

PSII mega-complex remodeling requires LTR155 and represents a novel photosynthetic acclimation mechanism independent of state transitions

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Introduction

Strong light quality gradients occurring in dense plant populations lead to imbalanced excitation of the two photosystems reducing photosynthetic efficiency.

So far, two counteracting processes are known: state transitions in the short-term and the long-term response (LTR) on a longer time scale.

Here, we describe a novel photosynthetic acclimation mechanism which induces reversible formation of PSII mega-complexes under PSII-limiting conditions.

Surprisingly, this acclimation is independent of state transitions.

Experimental setup

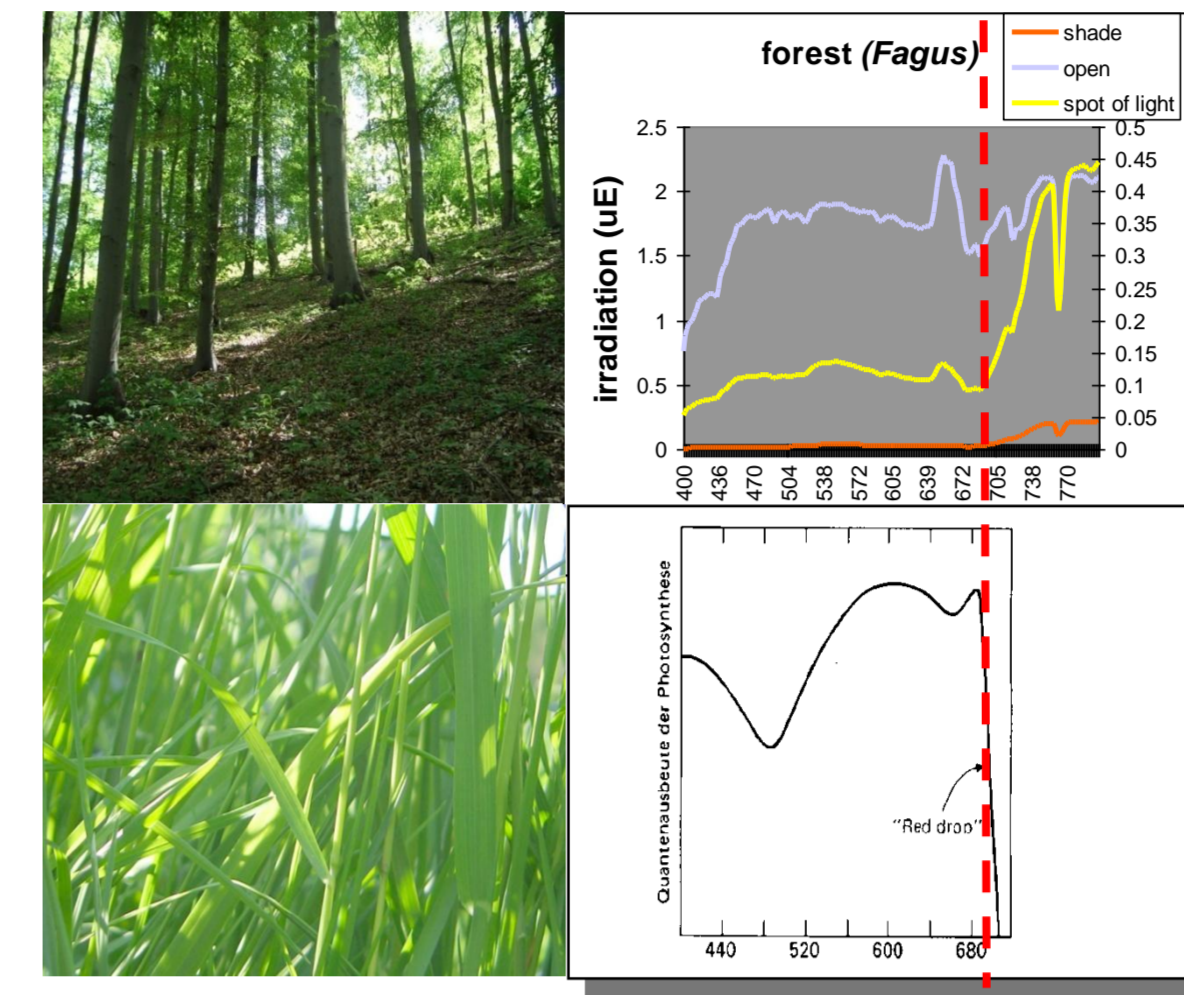


Fig. 1 Changes in light quality within different habitats.

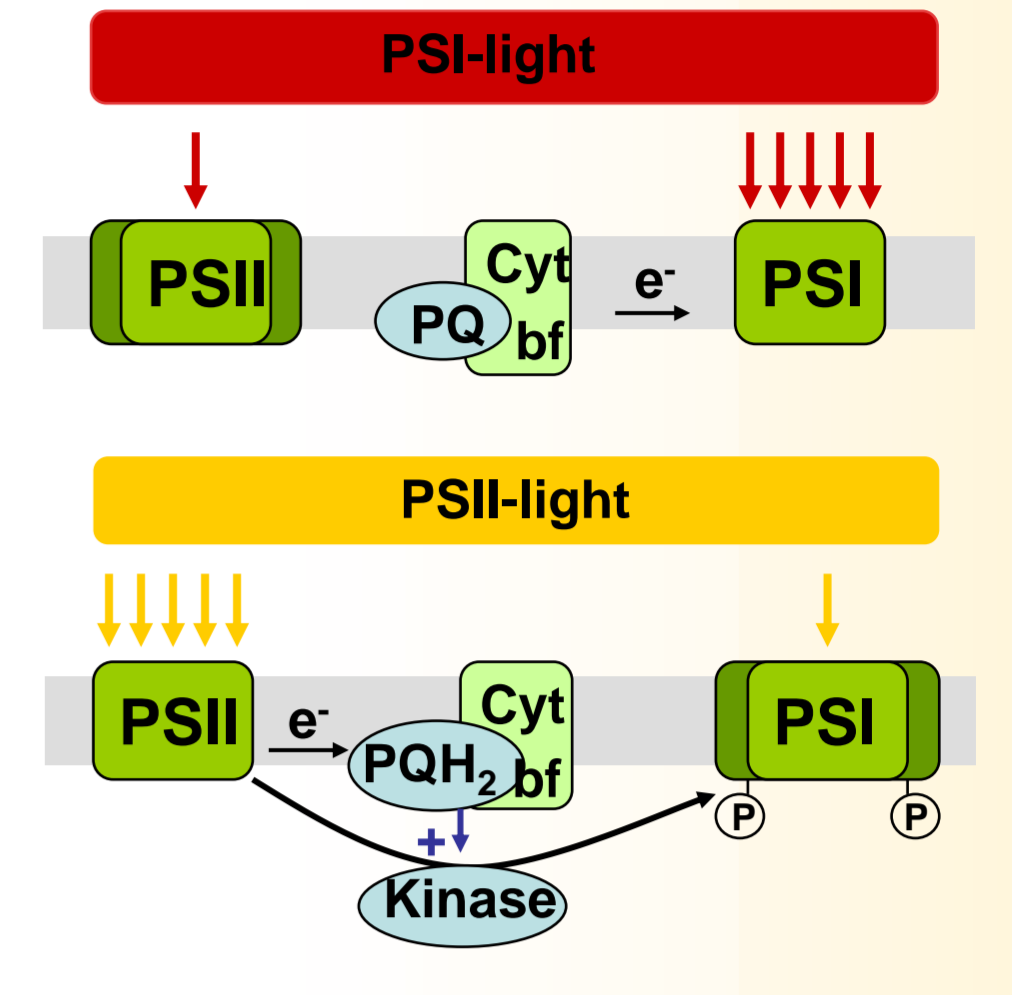


Fig. 2 Artificial light system. We mimic natural gradients in light quality using light sources favouring PSI or PSII.

PSII mega-complex remodeling in wildtype...

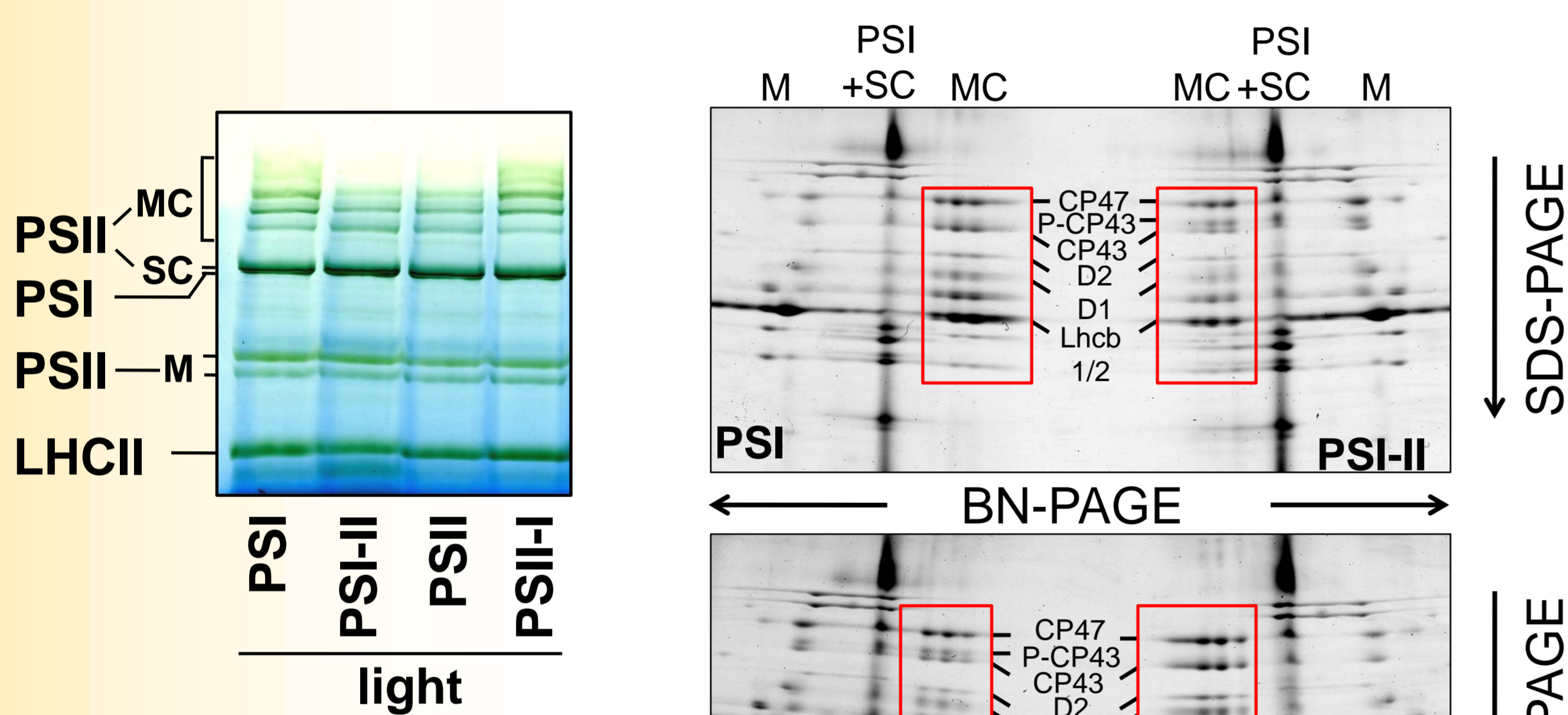


Fig. 3 PSII mega-complex remodeling in response to changing light qualities. BN-PAGE of WT thylakoid preparations from plants grown under PSI- or PSII-lights or shifts (MC, mega-complexes; SC, super-complex; M, monomers).

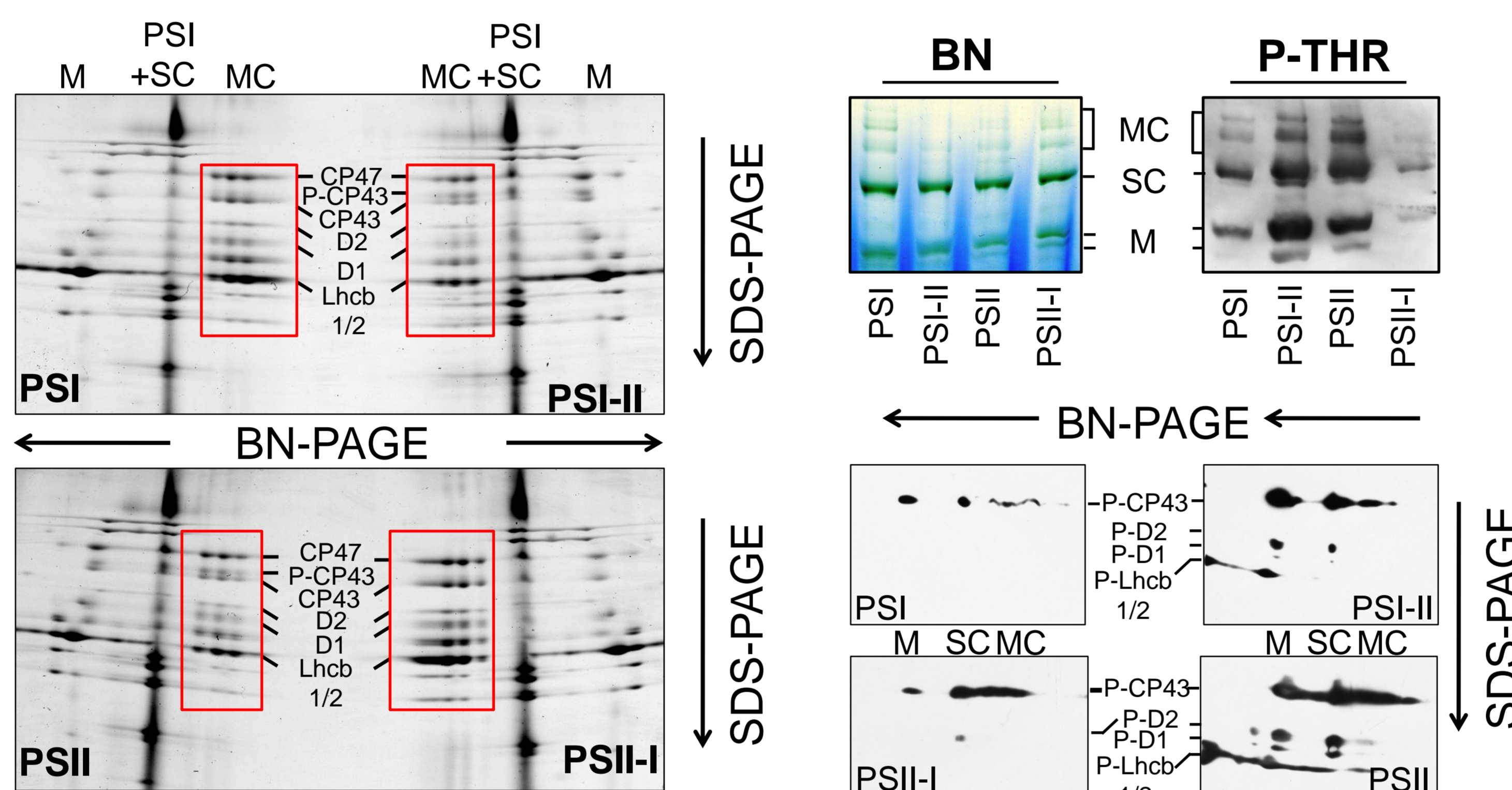


Fig. 4 Subunit composition of remodeled PSII mega-complexes. Subunits of PSI complexes from the 1st dimension blue native gel were separated by 2nd dimension SDS-PAGE and coomassie stained.

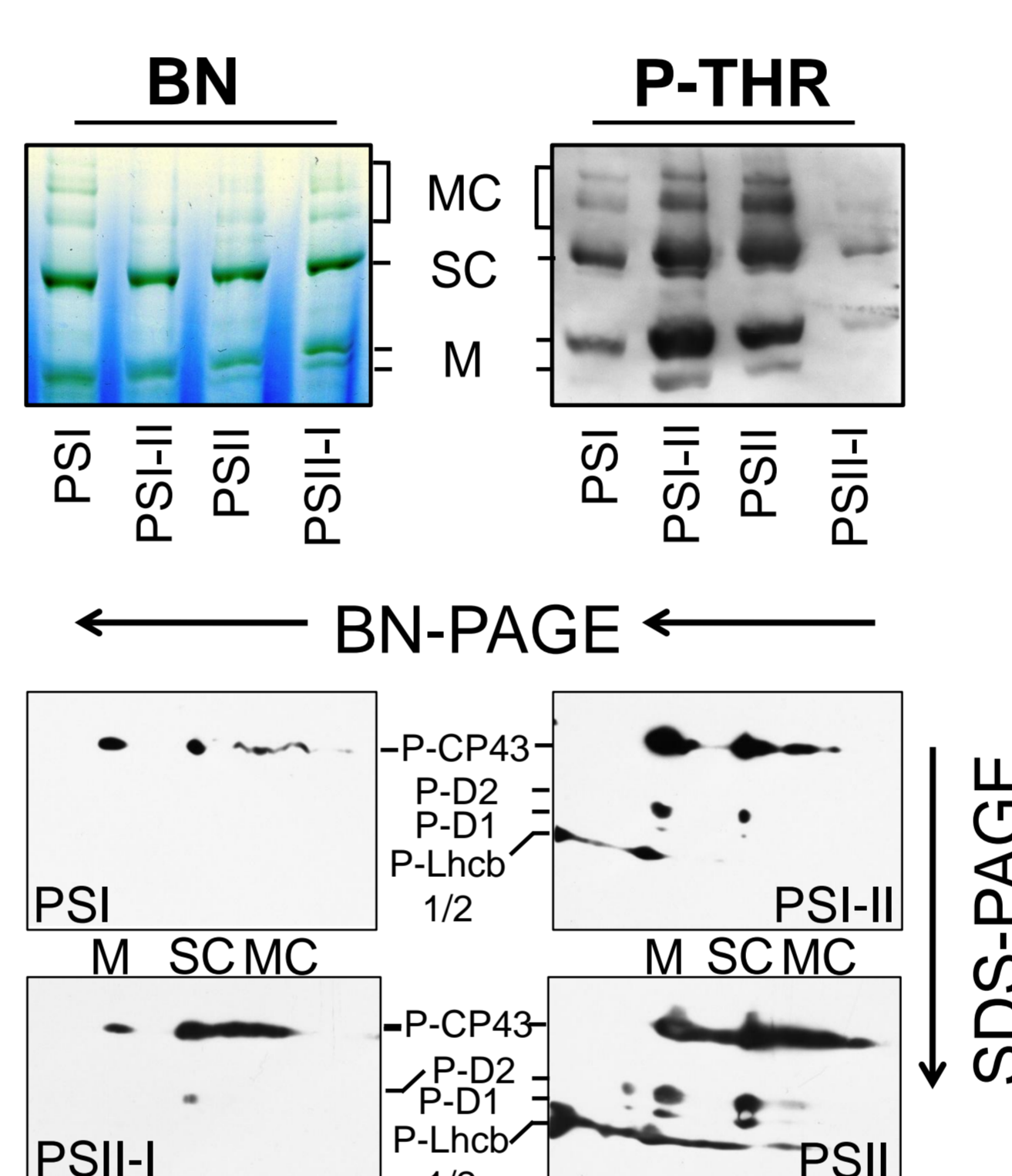


Fig. 7 Is phosphorylation required for PSII remodeling? Phosphorylated subunits within the various complexes identified after 1st dimension BN and 2D SDS-PAGE. MCs are highly phosphorylated at CP43 but not at LHCII. This indicates that PSII remodeling depends on more than phosphorylation.

...in acclimation mutants

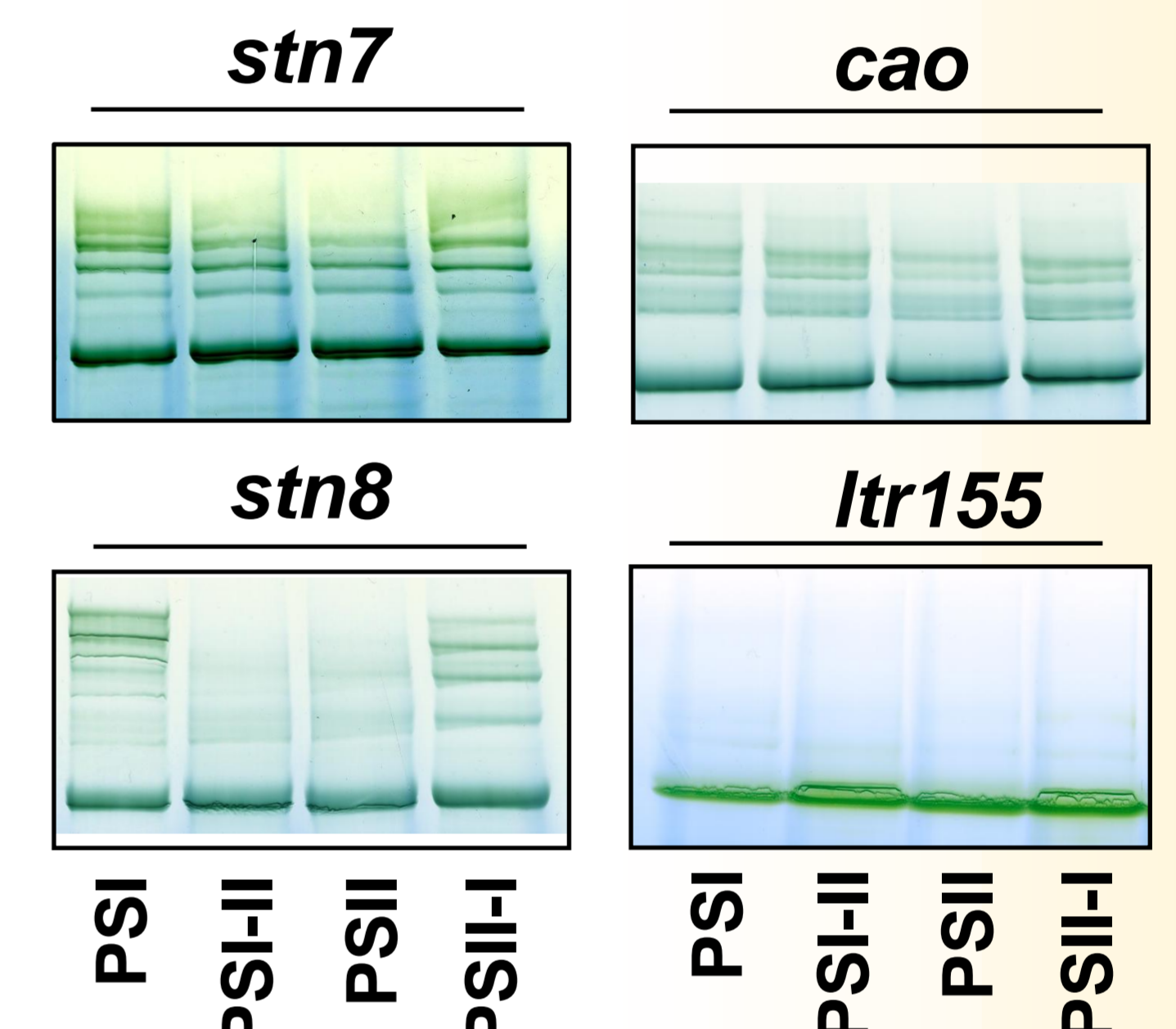


Fig. 6 BN-PAGE of mutants with defects in photosynthetic acclimation. *stn7* mutant displays WT-like PSII remodeling suggesting independence of LHCII phosphorylation. In *stn8* PSII-remodeling proceeds normally indicating that PSII mega-complex remodelling occurs independently of PSII core-phosphorylation. The *cao* mutant lacks LHCII but residual mega-complex formation still was observed. Solely, *ltr155* seems to be completely devoid of PSII mega-complexes.

... in *ltr155* loss of function line

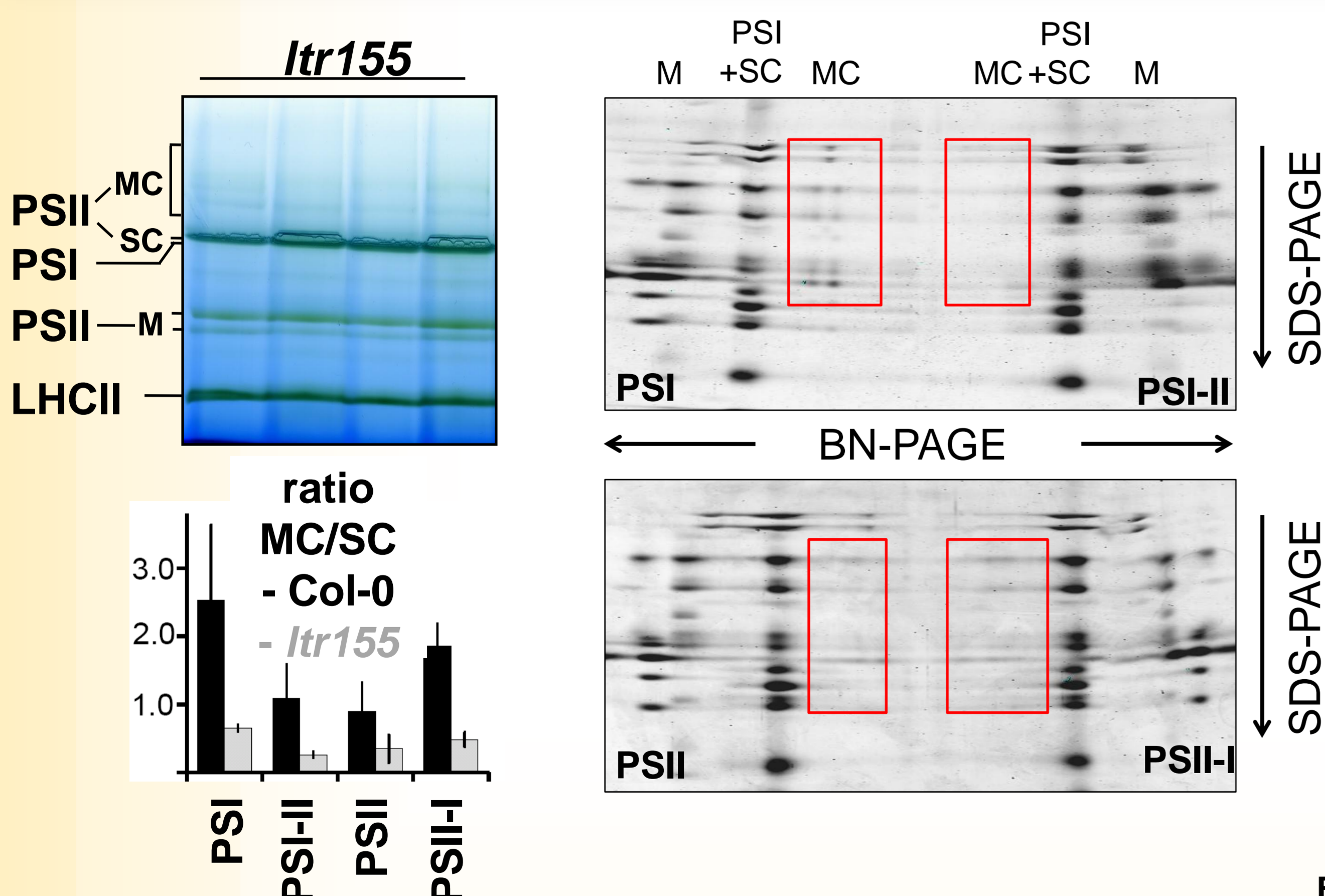


Fig. 8 BN-PAGE and subunit composition of remodeled PSII-complexes in *ltr155*. In comparison to WT, in *ltr155* PSII mega-complex formation is almost abolished implying a crucial role of LTR155 protein for PSII remodeling during light quality acclimation. Quantification reveals that in the mutant SCs might be formed at the expense of MCs.

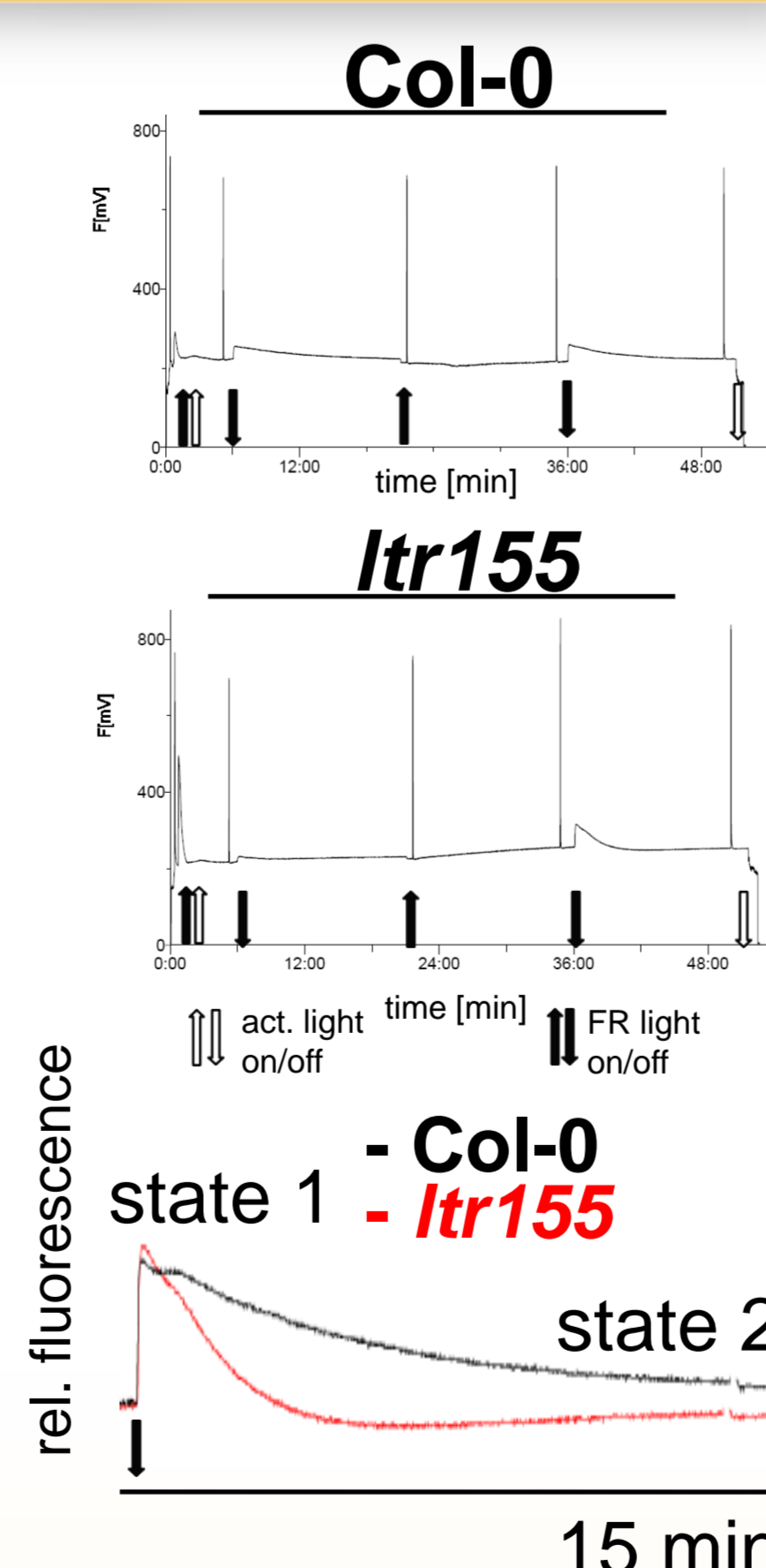
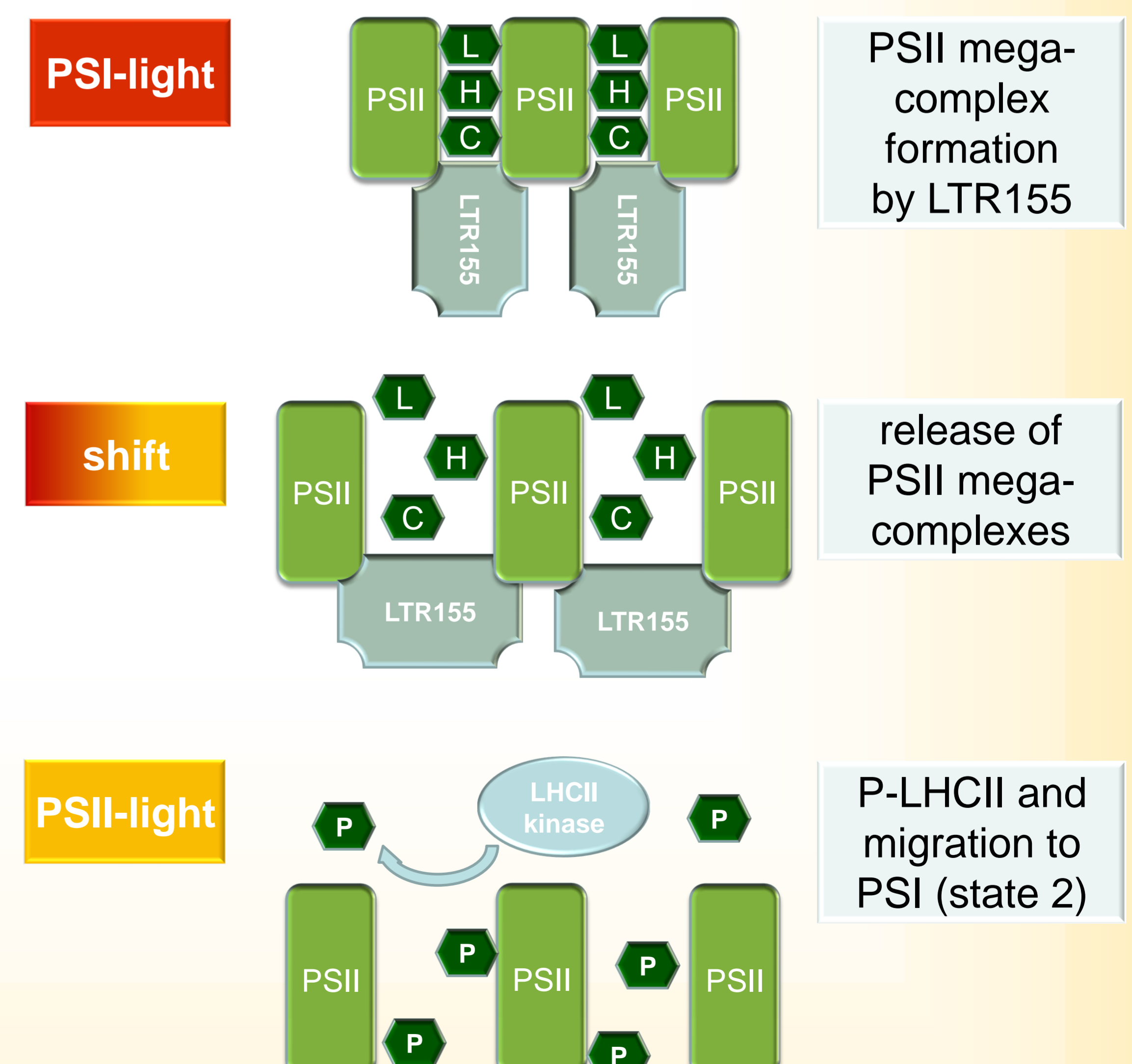


Fig. 9 State transitions in wildtype and *ltr155*. *ltr155* shows accelerated state 1-state 2 transitions implying that the lack of PSII mega-complexes leads to higher mobility of LHCII antenna complexes.

Model



Major findings

We found that formation of PSII mega-complexes in *ltr155* is almost abolished. In this mutant the kinetics of state transitions is highly accelerated indicating that the modulation of PSII-mega-complexes is a novel entry mechanism for other photosynthetic acclimation responses such as state transitions. Based on our data we propose a model that LTR155 triggers PSII mega-complex formation rather than solely LHCII-PSII interactions.