“Marsilea” Leaf Opening Is Controlled by Cooperation of Two Blue Light Systems, Stomata Opening and Gene Expression

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Plants often show nyctinastic response that is controlled by light and circadian rhythm. Legumes, “oxalis”, and the aquatic fern “Marsilea” have a special organ pulvinus for nyctinastic movement. The leaf opening in daytime and closing in the night are induced by water inflow into and outflow from the pulvinus motor cells, respectively. Since the precise mechanism is unknown, we have attempted solving the issue using “Marsilea quadrifolia”. “Marsilea’s” transpiration rhythm induced by stomata opening/closing matched the nyctinasty rhythm. When abscisic acid was administrated for stomata closing to suppress transpiration, leaves did not open by light irradiation. It indicated that stomata opening by light activated transpiration, then water from roots was delivered to the motor cells. Aquaporin is reported to be involved in leaf opening of the legume genus Samanea. When aquaporin inhibitor, HgCl2, was applied to “Marsilea” through petiole vascular bundles, their leaves did not open, suggesting that the aquaporin is also involved in “Marsilea”. Thus, “Marselia” aquaporin genes were cloned and 13 different genes were identified. The expression pattern of one of these genes matched the nyctinasty rhythm expressed at early daytime. Furthermore, leaf opening was inhibited when cycloheximide (protein synthesis inhibitor) was given. Therefore, the aquaporin synthesized in motor cells due to water inflow into motor cells by blue light activation results in leaf opening. In summary, two blue light systems, phototropin in guard cells that control water uptake and cryptochrome in motor cells that induce aquaporin function might cooperate in promoting leaf opening in “Marselia” nyctinastic response.