

# Entrainment of the Circadian Clock in Duckweed Plants to Periodic Changes of Sucrose Concentration in the Culture Medium

## 培地内スクロース濃度の周期的変化がウキクサ植物の概日時計にもたらす同調効果

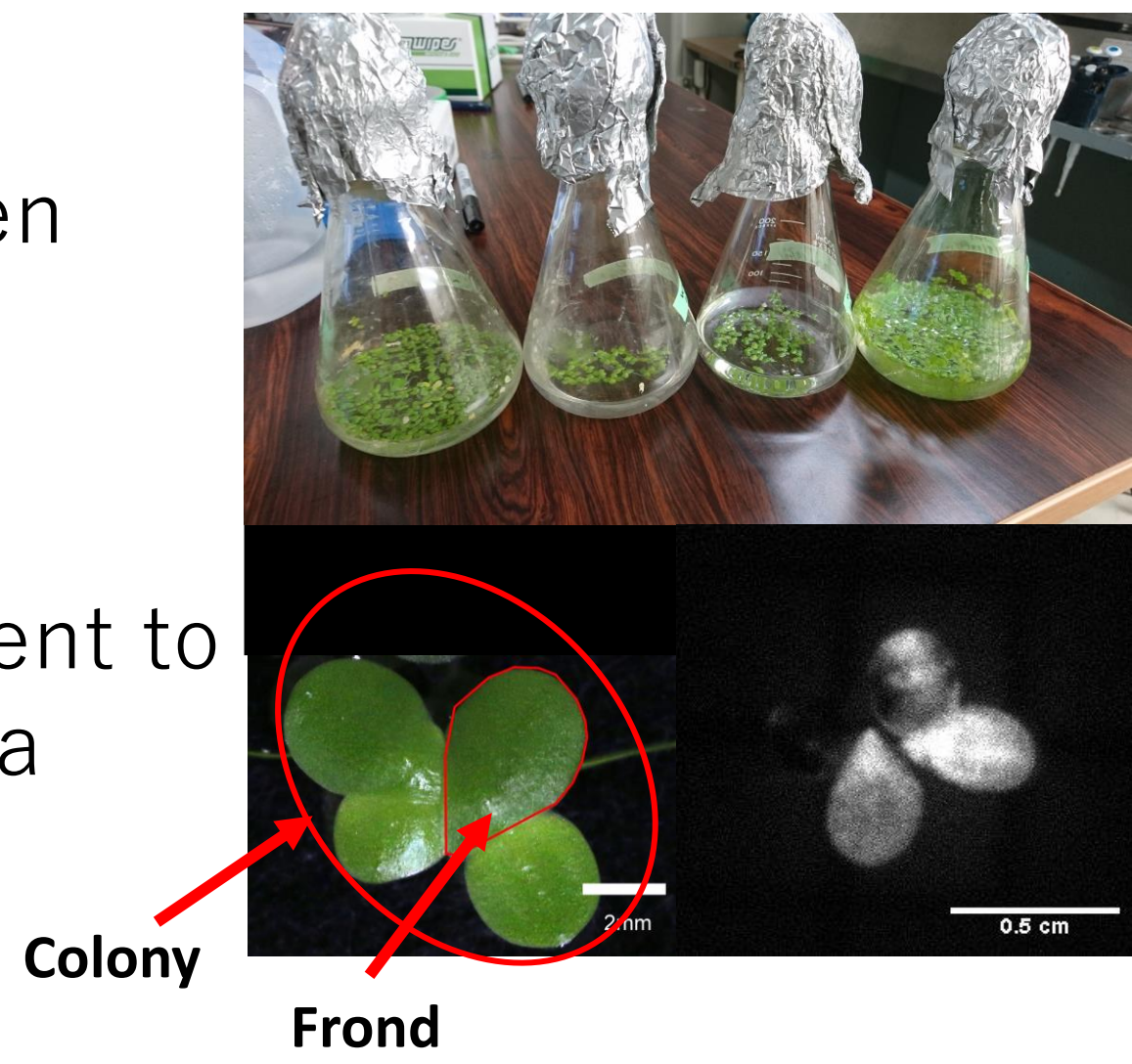
Akira Ogawa, Shogo Ito and Tokitaka Oyama Department of Botany, Graduate school of Science, Kyoto University

小川 晃, 伊藤 照悟, 小山 時隆 京都大学大学院理学研究科生物科学専攻

### Introduction

Each cell of a plant has the circadian clock, a self-sustained oscillator with a period of approximately 24 h, and modulates the rhythm to synchronize with the cycle of the external environment. The mechanism by which the rhythm of plants' cells synchronizes with each other remains unknown. Meanwhile, it has been reported that in *Arabidopsis thaliana*, exogenous sucrose sustains the circadian rhythm for a long time and shortened the period length.

Since sucrose is considered as a candidate of the material which transmits time information between cells, in order to elucidate the mechanism of cell-to-cell synchronization, we investigated effects of periodic sucrose treatment to the phase of circadian rhythms in a duckweed.

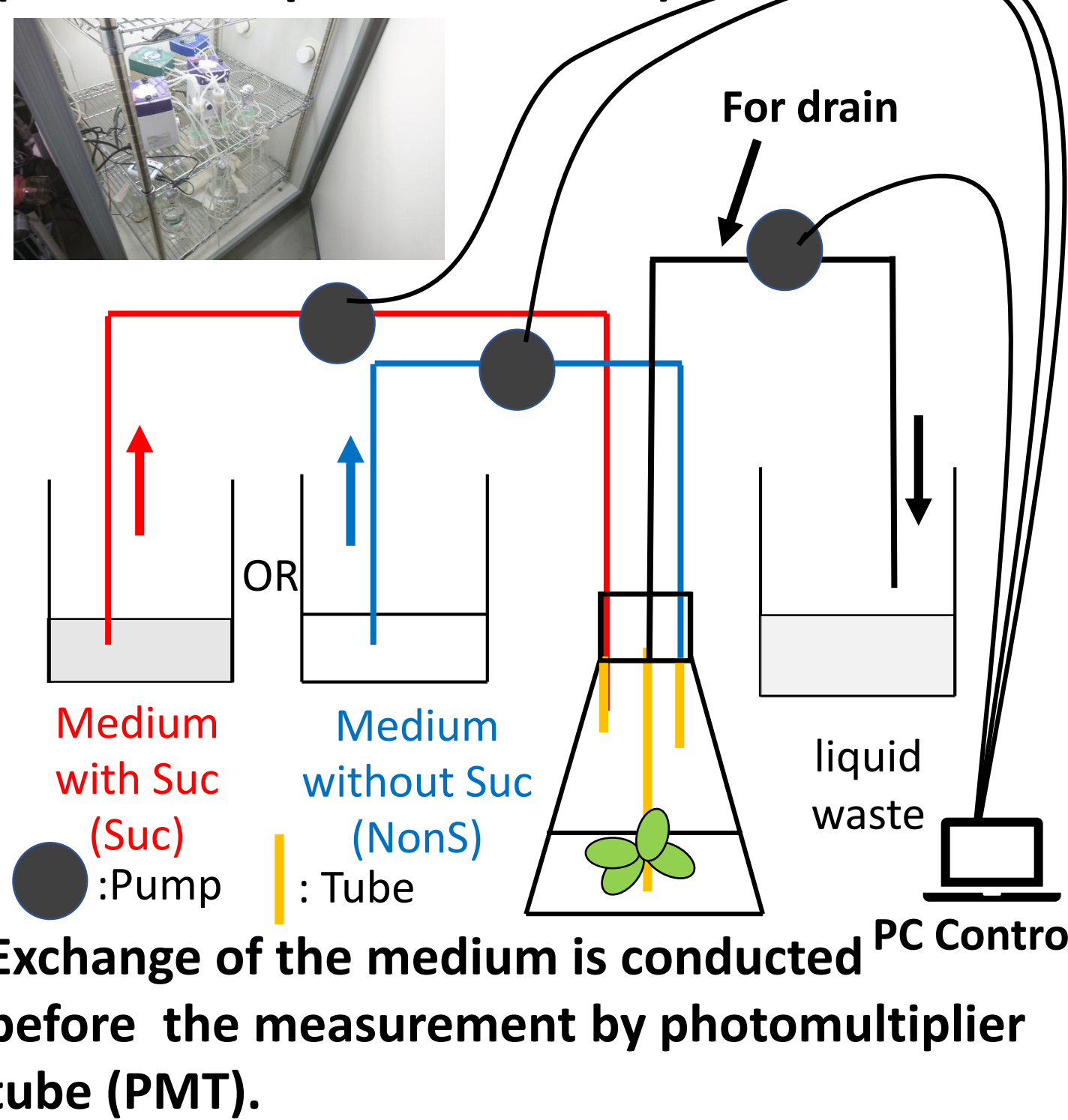


### Materials

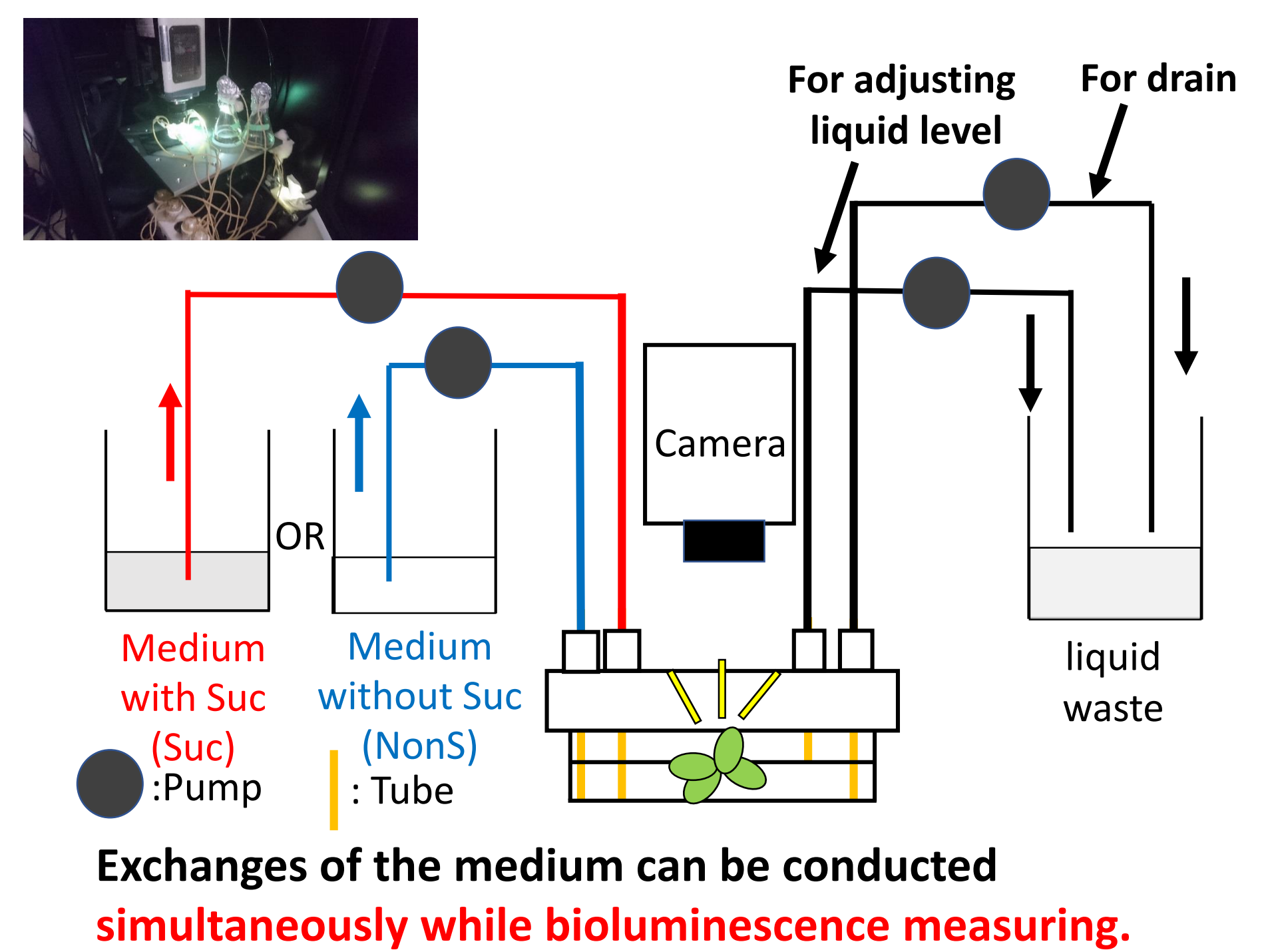
- Transgenic *Lemna minor* carrying a bioluminescent circadian reporter
- Reporter : *At CIRCADIAN CLOCK-ASSOCIATED1(CCA1)ex4:inLUC+(AtCCA1:LUC)*

### Labwares

#### Automatic Medium Exchanger (used for Experiment 1 & 2)



#### Automatic Bioluminescence Monitoring System with Automatic Medium Exchanger (used for Experiment 3)



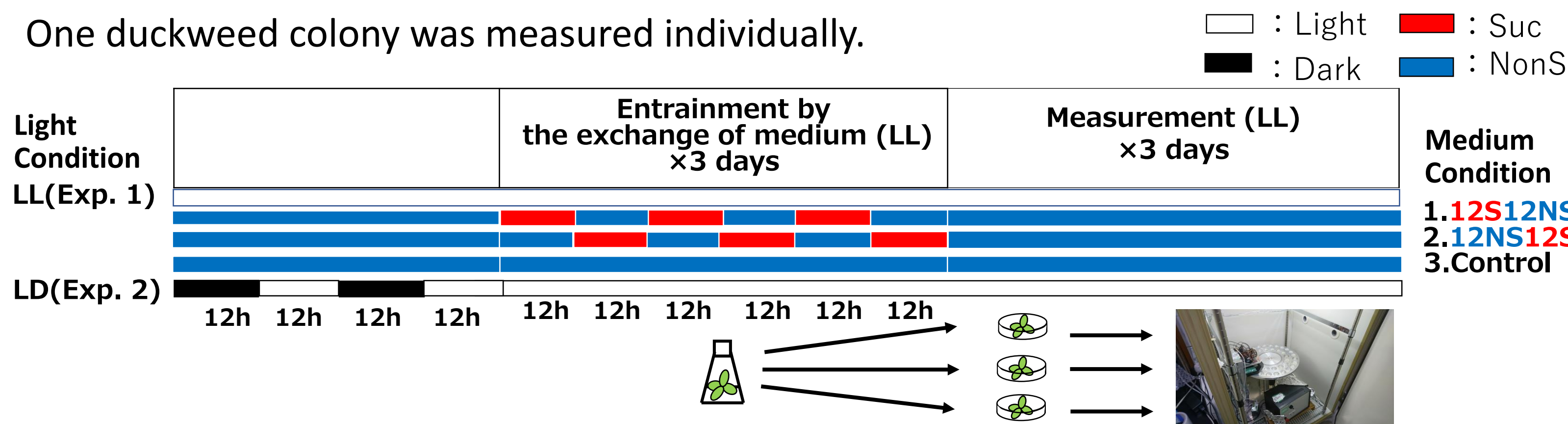
### Methods & Experimental Conditions

#### Procedures to examine entrainability by periodic sucrose treatment

Exp. 1 : Plants without any experience of L/D (Light/Dark) cycles

Exp. 2 : Plants being entrained by L/D cycles

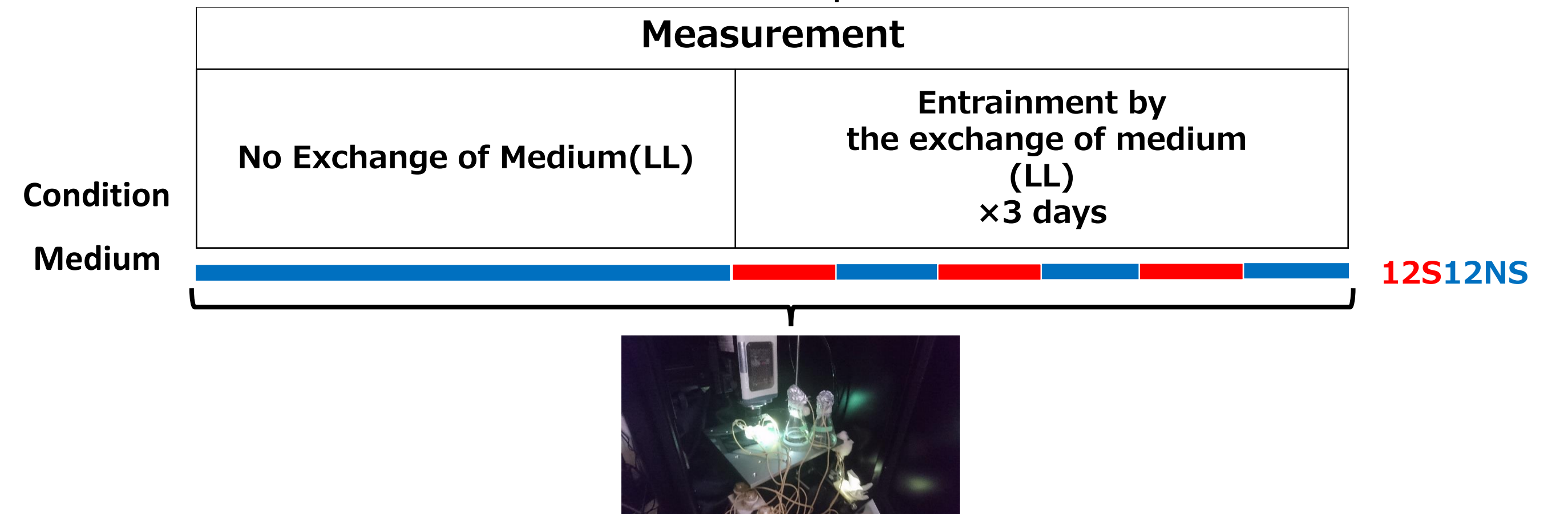
One duckweed colony was measured individually.



#### Procedure to monitor entrainment processes of plants

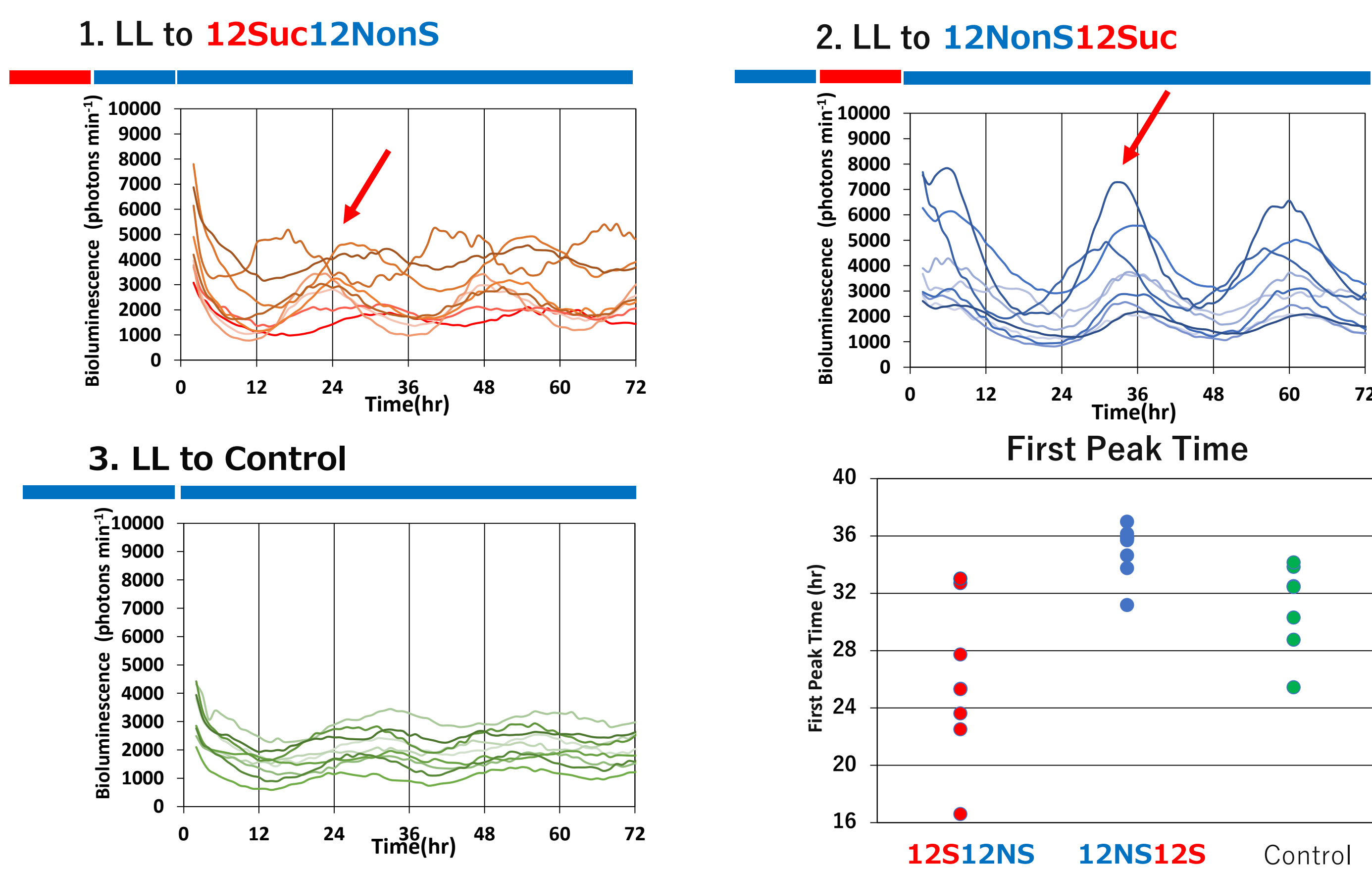
Exp. 3 : Plants without any experience of L/D cycles

The measurement is at one frond level with special information.



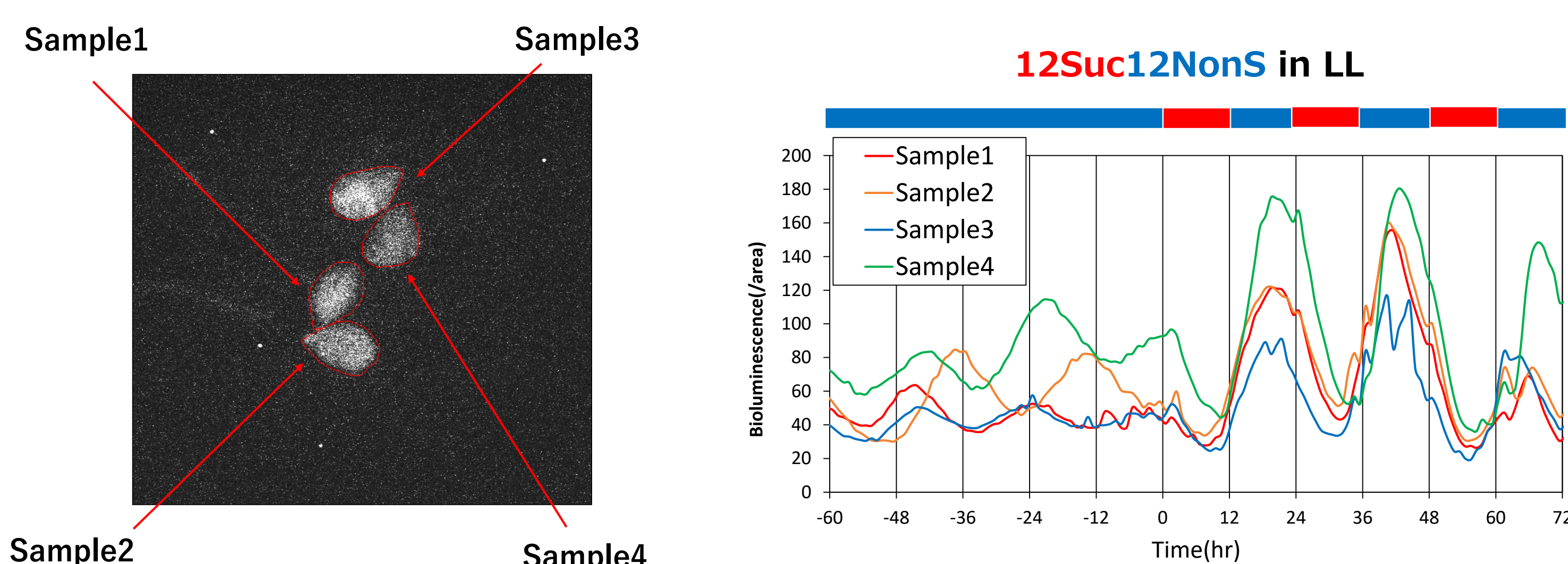
### Results

#### Exp. 1 Plants without any experience of L/D cycles were capable of being entrained by periodic sucrose treatment.



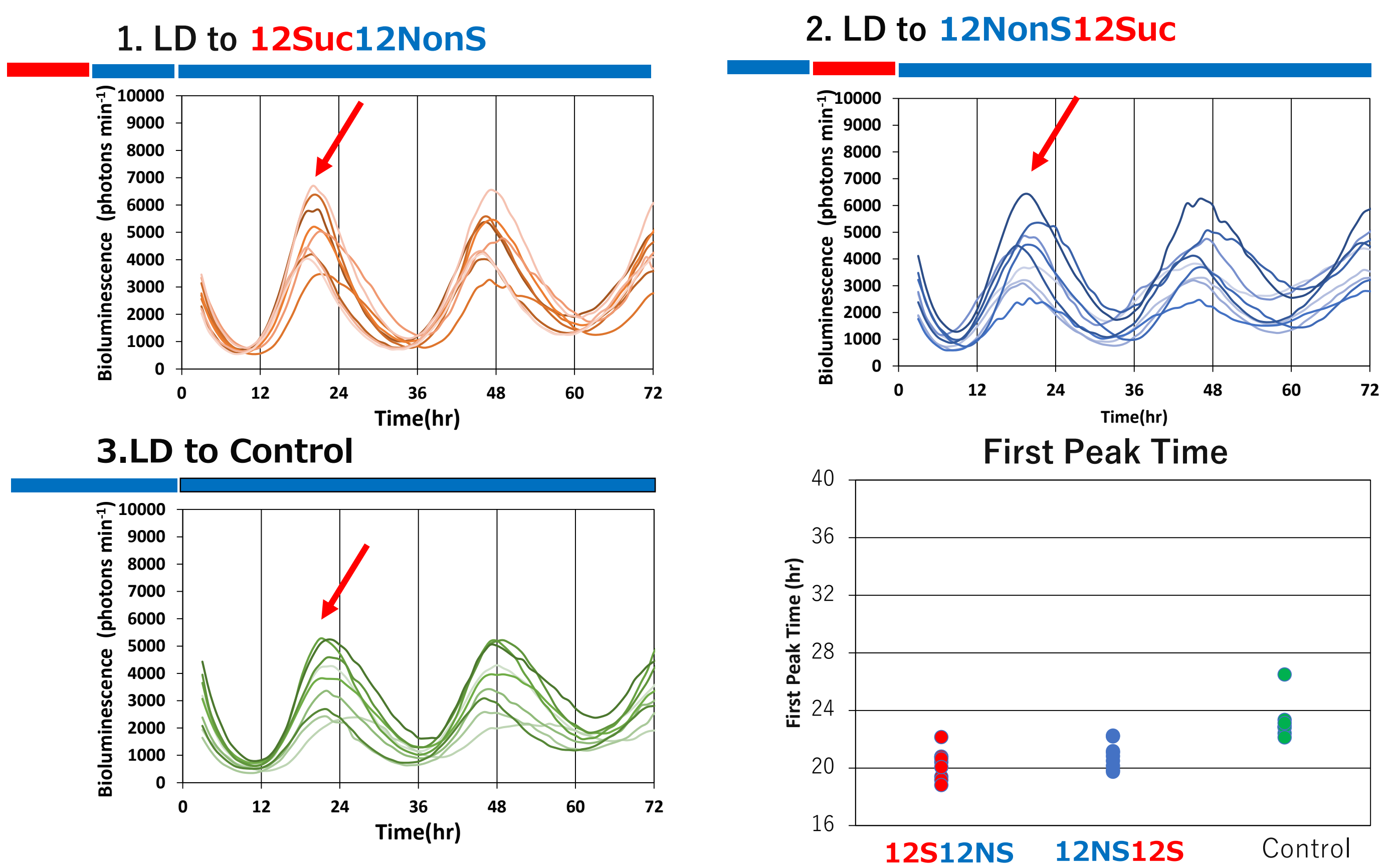
- 12Nons12S samples showed the higher amplitude rhythms with narrow distribution of phases of first peaks.
- 12S12NonS samples showed the lower amplitude rhythms with broad distribution of phases of first peaks, suggesting that the influence of sucrose treatment is weak.

#### Exp.3 One-time Sucrose treatment which started at the peaks of circadian phases was capable of fixing the phases of rhythms.



- The phases after sucrose treatment was independent of the circadian phases before sucrose treatment.

#### Exp. 2 Plants being entrained by L/D cycles were Not affected by periodic sucrose treatment.



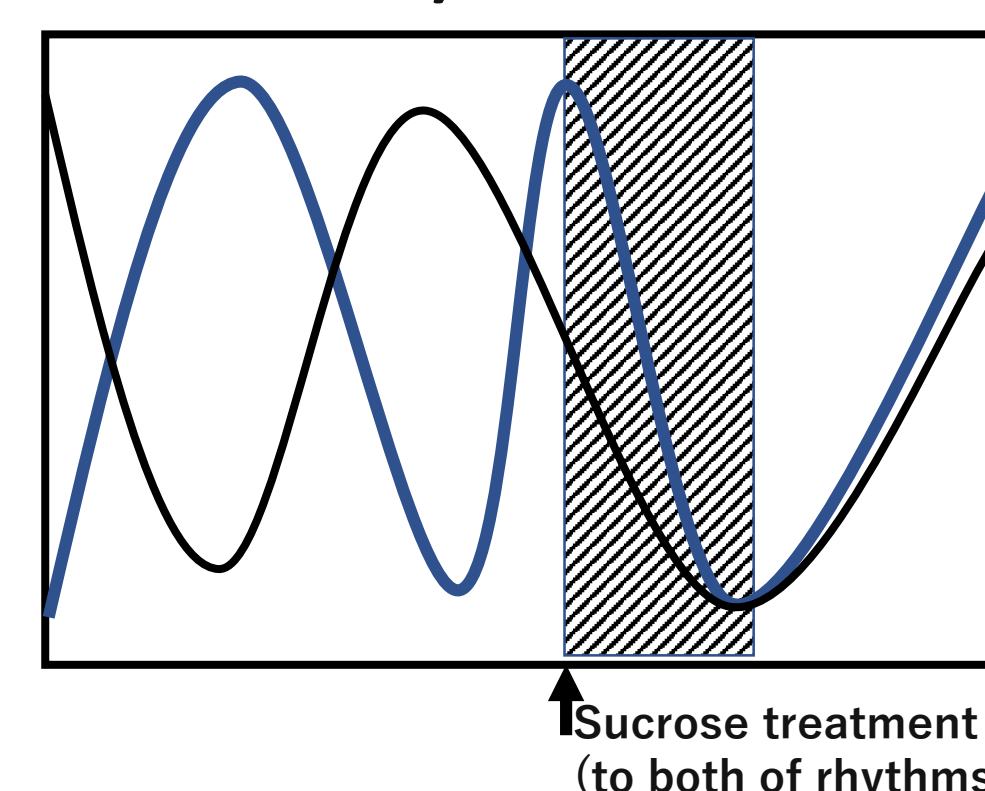
- The mean phases of first peaks among 12Nons12S, 12SNonS and control was not much different, which is independent on phases of circadian rhythms before sucrose treatment.

### Conclusions & Discussions

One-time sucrose treatment can entrain the rhythm of plants which does not have any experience of L/D cycles.

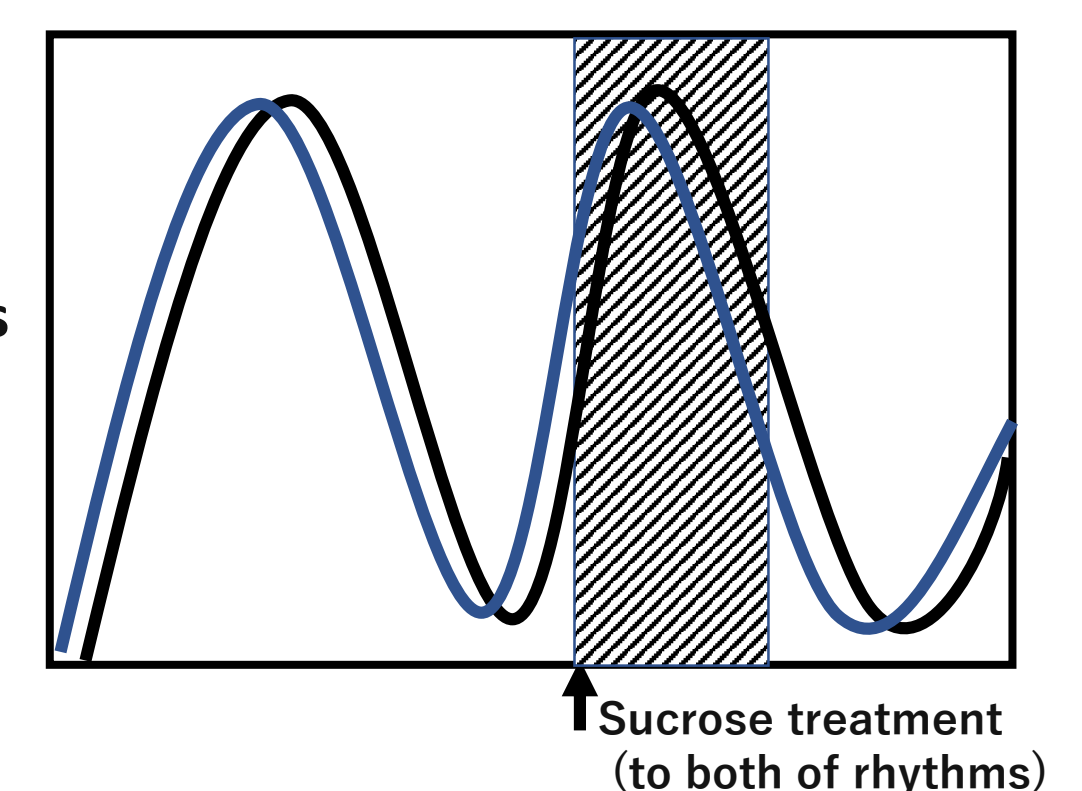
The entrainability of the rhythm of plants to sucrose might depend on the initial synchronization state at the first sucrose treatment.

Initial state: Asynchronous (Ex: under LL)



Sucrose can entrain the circadian rhythm in a plant.

Initial state :Synchronous (Ex: after entrained by L/D cycles)



The circadian rhythm in a plant is not entrained by sucrose.