Effect of High Humidity Environment on Photosynthetic Function of *Ginkgo biloba*

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Introduction
Urban trees play an important role in improving the urban environment by capturing air pollutants, and absorbing carbon dioxide.

However, urban trees grow in harsh environments where they are exposed to a variety of environmental stresses. Such stresses are known to reduce photosynthesis, which prevent trees roles. In resent years, the amount of water vapor in the air flowing in from the southwestern ocean due to the summer monsoon has increased due to the rise in sea surface temperature, and as a result the relative humidity around Japan has become very high. Against this background, street trees can be expected to experience rapid changes in humidity, and it is important for future street trees to adapt to changes in the humidity.

Ginkgo trees are high tolerance to stresses, it is the most planted tall roadside tree in Japan. However, although the response of Ginkgo to drought and salt stress has been investigated, there are few studies on the responses to the changes in humidity environment.

In this study, we measured photosynthetic function and carbon stable isotope ratios of Ginkgo trees grown under varying humidity conditions to investigate the response of photosynthetic function to changes in humidity in urban trees.

Materials and Methods
1. Tree species
Ginkgo biloba L.

2.Growing conditions
Ginkgo seedlings in a greenhouse for 2 months and then transferred to a growth chamber where they were grown for 2 weeks under 3 conditions: control (RH: 60%, temperature: 25˚C), high humidity (RH: 85%, temperature: 25˚C), and recovery (RH: 60%, temperature: 25˚C). Leaves were collected on the last day of each condition for the measurements of photosynthetic function and carbon stable isotope ratio of leaves.

3. Measurements using the Li-6400 XT
The collected leaves were used to generate A-Ci curves using a photosynthesis measurement system (Li-6400 XT, Li-Cor, USA). The maximum carboxylation rate (Vcmax) and the electron transpoter rate (J) of the thylakoid membrane were determined from the A-Ci curves.

4. Carbon stable isotope ratio measurement of leaves
The dried leaves were powdered and then sealed in tin capsuls at 1.0 ±0.05 mg each. The stable isotope ratios were measured using a CN-IRMS mass spectrometer (Flash1112+Conflo+delta V advantage, Thermo Fisher Electric, USA) at the Research Institute for Humanity and Nature. Working standards CERKU-03 (Glycine), and CERKU-07 (starch) were used as a correction of isotope values.

Results
Although there was a decreasing trend in the photosynthetic rate under high humidity and recovery conditions compared to the control condition, the changes were not statistically significant. The short-term water use efficiency and carbon stable isotope ratios at high humidity and recovery conditions were not significantly different from those of control condition. Similarly, the stomatal conductance and maximum carboxylation rate, which affect the photosynthetic rate, did not change significantly. On the other hand, the electron transport rate was significantly decreased in the recovery condition compared to the control condition.

Discussion
There were no significant changes in photosynthetic rate, stable carbon isotope ratio, or short-term water use efficiency after 2 weeks of growth experiment under high humidity, suggesting that high humidity imposed no significant stress for Ginkgo biloba. However, only the electron transfer rate was significantly reduced in the recovery condition, suggesting that experiencing a high-humidity environment may reduce the regeneration capacity of Rubisco when the humidity is reduced to normal conditions.

Keywords: Stable carbon isotope ratio, Environmental stress, Photosynthesis

