

( 続紙 1 )

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論文題目	Ecological strategy of woody plants in a seasonally dry tropical forest on infertile sandy soil (貧栄養砂質土壤に成立する熱帯季節的乾燥林における木本植物の生態学的戦略)		
(論文内容の要旨)			
<p>This doctoral thesis examines the structure and tree species diversity of a seasonally dry tropical forest on infertile quartz-rich sand in the Ankarafantsika National Park (ANP) in Madagascar. The primary forest stands within ANP represent the largest remnant of the original forest type that dominated the Northwestern Madagascar, most of which has been lost in recent years under anthropogenic pressures. As such, it is urgent to understand how natural forests as the foundation of regional biological diversity regenerate. The contents of this thesis represent the first description of the forest tree community in the region beyond a mere floristic survey.</p> <p>Chapter 1 explains the background and objectives of the study. It introduces the importance of variations in leaf phenology and functional traits among tree species that compose seasonally dry tropical forests.</p> <p>Chapter 2, “Structure and diversity of woody plant communities in a seasonally dry forest in Madagascar” describes the characteristics of a woody plant community, including both trees and lianas (woody vines). This is the first report utilizing the data base from the 15-ha forest dynamics monitoring plot established by an international collaboration team led by Kyoto University researchers. In this plot, all woody stems greater than 5 cm in diameter at breast height were mapped, tagged, measured for diameter, and identified to species. The forest stand was characterized by small-sized individuals (75% of stems with DBH &lt; 10 cm, with 99% of trees with height &lt; 15 m), encompassing 35,758 and 513 individuals of trees and lianas, respectively, belonging to 160 species in 53 families. For this size class, lianas accounted for 1.4% of the woody stems. It was also noted that the two most dominant species were evergreen, which suggest the prevalence of drought tolerant strategy, in coexistence with deciduous trees that employ drought avoidance strategy.</p> <p>Chapter 3 reports variations in leaf and stem traits between the different types of leaf phenology for the most dominant 22 tree species within the 15 ha plots, distinguishing four phenology types (10 evergreen, 5 late deciduous, 3 progressively deciduous, and 4 early deciduous species). Distinguishing deciduous habit to finer subgroups by the timing of leaf loss demonstrated how functional traits varied with leaf phenology as predicted by the theory of leaf economic spectrum. In contrast, these traits were independent of the tree height. Hence, in this forest, where evergreen species occupy nearly half of the tree community despite the long pronounced dry season, consist of tree species that exhibit continuous variations from drought tolerance to drought avoidance strategies. This chapter also reports the allometric</p>			

relationships between diameter and tree height, and the estimation of above ground biomass in this seasonally dry forest.

Chapter 4 reports functional traits of the most dominant 22 liana species in addition to those of the 22 trees reported in Chapter 3. Whereas lianas are considered to employ a more acquisitive strategy of fast growth compared to tree species, few published studies comparing lianas vs. trees have simultaneously considered life forms and leaf phenology types. The results showed that such consideration is important, as both life form and leaf phenology types affected functional traits. Within a given life form, early deciduous species had more the more acquisitive trait syndrome of lower leaf mass per area, higher nitrogen contents, and lower wood density than evergreen species. Within each phenology type, lianas tended to have more acquisitive traits than trees.

Chapter 5, “Topographical gradient of woody plant community in a seasonally dry tropical forest on sandy soil in Northwestern Madagascar”, reports how the structure and species composition of the tree community change with elevation from 150 m to 200 m above sea level on a gentle slope. With increasing elevation, stem density and species diversity increased, but tree height and diameter decreased. The most abundant two species, *Drypetes perrieri* (Putranjivaceae) and *Noronhia alleizettei* (Oleaceae) exhibited opposite trends, with their abundance decreasing and increasing with elevations, respectively. The community-weighted mean of leaf thickness, leaf mass per area, and wood density increased, and leaf nitrogen content decreased with elevations. Although environmental heterogeneity within the plot is not quantified, those results suggest the possibility of habitat differentiation and variations in resource competition among trees contributing to the species diversity in this forest.

Overall, from a series of field-based data, this thesis represents the first rigorous report of the structure and functional characteristics of woody plant communities in NW Madagascar. The large data from a contiguous plot of 15 ha allowed the detection of previously unrecognized patterns, such as how they change with gentle topographical gradients, which would otherwise be difficult to detect. The simultaneous evaluation of functional traits of trees and lianas in relation to phenological variation is also the first of this kind not only in Madagascar, but also in tropical forests worldwide.

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、400～1,100 words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。

(論文審査の結果の要旨)

熱帯季節林では熱帯雨林以上に、人間活動による森林破壊が進んでおり、希少かつ保全価値の高い自然林の構造や生物多様性の定量的評価が急務である。本論文は、マダガスカル北西部の熱帯季節林に近年設置された15ヘクタールの大規模森林動態調査区を用いて、森林構造とその空間変異、及び木本植物の分類的多様性と機能形質多様性を定量的に解析した。評価すべき点は以下の4点にまとめられる。

1. マダガスカルでは初となる世界的標準手法に基づく大規模森林調査区の森林構造と木本植物多様性の調査結果をまとめており、今後世界の他の森林との比較などの学術展開の礎となる。
2. 当該森林の樹木と木本性ツル植物の高い固有種の割合を定量的に明らかにした。その一方で、これらの木本性植物の機能形質の種間変異が世界規模の葉の経済学的スペクトル (worldwide leaf economic spectrum) などの一般則にも適合し、俯瞰的に捉えることができることを示した。
3. 葉の常緑性と落葉性を二分するのではなく、連続的に捉えることで、既往研究において曖昧であった樹木とツルの機能形質の変異を統一的に説明できることを明らかにした。
4. 15ヘクタール内の緩斜面における森林構造、樹木種多様性、機能形質の空間的パターンが標高差に関連していることを定量的に示した。

以上のように、本研究は、マダガスカルで初の大規模森林調査区における森林構造と木本植物多様性の報告であり、複数の興味深い知見を得た。固有種が多いマダガスカル自然林において、保全に必要な科学的知見を集積し、植物学、植物生態学、森林生態学、植物生理生態学、生態系生態学、保全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6年6月14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。