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京都大学	博士（地域研究）	氏名	RAZANAPARANY Tojotanjona Patrick
論文題目	Ecological Flexibility of the Common Brown Lemur (*Eulemur fulvus*) and Its Conservation in the Dry Deciduous Forest in Northwestern Madagascar （マダガスカル北西部の乾燥落葉樹林におけるチャイロキツネザル（*Eulemur fulvus*）の生態的柔軟性と保全）		

（論文内容の要旨）

Environmental conditions challenge organisms to develop survival strategies and adapt to distinct ecological niches. In animals, ecological flexibility in various behavioral traits, such as diet, social systems, and movement patterns, has also evolved to deal with dynamic environmental factors. One such behavioral strategy is an activity pattern shifted toward the daytime or nighttime; such temporal flexibility can mitigate stress and thus confers a survival advantage. Some primates are cathemeral and show significant activity during both the day and dark parts of the 24-h cycle, despite differences in diurnal and nocturnal niches. Cathemeral lemurs living in Madagascar retain intermediary traits between diurnal and nocturnal primates. The relat previous studies have analyzed their activity patterns to understand their temporal flexibility and the evolution of diurnality in primates. However, the determinants of cathemerality in Malagasy lemurs remain controversial, particularly due to new hypotheses arising from the discovery of many cathemeral lemurs living in various habitats. Temporal flexibility may allow cathemeral lemurs to persist in artificially disturbed and degraded forests. However, such ecological flexibility has rarely been considered in the context of wildlife conservation.

To understand the temporal flexibility of Malagasy primates, the author studied the cathemerality of the common brown lemur (*Eulemur fulvus*) in Ampijoroa Forest Station, Ankarafantsika National Park (ANP) in northwestern Madagascar. In total, 46 all-day (6:00–18:00) and 33 all-night (18:00–6:00) behavioral observations of two lemur groups were made from July 2015 to March 2016, evenly distributed between the dry and wet seasons. The details of the study site and focal animal species are introduced in Chapter 1, and the effects of abiotic factors were examined in Chapter 2 to understand the proximate factors causing cathemeral activities. The brown lemurs were cathemeral regardless of the season. Their diurnal activity increased with day length and humidity, but decreased on days with high ambient temperatures and after new-moon nights. Their nocturnal activity increased on nights with short day lengths or full moons. Both diurnal and nocturnal activity decreased during heavy rainfall. These results indicate that photoperiod variation entrained the 24-h activity rhythm of brown lemurs as a zeitgeber, while moonlight facilitated lemur activity at night as a masking effect. As high daytime humidity occurred in the wet season, these findings suggest that high water availability mitigates daytime heat stress via evaporative cooling.

Chapter 3 analyzes the 24-h feeding ecology of brown lemurs. Although the fruiting phenology of 817 trees of 26 species was characterized by seasonal variation in fruit availability,

brown lemurs modified their folivorous and frugivorous diet independent of fruit availability. During the wet season, they were mainly frugivorous regardless of the time of day. In the dry season, while the lemurs heavily consumed leaves (particularly the succulent, water-rich leaves of the orchid *Lissochilus rutenbergianus*) during daytime with low humidity and high temperatures, they mainly fed on fruit at night. This consumption of succulent leaves can be interpreted as a feeding strategy to improve water intake under dry/heat stress, while nocturnal frugivory can be understood as a modified behavior aimed at increasing energy intake.

To determine the adaptive significance of cathemerality in brown lemurs in Ankarafantsika, major hypotheses proposed elsewhere were assessed in Chapter 4. The activity patterns of brown lemurs in Ankarafantsika supported the hypotheses that cathemerality is an antipredator strategy to avoid diurnal raptors, and a thermoregulation strategy to avoid overheating when there are high ambient daytime temperatures. Moreover, the author proposed a novel hypothesis, i.e., that the cathemerality of brown lemurs living in tropical dry forests is probably due to a combination of strategies to cope with daytime dry/heat stress and meet energy intake requirements via nocturnal frugivorous activity.

In Chapter 5, the habitat of mid-sized lemurs, including brown lemurs, was examined in transect surveys in two types of forest habitat: forest managed by Madagascar National Parks and forest managed by local communities in ANP. A tree census was performed in 10 × 10 m quadrats in the two forest types to analyze the vegetation structure. The heads of local households were also interviewed to ascertain their understanding of forest management. Forests managed by the local communities had fewer large-stem trees than the park-managed forest. The species compositions of the tree communities also differed between the two types of forest. These findings indicate that community-managed forests can be categorized as secondary forests with environmental disturbance. Lemur census surveys confirmed the presence of medium-sized lemurs in both forests, although the encounter rate of lemurs, including brown lemurs, was lower in the community-managed forests. Based on the interviews and observations of human activity traces in the forests, the existence of illegal hunting, logging, and forest fires was confirmed in the community-managed forests. Those artificial environmental disturbances were probably responsible for the lower population densities of mid-sized lemurs in the community-managed forests.

This dissertation ends with a general discussion of current issues and suggestions for future lemur conservation work based on the observed ecological flexibility of brown lemurs and their population densities in different habitats in ANP. Cathemerality is an adaptive strategy that enhances the ecological flexibility of brown lemurs so that they can cope with variation in environmental conditions and fit within their niches. However, the persistence of brown lemurs in artificially degraded forests seems to be limited by high hunting pressure, the risk of forest fires, and fewer large trees and low food availability. Lemur conservation in community forests and buffer zones must consider the limits of ecological flexibility and tolerability of future environmental disturbances.