学位論文の要約
Thesis Abstract (English)

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１．論文題目

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Analysis of leaf functions in relation to photosynthetic traits in ferns

２．論文要約

Thesis Abstract

Ferns are primitive vascular plants emerged from 400 million years ago, when atmospheric CO_2 concentration was much higher than present. Although ferns are important group to understand history of land plant evolution and have important role in the current terrestrial ecology, leaf functions of ferns in relation to photosynthesis and their difference from the other vascular plant lineage was not well understood. 35 ferns species including 5 Japanese ferns were used in the present study to analyze the difference in the leaf photosynthetic functions between ferns and other vascular plants. I focused on CO_2 diffusion during the process of photosynthesis, mesophyll conductance in particular, because mesophyll conductance may be a key trait to explain the leaf photosynthetic functions of ferns and their difference from that of seed plants. Gas exchange measurements and leaf anatomical analysis using 35 fern species showed that ferns are lower photosynthetic group in vascular plants. Photosynthesis rates were strongly and positively correlated to mesophyll conductance. Mesophyll conductance of ferns positively correlated to the surface area of chloroplast exposing to intercellular air space (S_c), and negatively correlated to cell wall thickness (T_{cw}). These indicates that low mesophyll conductance with low S_c and high T_{cw} strongly limits photosynthesis rate in ferns. Moreover, this study suggest that, in land plant's evolutionary history, plants have increased mesophyll conductivity to adapt to the present low atmospheric CO_2 concentration.

Regulation of stomatal and mesophyll conductance of ferns to the changes in CO_2 concentration were also measured using two fern species. These ferns lacked

sensitive control of stomatal conductance to the changes in CO_2. In contrast, they rapidly changed mesophyll conductance to the changes in CO_2 concentration, which suggested that vascular plants would have response of mesophyll conductance earlier than stomatal response in the evolutionary history.

Finally, photosynthetic responses to drought stress were measured using five Japanese ferns with various habitats and life forms. *L. thunbergianus*, an epiphytic fern, showed high water use efficiency than the other ferns under drought, which indicates that high water use efficiency is one of the adaptative traits for epiphytic ferns, which are subjected to frequent and/or severe drought.