博士（環境科学）　OROU M.T.B. Augustin

学 位 論 文 題 名

Tree community structure, architecture and dynamics of woody savanna of the Dahomey Gap in West Africa

（西アフリカ、ダホメ・ギャップにおける木本サバンナの樹木群集構造、樹冠構造と動態）

学位論文内容の要旨

The Dahomey gap is a woody savanna region separating the West African rainforests into two regions. This savanna region is characterized by a rainfall gradient from south to north towards Sahara Desert and human-induced recurrent grass-layer fire. So far, no study has been carried out on tree communities of woody savanna in Dahomey Gap. In this thesis, I examined tree species composition and stand structure of tree communities in woody savanna in two sites (north site with lower rainfall and south site with higher rainfall), about 225 km distant from each other, to quantify tree communities for future sustainable management of this unique region.

The study was conducted in six 1-ha plots in each site that cover three types of canopy-closure (closed, semi-open and open). We recorded 3,720 trees that were larger than 5 cm in trunk diameter at breast height, consisted of 70 species and 34 families. Most abundant species such as *Isoberlinia doka*, *Vitellaria paradoxa* and *Pericopsis laxiflora* were distributed in both sites. The high similarity in species composition (82%) was found across two sites. The detrended correspondence analysis (DCA) based on species abundance divided 12 plots into groups of north and south sites along the first axis, whereas canopy-closure types were not associated with DCA axes. The stand structure was also different between

the two sites. At any given total tree height, trees in the north site had relatively slenderer stems with narrower crowns than those in the south site. The specific leaf area was smaller in the north site. Between-site differences in species abundance and allometry are possibly driven by stronger water stress in the north site close to Sahara Desert.

Crown architecture of tree species populations are quantified by allometric relationships among tree crown dimensions. I compared tree allometry across species, and intra-specific plasticity of allometry between two sites, to characterize tree communities of woody savanna. I carried out two-step comparison of allometry, namely, the site-level and specie-level analysis, to test how species invest in radial growth of trunk and crown expansion. The intercept parameters of allometries were different among species for the relationship between tree height and trunk diameter, and for that between tree height and crown width. Trunk diameter tended to be consistently larger in south than in north site for most species. Allometric properties were different between tall-, medium-, and short-statured species, suggesting the maximum-height related inter-specific functional differentiation. Allometric relationships were consistent for trunk diameter and crown architecture for tall species (with wider crown and thicker stem at the same height) but not for medium- and short-statured species. These shorter species tended to have wider crown whereas smaller trunk diameter at the same tree height in southern site compared to trees in the northern site.

To quantify the growth rate in trunk diameter, annual increment between January 2011 and December 2011 was monitored for all trees in 12 plots. The generalized linear model with Gamma distribution of growth-rate variation was carried out to quantify the size-dependent grown in trunk diameter between sites and among canopy-closure types. Trees in the woody savanna were characterized by low rate of growth and recruitment. Differentiation in growth rate was found among species but not between sites nor across canopy-closure types. I concluded that tree populations in Dahomey Gap savanna are adapted to arid conditions with low turn-over rates. In consequence, the rate of biomass accumulation was low regardless of high wood density. Tree species of woody savanna show a pronounced inter-specific variation and intra-specific plasticity in morphology and architecture. These enable the sustainability of woody savanna in this region. Meantime, intensive disturbance of woody savanna brings about serious degradation of tree communities.

学位論文審査の要旨

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The study was conducted in six 1-ha plots in each site that cover three types of canopy closure (closed, semi-open and open). In total, 3,720 trees that were larger than 5 cm in trunk diameter at breast height was recorded, consisted of 70 species and 34 families. Most abundant species such as *Isoberlinia doka*, *Vitellaria paradoxa* and *Pericopsis laxiflora* were distributed in the both sites. The high similarity in species composition (82%) was found across two sites. The detrended correspondence analysis

(DCA) based on species abundance divided 12 plots into groups of north and south sites along the first axis, whereas canopy-closure types were not associated with DCA axes. The stand structure was also different between the two sites. At any given total tree height, trees in the north site had relatively slenderer stems with narrower crowns than those in the south site. The specific leaf area was smaller in the north site. Between-site differences in species abundance and allometry are possibly driven by stronger water stress in the north site close to Sahara Desert.

Crown architecture of tree species populations are quantified by allometric relationships among tree crown dimensions. Tree allometries were compared across species and between two sites. Two-step comparison of allometry was carried out, namely, the site-level and specie-level analysis, to test how species invest in radial growth of trunk and crown expansion. Significant differences were detected in the intercept in allometric relationships in tree height vs. trunk diameter and that in tree height vs. crown width among. species. Trunk diameter tended to be consistently larger in south than in north site for most species. Allometric properties were different between tall-, medium-, and short-statured species, suggesting the maximum-height related inter-specific functional differentiation. Allometric relationships were consistent for trunk diameter and crown architecture for tall-statured species (with wider crown and thicker stem at the same height) but not for medium- and short-statured species. These shorter species tended to have wider crown whereas smaller trunk diameter at the same tree height in the south site compared to trees in the north site.

To quantify the growth rate in trunk diameter, annual increment was monitored between January and December 2011 for all trees in 12 plots. Recorded size-dependent growth rate in trunk diameter was not different between sites and among canopy-closure types. Trees in the woody savanna were characterized by low rate of growth and recruitment. Differentiation in growth rate was found among species but not between sites nor across canopy-closure types. This thesis thus concluded that tree populations in Dahomey Gap savanna are adapted to arid conditions with low turn-over rates. In consequence, above-ground biomass was maintained with long residence time. Tree species of woody savanna show inter-specific variation and intra-specific plasticity in morphology and architecture. These enable the sustainability of woody savanna in this region.

The examination committee recognized that the present thesis provides novel ecological information for the sustainable management of the unique savanna ecosystem. The committee also evaluated enthusiasm of the applicant in intensive field work and skillful data analysis, and for collaboration with many researchers worldwide during the course of graduate school, thereby concluded that the applicant is eligible for the degree of Doctor of Philosophy (Environmental Science).