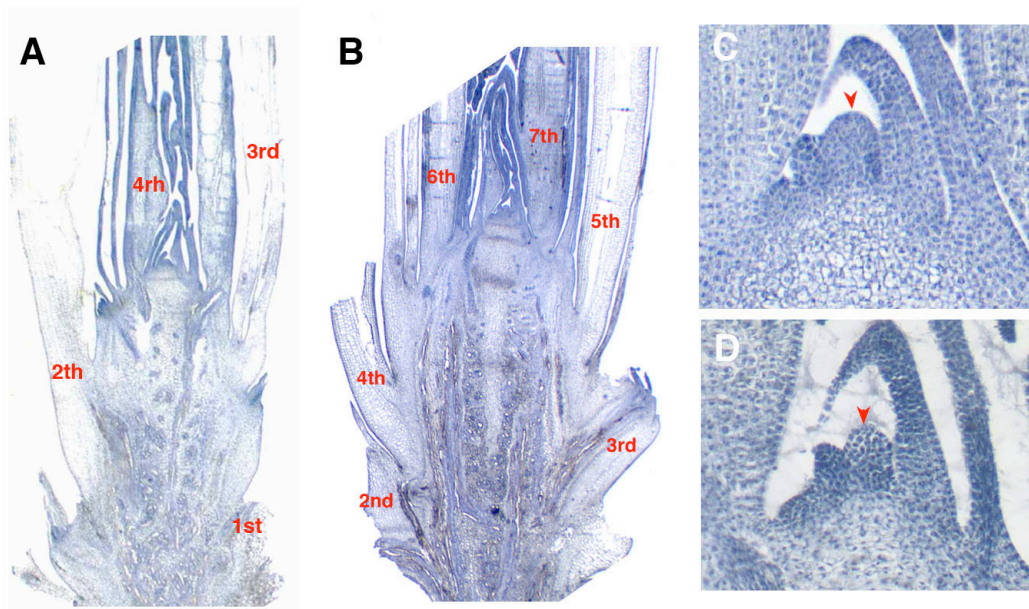


Fig. 2. Morphology of stem and shoot apex. (A) Wild type shoot at 2 weeks after germination. (B) *pps* shoot at 3 weeks after germination. (C) Wild type shoot apex at 10 days after germination. (D) *pps* shoot apex at 10 days after germination. Arrowheads indicate SAM.