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ANTHROPOGENIC DISTURBANCE, NOT TOPOGRAPHIC DISPERSAL BARRIERS, LIMIT FOREST AND MAINTAIN MADAGASCAR'S DERIVED SAVANNAS

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Study Description

In an attempt to explain ancient pyrogenic savannas and absence of forest across central-western Madagascar, a range-pinning model, using the escarpment as a barrier to eastern forest expansion was proposed. By plotting extant forest systems, we demonstrate the presence of multiple remnant closed-canopy forest patches across these savanna–grasslands, proving that range-pinning does not apply. Furthermore, current grass assemblages are fire adapted, and selected by regular anthropogenic pastoralist burning. The novelty of these pyrogenic, derived systems is supported by multiple lines of evidence from evolutionary biology, paleoecology, ecology, geomorphology, molecular studies, and indigenous knowledge, which names much of this grassland as forest.

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Photo 1. Central Highland grassland (RN7 national road; Isalo district). Levels of grass endemicity in Madagascar are most similar to those of the derived grasslands of the previously forested islands of New Guinea, New Zealand, Japan, and the Mascarenes (Mauritius, Réunion, and Rodrigues). Annual burning of Malagasy treeless grasslands west of the escarpment to support zebu cattle is so intensive that it exposes topsoil and selects a fire-adapted anthropogenic grass assemblage of low palatability, dominated by *Loudetia simplex, Schizachyrium sanguineum*, and *Trachypogon spicatus*. This habitat is driven by pastoralism, not topography. Photo credit: Grant Joseph.



Photo 2. Critically Endangered Verreaux's sifaka (*Propithecus verreauxi*) in remnant forest at Zombitse, surrounded by anthropogenic grassland. Zombitse is just one of many areas west of the escarpment harboring closed-canopy forests. Over 90% of vertebrates, being predominately forest-adapted, are limited to such areas across Madagascar, despite the fact that almost 80% of the island not under agriculture is now grassland. This evolutionary anomaly is best explained by treeless grasslands having been historically smaller, or ephemeral. Photo credit: Grant Joseph.



Photo 3. Despite sharing common ancestry with African Herpestids that have easily evolved to open habitats [e.g., *Cynictis penicillata* (a); *Suricata suricatta* (b)], Malagasy Euplerids [e.g., the Endangered *Mungotictis decemlineata* (c); the Vulnerable and decreasing *Cryptoprocta ferox* (d)] are forest-adapted. The same is true of all non-arboreal Malagasy mammal lineages, which have failed to evolve into savanna–grassland specialists, suggesting that open habitats have either not been sufficiently stable or sufficiently vast to promote open-habitat adapted species. Photo credit: Colleen Seymour (a); Grant Joseph (b–d).

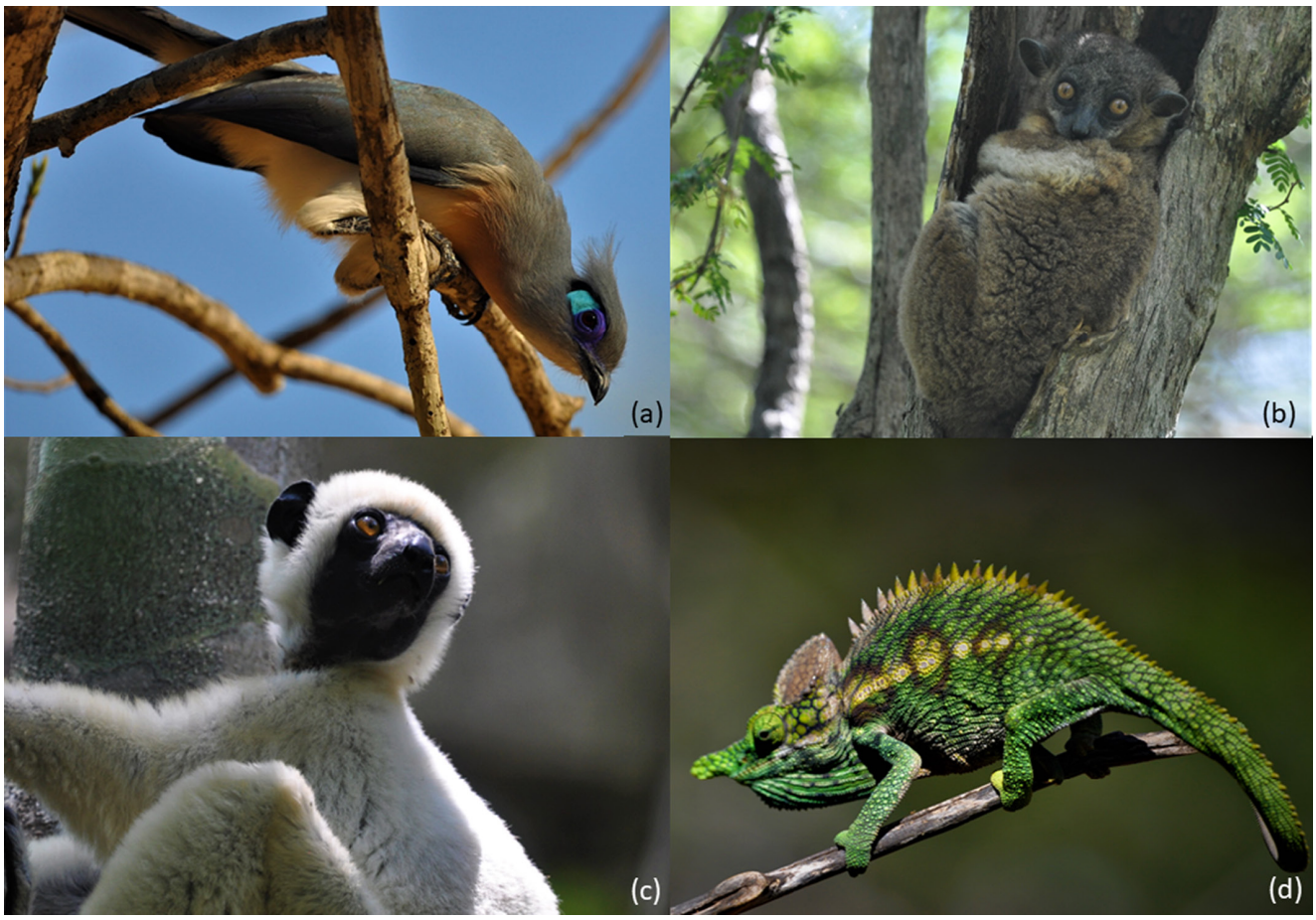


Photo 4. Aside from the remaining subhumid forest patches on the Central Highlands which share many tree species with eastern lowland forest (thus contradicting the proposal of range-pinning), there are multiple canopied, non-savanna systems west of the escarpment, harboring species dependant on woody vegetation. Examples include deciduous forest, e.g., Kirindy Forest, harboring *Coua cristata* (a); Zombitse Forest, home to the Endangered *Lepilemur hubbardorum* (b); Tsingy De Bemaraha Forest sustaining Critically Endangered *Propithecus deckenii* (c), and Spiny Forest, e.g., Raniala Forest, here providing habitat for the Vulnerable and decreasing *Furcifer antimena* (d). Photo credit: Grant Joseph.



Photo 5. Zebu (*Bos taurus indicus*) cattle number 7 to 10 million head, and form obligate C4 grazing lawns on Madagascar. There is no evidence to date for any Malagasy obligate grazers, past or present. Treeless grazing lawns now occur where paleoecological evidence supports recent existence of C3 forest and woodland tree species, containing subfossils representing extinct herbivores that included a large component of C3 species in their diets. Transformation of these woodlands and forests to grassland, and extirpation of endemic tree-adapted herbivores occurred coeval with the switch from human gathering and hunting to pastoralism and farming. Photo credit: Grant Joseph.

These photographs illustrate the article "Dispersal limitation and fire feedbacks maintain mesic savannas in Madagascar: Comment" by Grant S. Joseph and Colleen L. Seymour published in *Ecology*. https://doi.org/10.1002/ecy.4045