（ 続紙 1 ）

京都大学	博士（ 農 学 ）	氏名	張 庭維
論文題目	Study on isoprene emission from leaves of bamboo species (タケ個葉からのイソプレン放出に関する研究)		

(Abstract of the thesis)

Isoprene (2-methyl-1,3-butadiene) emitted from terrestrial vegetation can be considered as a carbon source in the global carbon budget. The chemistry of isoprene can potentially aggravate air quality and impact climate change. This study measured leaf-scale isoprene emission rates for multiple bamboo species. For this, the responses of leaf isoprene emission rate to potential meteorological, morphological, and physiological controllers such as leaf temperature, light intensity, leaf mass per area, leaf nitrogen concentration, photosynthetic rate, and electron transport rate were examined. This study verifies the relationships of isoprene emission flux from bamboo leaves with these factors, and aids in a better estimation of bamboo isoprene emissions.

Chapter 1 of this study reviews the biochemical process of isoprene synthesis in plant leaves, the adaptive significance of isoprene emission by plants, the history of model development of isoprene emission from plant leaves, and the isoprene emission capacity of multiple plant species reported by previous studies. Also, the importance of bamboo species in the global isoprene emission, which suggests the need of a further research on bamboo species, is described. Understanding isoprene emission dynamics from bamboo leaves can provide critical information on mitigating its negative impact on the atmospheric chemistry. However, the lack of further data leads to a main obstacle for reliable estimation of isoprene emission dynamics from bamboo species.

In Chapter 2, the isoprene emission rate of the leaves of *Phyllostachys pubescens*, an introduced bamboo, in response to varied leaf temperature and light intensity was examined. The results confirm that *P. pubescens* is a major isoprene emitter, equivalent to or even stronger than previously reported emitters. When validating the reproducibility of an existing isoprene emission model, the isoprene emission rate in response to light intensity was well reproduced in this species. However, the model did not reproduce the response to leaf temperature owing to overestimation of isoprene emission rates under low temperatures. Although the overestimation problem was substantially corrected by applying an optimization on certain parameters in the model, a large variation among leaves led to difficulties in reproducing isoprene emission rate from *P. pubescens* with a constant basal isoprene emission rate. Further investigation of the controlling factors by considering the seasonal and inter-leaf variation in isoprene emission is needed.

In Chapter 3, morphological and physiological factors which could alter the isoprene emission capacity of bamboo leaves were examined. A strong correlation between leaf mass per area and area-based isoprene emission rate was found. On the other hand, mass-based photosynthetic rate and leaf nitrogen concentration did not exhibit any correlation with mass-based isoprene emissions. By combining data from *P. pubescens* across the three sites in this study, under constant light (1000 μmol m^{-2} s^{-1}) and leaf temperature (30 °C), the correlation between leaf mass per area and area-based isoprene emission rate was also demonstrated across these sites. This result partly explains that the inter-leaf variation in isoprene emission rate is related to leaf mass per area, and suggests that the detection of leaf mass per area can effectively determine a representative isoprene emission rate of bamboo leaves.

In Chapter 4, isoprene emission rate, leaf temperature, leaf mass per area, photosynthetic rate, and electron transport rate were recorded for 18 bamboo species within 5 genera, incorporating different growth types (tall and dwarf) and climates of the region of origin (temperate, warm-temperate, and subtropical). Dwarf bamboos showed negligible to no emissions of isoprene under any leaf temperature; in contrast, tall bamboos demonstrated considerable isoprene emission rates, mainly in August and September, at leaf temperatures higher than 30 °C. For tall bamboos, area-based isoprene emission rate generally showed a positive correlation to leaf mass per area across species. Mass-based isoprene emission rates showed a positive correlation to mass-based electron transport rates across species. Since no difference in leaf mass per area and electron transport rate was found between the tall species and dwarf species, different isoprene emission rates between them were independent of leaf mass per area, and electron transport rate.

Finally, Chapter 5 summarizes the findings in the above chapters. The results of this study show that bamboo species categorized as tall bamboos emit a considerable amount of isoprene. This emission amount is comparable to those of known high-emitter tree species. By having quantified the variability of isoprene emission rates, in response to factors such as leaf temperature, light intensity, leaf mass per area, and electron transport rate, from bamboo leaves of different species, this study allows us to achieve a better estimation of isoprene emission from leaves of bamboo species.

注)論文内容の要旨と論文審査の結果の要旨は１頁を３８字×３６行で作成し、合わせ
て、３,０００字を標準とすること。
論文内容の要旨を英語で記入する場合は、４００～１,１００wordsで作成し
審査結果の要旨は日本語５００～２,０００字程度で作成すること。

（続紙　２　）

（論文審査の結果の要旨）

植物個葉から放出されるイソプレンは、大気化学に大きな影響力をもつだけでなく、陸域生態系における炭素循環の新しい概念を構築する上で１つの重要な炭素排出源と考えられている。タケ類はアブラヤシ属、コナラ属などと並ぶハイエミッターである可能性が指摘されているが、その放出特性については未解明であった。本研究は、タケ個葉からのイソプレン放出特性をフィールド調査に基づいて定量的に解析したものである。本研究の評価できる点は以下の通りである。

1. モウソウチク個葉からのイソプレン放出速度およびその光依存・温度依存特性を明らかにし、これまで一定の温度依存式が使われてきたイソプレン放出推定モデルに、種固有の温度依存式を導入する必要性を指摘した。
2. モウソウチク個葉のLMA（単位葉面積あたり乾重）と単位葉面積あたりイソプレン放出速度との高い相関を明らかにし、LMAが、サイト間・個体間で大きい変動幅を持つ単位葉面積あたりイソプレン放出速度の主要な説明要因であることを示した。
3. タケ類18種からのイソプレン放出速度および葉の形態的・生理的特性を調べ、原産地の気候とは関係なく大型種で放出速度が高く小型種ではほとんど放出されないこと、また大型種ではLMAおよび電子伝達速度が種間差の説明要因になっていることを明らかにした。

以上のように、本論文は、タケ個葉からのイソプレン放出特性を多面的に明らかにしたものであり、森林水文学、森林環境科学、植物生理生態学の発展に寄与するところが大きい。

よって、本論文は博士（農学）の学位論文として価値あるものと認める。

なお、令和３年７月８日、論文並びにそれに関連した分野にわたり試問した結果、博士（農学）の学位を授与される学力が十分あるものと認めた。

また、本論文は、京都大学学位規程第１４条第２項に該当するものと判断し、公表に際しては、当該論文の全文に代えてその内容を要約したものとすることを認める。

注）論文内容の要旨、審査の結果の要旨及び学位論文は、本学学術情報リポジトリに掲載し、公表とする。

ただし、特許申請、雑誌掲載等の関係により、要旨を学位授与後即日公表することに支障がある場合は、以下に公表可能とする日付を記入すること。

要旨公開可能日：　　年　　月　　日以降（学位授与日から３ヶ月以内）