OWL1 Is a Phytochrome A Signaling Component Dedicated to the Very Low Fluence Response

In *Arabidopsis thaliana*, there are five phytochromes that sense red (R) and far-red (FR) light (reviewed in Bae and Choi, 2008). Phytochrome A (phyA) is the major phytochrome in etiolated seedlings and plays roles in the very low fluence response (VLFR), high irradiances responses (HIRs), and, as recently shown, the low fluence response (LFR) (Shen et al., 2009). While phyA signaling molecules have been identified that are involved in the FR-HIR or in both the FR-HIR and the VLFR, new work from Kneissl et al. (pages 3212–3225) describes a signaling component dedicated specifically to the VLFR.

Kneissl et al. analyzed an *Arabidopsis* phyA signaling mutant disrupted in a class III J domain protein, which they named OWL1 for the ability of owls to see in low light. Upon exposure to light, wild-type seedlings undergo photomorphogenesis, including cotyledon unfolding, greening, and inhibition of hypocotyl elongation. phyA is strictly required for these processes under FR light conditions, and phyA mutant seedlings in FR light have an apical hook with folded cotyledons (see figure) and longer hypocotyls than the wild type. Kneissl et al. found that when etiolated *owl1* seedlings were transferred to VLF R or FR light, they had longer hypocotyls than did the wild type but not as long as those of phyA. In addition, the degree of cotyledon opening in *owl1* was in between the wild type and phyA (see figure). Furthermore, overexpression of OWL1 could reverse both effects. By contrast, conditions that induce the FR-HIR caused no difference between *owl1* and the wild type. Moreover, the authors saw no significant differences in the dark or in blue light.

The authors went on to examine other aspects of the VLFR in the mutant. *owl1* had much lower germination rates than the wild type in light conditions designed to induce the VFLR. Under conditions that lead to the LFR, however, *owl1* germination rates were comparable to the wild type. Similar results were found in all facets of the VLFR tested, from effects of light on agravitropic hypocotyl growth, to greening upon transfer to light after prolonged FR light exposure. In all cases, defects were seen in *owl1* consistent with a role for OWL1 in the phyA-dependent VLFR. J domain proteins typically bind and activate the adenosine triphosphate hydrolysis activity of heat shock protein 70s (Hsp70s) (reviewed in Qiu et al., 2006). Kneissl et al. found OWL1 protein throughout the plant and show that it localizes to the nucleus and cytoplasm, depending on light conditions. Intriguingly, they identified LONG HYPOCOTYL IN FAR-RED1 (HFR1) as directly interacting with OWL1. HFR1 is a putative transcription factor known to be involved in the FR-HIR and to play a part in the VLFR and in blue light signaling (Duck and Fankhauser, 2003). In fact, HFR1 was recently shown to be a part of a protein complex including phyA and other phyA signaling molecules (Yang et al., 2009). Whether OWL1 is also a part of this complex remains to be seen, as does whether it interacts with an Hsp70, but this work from Kneissl et al. provides an excellent starting point toward understanding the molecular basis of VLFR signaling.

**REFERENCES**


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Nancy R. Hofmann

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