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- lands. Pp. 437-450. In: D.J. Levey; W.R. Silva; M. Galetti (eds.). Seed Dispersal and Frugivory: Ecology, Evolution and Conservation. CABI Publishing, Oxford, UK.
- Ganzhorn, J.U.; Fietz, J.; Rakotovo, E.; Schwab, D.; Zinner, D. 1999. Lemurs and the regeneration of dry deciduous forest in Madagascar. *Conservation Biology* 13(4):794-804.
- Golden, C.D. 2009. Bushmeat hunting and use in the Makira Forest, north-eastern Madagascar: a conservation and livelihoods issue. *Oryx* 43: 386-392.
- Goodman, S.M. 1997. Observations at a *Ficus* tree in Malagasy humid forest. *Biotropica* 29: 480-488.
- Gosper, C.R.; Stansbury, C.D.; Vivian-Smith, G. 2005. Seed dispersal of fleshy-fruited invasive plants by birds: contributing factors and management options. *Diversity and Distributions* 11: 549.
- Haddad, N.M.; Bowne, D.R.; Cunningham, A.; Danielson, B.J.; Levey, D.J.; Sargent, S.; Spira, T. 2003. Corridor use by diverse taxa. *Ecology* 84: 609-615.
- Hatchwell, M. 1999. Plan de gestion de complexe des Aires Protégées de Masoala. Unpubl. Wildlife Conservation Society report.
- Hekkala, E.R.; Rakotondratsima, M.; Vasey, N. 2007. Habitat and distribution of the ruffed lemur, *Varecia*, north of the Bay of Antongil in northeastern Madagascar. *Primate Conservation* 22: 89-95.
- Holloway, L. 1997. Catalysing natural regeneration of rain-forest: Masoala corridors. Unpublished report presented to Wildlife Conservation Society, Madagascar.
- Howe, H.F. 1986. Seed dispersal by fruit-eating birds and mammals. Pp. 123-189. In: D.R. Murray (ed.). *Seed Dispersal*. Academic Press, Sydney.
- Howe, H.F.; Smallwood, J. 1982. Ecology of seed dispersal. *Annual Review of Ecology and Systematics* 13: 201-228.
- Into, I. 2009. Investigation into the illegal felling, transport and export of precious wood in the SAVA region of Madagascar. Global Witness and the Environmental Investigation Agency, Inc. Report.
- IUCN. 2008. Red List of Threatened Species. www.iucnredlist.org.
- Kaplin, B.A.; Lambert, J.E. 2002. Effectiveness of Seed Dispersal by *Cercopithecus* Monkeys: Implications for Seed Input into Degraded Areas. Pp. 351-364. In: D.J. Levey; W.R. Silva; M. Galetti (eds.). *Seed Dispersal and Frugivory: Ecology, Evolution and Conservation*. CABI Publishing, Oxford, UK.
- Kaplin, B.A.; Moermond, T.C. 1998. Variation in seed handling by two species of forest monkeys in Rwanda. *American Journal of Primatology* 45: 83-101.
- Link, A.; Di Fiore, A. 2006. Seed dispersal by spider monkeys and its importance in the maintenance of neotropical rain-forest diversity. *Journal of Tropical Ecology* 22: 235-246.
- McKey, D. 1975. The ecology of coevolved seed dispersal systems. Pp. 159-191. In: L.E. Gilbert, P.H. Raven (eds.). *Coevolution of Animals and Plants*. University of Texas Press, Austin, TX, USA.
- Mech, S.G.; Hallett, J.G. 2001. Evaluating the effectiveness of corridors: a genetic approach. *Conservation Biology* 15: 467-474.
- Mittermeier, R.A.; Konstant, W.R.; Hawkins, F.; Louis, E.E.; Langrand, O.; Ratsimbazafy, J.; Rasoloarison, R.; Ganzhorn, J.U.; Rajaobelina, S.; Tattersall, I. 2006. *Conservation International Tropical Field Guide Series: Lemurs of Madagascar*. Conservation International, Washington, DC, USA.
- Neilan, W.; Catterall, C.P.; Kanowski, J.; McKenna, S. 2006. Do frugivorous birds assist rainforest succession in weed dominated old field regrowth of subtropical Australia? *Biological Conservation* 129: 393-407.
- Poulsen, J.R.; Clark, C.J.; Smith, T.B. 2001. Seed dispersal by a diurnal primate community in the Dja Reserve, Cameroon. *Journal of Tropical Ecology* 17: 787-808.
- Razakamaharavo, V.R.; McGuire, S.M.; Vasey, N.; Louis, E.E.; Brenneman, R.A. 2010. Genetic architecture of two red ruffed lemur (*Varecia rubra*) populations of Masoala National Park. *Primates* 51: 53-61.
- Rigamonti, M.M. 1993. Home range and diet in red ruffed lemurs (*Varecia variegata rubra*) on the Masoala Peninsula, Madagascar. Pp. 25-40. In: P.M. Kappeler; J.U. Ganzhorn (eds.). *Lemur social systems and their ecological basis*. Plenum Press, New York, USA.
- Schupp, E.W. 1993. Quantity, quality and the effectiveness of seed dispersal by animals. *Plant Ecology* 107: 15-29.
- Schuurman, D.; Lowry, I.I. 2009. The Madagascar rosewood massacre. *Madagascar Conservation & Development* 4 (2): 98-102.
- Sokal, R.R.; Rohlf, F.J. 1995. *Biometry: the principles and practice of statistics in biological research*. WH Freeman, New York, USA.
- Stevenson, P.R. 2000. Seed dispersal by woolly monkeys (*Lagothrix lagotherica*) at Tinigua National Park, Colombia: dispersal distance, germination rates, and dispersal quantity. *American Journal of Primatology* 50(4): 275-289.
- Vasey, N. 1997. Community ecology and behavior of *Varecia variegata rubra* and *Lemur fulvus albifrons* on the Masoala Peninsula, Madagascar. Unpubl. Ph.D. thesis, Washington University, St. Louis, USA.
- Vasey, N. 2003. *Varecia*, ruffed lemurs. Pp. 1332-1336. In: S.M. Goodman; J.P. Benstead (eds.). *The Natural History of Madagascar*. Chicago University Press, Chicago, USA.
- Wehncke, E.V.; Dalling, J.W. 2005. Post-dispersal seed removal and germination of selected tree species dispersed by *Cebus capucinus* on Barro Colorado Island, Panama. *Biotropica* 37: 73-80.

Feeding ecology of the crowned sifaka (*Propithecus coronatus*) in a coastal dry forest in northwest Madagascar (SFUM, Antrema)

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The crowned sifaka (*Propithecus coronatus*; Milne-Edwards, 1871) inhabits dry forests, riparian forests and mangroves of northwest Madagascar. Originally believed to occur in a restricted area between the Mahavavy River in the southwest (where it overlaps with *P. deckenii*) and the Betsiboka River in the northeast (which separates it from *P. coquereli*), sightings west of the Mahavavy River and along the Bongolava Massif suggest that the distribution of this medium-sized species is wider (Tattersall, 1986; Thalmann et al., 2002). The distribution and the taxonomic status of crowned sifakas have long been debated, but the combination of morphological and biogeographic evidence supports considering it as a valid species (Thalmann et al., 2002; Mittermeier et al., 2006; Groves and Helgen, 2007; Mittermeier et al., 2008). Considered as Endangered (A2 c,d) by the IUCN (2010), populations of crowned sifakas were estimated not to exceed 1,000 individuals in the wild. However, recently discovered populations in restricted fragmented forests extend the species' distribution range farther towards the Southwest. A "Bio-cultural Project" was therefore initiated at Antrema (a site located in the Mahajanga region) in 2000 to promote sustainable management (Gauthier et al., 2001). The project aims at

preserving a coastal environment in which crowned sifakas occur in high densities while allowing villagers, mainly fishermen, to use natural products of the environment with parsimony and to benefit from technical and economical help. The project also aims at promoting local socio-cultural rules and a way of life that tends to respect the forest environment, including useful plants and several sympatric lemur species (*Propithecus coronatus*, *Eulemur fulvus*, *Eulemur mongoz*, *Lepilemur* sp., *Microcebus murinus*). The site contains three of the Northwest's typical ecosystems (dry semi-deciduous forest, mangrove swamp, savanna), which suffer moderate anthropogenic pressure (Gauthier et al., 2001). Owing to local beliefs, especially the sacred ("masina") nature of sifakas, the Sakalava community plays a central role in this conservation process (Harpet et al., 2000, 2008). In this context, a few studies started investigating the behavior in relation to habitat and food supply of the lemur species of Antrema (Gauthier et al., 1999; Razafimahafa, 2001; Ramanikirahina, 2004). However, a detailed analysis of the feeding ecology and population densities of *P. coronatus* is still lacking. We present here preliminary data on the plant species composition of the white-sand coastal forest inhabited by a dense population of sifakas (among other prosimian species) and on the feeding ecology of sifaka groups censused since 2008.

Methods

Study site

The Antrema station is a coastal area of 12,300 ha located on the left riverside of the Betsiboka estuary, northwestern Madagascar (15°42'-15°50'S, 46°-46°15'E; Gauthier et al., 2001). The region undergoes a distinct dry season of 7 months from April to October. The mean annual rainfall ($n = 9$ years) in the Mahajanga region is 1,410 mm (with a peak in January-February), with irregular rainfall during the dry season. With an annual mean of 27° C, temperature is highest in October and lowest between June and August (Airport of Mahajanga, 2000-2009).

Although the Antrema area has been traditionally protected by the local Sakalava beliefs, forest areas where studies are conducted are fragmented. After two first surveys in November 2007 and April-May 2008, we decided to establish the study site at Badrala (15°45.665'S, 46°12.300'E). With about 20 ha just behind the littoral dune, this non-sacred forest site offers suitable conditions to study the socioecology of sifakas and the dynamics of a dry forest in Madagascar. The forest there is partly split by a sandy open dune that sifaka groups can cross easily. Tree logging occurs at low intensity (with few selected species for defined use, e.g. for boats or coffins) and small trees are sporadically cut for fences and house building. We studied floristic composition by inventorying trees along four North/South-oriented line transects, 10m-wide each, that were roughly perpendicular to the sea front. Within this 0.73 ha, we tagged each tree 40 cm diameter at breast height (DBH) with plastic labels, recorded their DBH, the number of stems and their vernacular name. Likewise, we counted woody lianas and herbaceous vines 1 m high within eight 10 x 10 m (800 m²) plots regularly spaced along the transects. Plant species were sampled and dried for later botanical identification.

Sifaka population density

In order to locate and identify groups of *P. coronatus* in Badrala, we initially mapped groups encountered during repeated transect walks. We drew individuals' facial masks for each of the followed groups, noted their sex from visual

inspection of the genitalia and other external characteristics (cysts, scars, damaged ears, fur colour), and took pictures. Knowledge gained progressively of groups and individuals allowed us to provide a preliminary estimate of population density for the Badrala site.

Behavioral data collection

We collected behavioral data during 4 periods (06 to 21 July 2008; 11 November to 12 December 2008; 05 April to 06 June 2009; 17 October to 22 November 2009). Most groups were already accustomed to the sporadic presence of local people. Once we could observe animals at close distances, we followed each group successively over 2 to 5-day periods, from 06:30 to 18:30 hours.

We used the instantaneous scan-sampling method (Altmann, 1974) to study group activity budget. Every 5 minutes, we recorded the individuals' activity using one of the following categories: resting (immobile, with eyes open or closed), moving (more than 0.5 m), foraging (searching for a food item), feeding (processing or chewing a food item), social activity (displaying agonistic and affiliation behaviors with other individuals) and other miscellaneous behaviors. We noted the plant part and species eaten by individuals.

Besides recording activity budgets, we determined diet from mouthful counts converted into weight of ingested matter (Hladik, 1977) for 2 periods: April-June 2009 and October-November 2009. We estimated food intake in focal individuals that were followed continuously for 30 minutes each. Observations were alternated across males and females (excluding juveniles) within groups.

Results

Forest composition

Plant families occurring at Badrala are presented separately for trees and lianas/vines in Fig. 1. To date, 91 tree and liana or vine species have been identified at least at the family level, and taxonomic identification of 15 more putative species is still in progress. The 5 richest families in terms of the number of species are Fabaceae, Sapindaceae, Ebenaceae, Euphorbiaceae and Apocynaceae. The most dominant tree species are *Strychnos decussata*, *Vitex beraviensis*, *Mimusops occidentalis*, *Baudouinia fluggeiformis* and *Macphersonia gracilis* that represent almost one third of total basal area and tagged trees. *Combretum coccineum*, *Hypoestes* sp., *Landolphia perrieri* and *Reissantia* sp. accounted for more than one third of the lianas and vines.

Density of trees inventoried on the 4 transects ($n=486$) corresponds to 666 inds. ha⁻¹ with a total basal area of 14.5 m² ha⁻¹. We found a high density of woody lianas and herbaceous vines in the 800m² plots ($n=373$).

Sifaka population density and group composition

Groups at Badrala have 1-3 breeding adult males, 1-4 breeding adult females, and 1-4 immature offspring. We encountered between 15 and 20 groups at this site. Based on current recognition of individuals within these groups, a minimum estimate of 300 inds. km² was calculated. Mean size of focal groups was 4.3 ± 1.8 individuals ($n=16$).

Diet and activity pattern

Sifakas consumed at least 60 plant species from 32 families. Tab. 1 lists major food species eaten. During the dry season, 14 plant species represented 75 % of the diet whereas only 7 species were the main food resource in the wet season. Sifakas were highly folivorous during both seasons, supplementing their diet with flowers, fruits, vegetative

Tab. 1: Food species accounting for 50 and 75 % of the diet of *Propithecus coronatus* during the dry season and the wet season. Eaten plant species are listed in decreasing order and their abundance in transects and plots (see text) is indicated.

Family	Species	Vernacular name	Items	Abundance (%)
Dry season				
Lamiaceae	<i>Vitex beraviensis</i>	Mojiro	yl	10.7
Fabaceae	<i>Baudouinia fluggeiformis</i>	Manjakabentany	yl ml	4.7
Sapotaceae	<i>Mimusops occidentalis</i>	Natofotsy	yl stems	3.9
Anacardiaceae	<i>Operculicarya gummifera</i>	Atokonjo	ml buds	3.5 50 %
Sapindaceae	<i>Majidea zanguebarica</i>	Tsipopoka	yl ml fl	2.3
Oleaceae	<i>Noronhia boinensis</i>	Tsilaitra beravina	yl	1.9
Moraceae	<i>Trilepisium occidentale</i>	Kililo	ml	1.2
Sphaerosepalaceae	<i>Rhopalocarpus lucidus</i>	Hazondringitra	yl fr	1.0
Melastomataceae	<i>Warneckea</i> sp.	Voatrotrokoala	yl	0.6 75 %
Burseraceae	<i>Commiphora</i> sp.	Arofy	fr buds	0.4
Fabaceae	<i>Bussea perrieri</i>	Morango	ml	0.2
Olaceae	<i>Olax dissitiflora</i>	Ambiotsy	ml	0.2
Moraceae	<i>Ficus pyrifolia</i>	Nonika	fr	
Unidentified	-	RR80	ml	
Wet season				
Anacardiaceae	<i>Abrahamia deflexa</i>	Motsovavy	yl fl	3.1
Anacardiaceae	<i>Abrahamia</i> sp.	Manavodrevo	buds yl fl	1.2
Fabaceae	<i>Chadsia flammea</i>	Fanamohazo	buds yl fl	0.8 50 %
Sapotaceae	<i>Capurodendron gracilifolium</i>	Natoboay	buds yl fr	0.2
Apocynaceae	<i>Landolphia perrieri</i>	Vahipira	yl	6.8 75 %
Combretaceae	<i>Terminalia</i> sp.	Taly	buds yl	3.1
Anacardiaceae	<i>Operculicarya gummifera</i>	Atokonjo	yl	3.5

yl: young leaves; ml: mature leaves; fl: flowers; fr: fruits

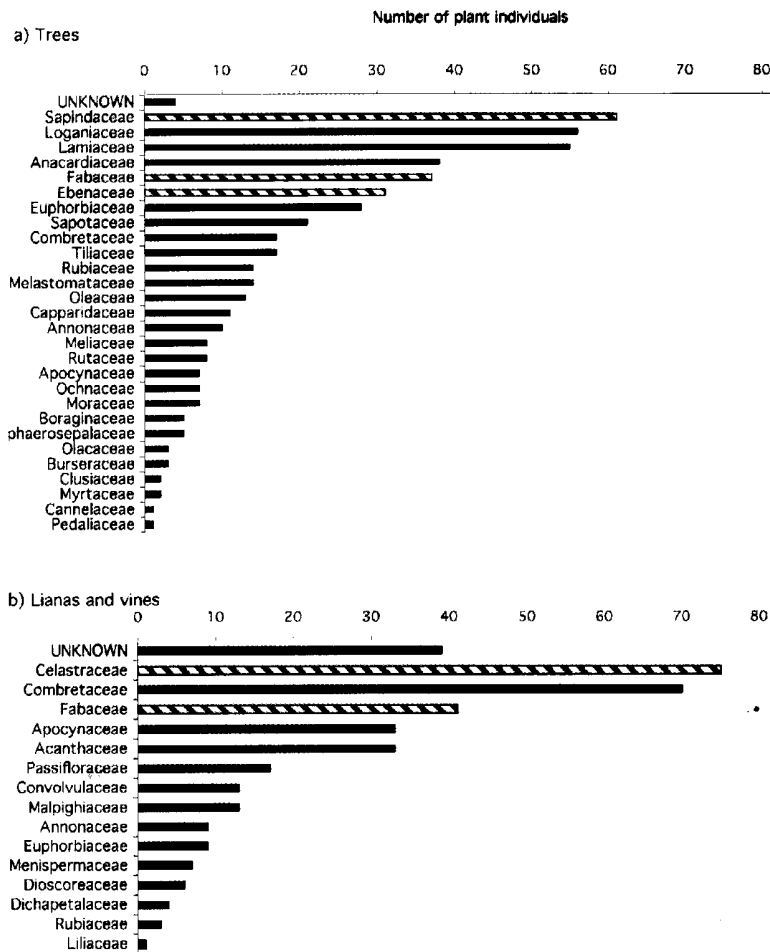


Fig. 1: Abundance of plant families plotted in decreasing number of individuals among a) trees with DBH > 10cm (based on transects; 0.73 ha) and b) woody lianas and herbaceous vines > 1 m height (based on plots; 0.08 ha). Striped bars refer to the plant families with the highest number of species.

buds, and sometimes young stems (Fig. 2). They consumed more mature leaves and fruits in the dry season and more flowers in the wet season.

The activity budget of the sifakas is presented in Fig. 3. Although 'resting' predominated throughout the study, individuals rested more in the dry season than in the wet season. ~~However, they~~ travelled and engaged in feeding activities more often during the wet season.

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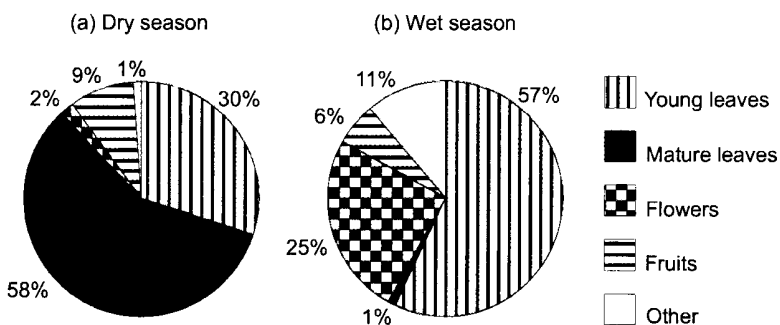


Fig. 2: Food categories in the diet of *Propithecus coronatus* during the dry season (a) and the wet season (b).

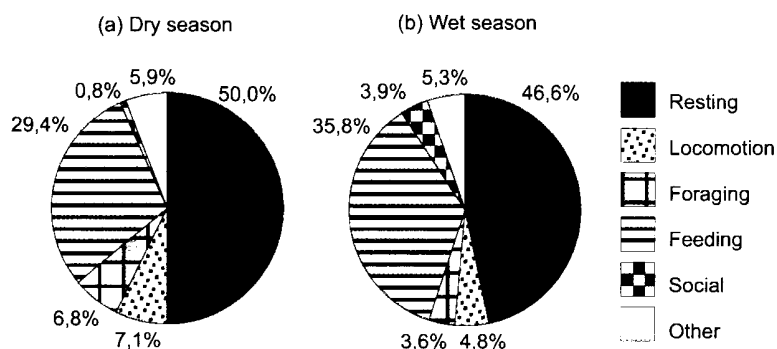


Fig. 3: Activity budget of *Propithecus coronatus* during the dry season (a) and the wet season (b).

Discussion

The sifaka density was found to be high in the dry forest of Antrema, with a minimum estimate far above the 173 inds. km² found in the riparian forest of Anjamena (Muller *et al.*, 2000) or for other sifaka species in dry or wet forests (O'Connor, 1988; Ganzhorn, 1992). This high density might be related to some peculiar characteristics of the forest in terms of food quantity and/or food quality available to this prosimian species. However, tree basal area was not particularly high compared with other dry forests in Madagascar and Mayotte (Hladik, 1980; Simmen *et al.*, 2005). It is not yet clear also whether high density is related to a putative low predation pressure. To our knowledge, no sightings or traces of viverrid carnivores have been reported; large raptors and boas would be the only predators that could affect the demography of the Antrema sifaka population (Garbutt, 2007; Sinclair and Legrand, 2008).

As regards their feeding behavior, crowned sifakas fed primarily on leaves from a few tree, liana and vine species, and supplemented their diet with a wide range of secondary items as commonly occurs in other *Propithecus* species (Meyers and Wright, 1993; Simmen *et al.*, 2003; Lehman and Mayor, 2004; Irwin, 2008). Although this species remained folivorous during our study, its diet changed with seasons.

Young leaves were the preferred food type in the early wet season, while mature leaves were the dominant one in the beginning of the dry season. In addition, *P. coronatus* ate a higher proportion of liana and vine parts during the wet season. Crowned sifakas also followed the typical activity pattern of other sifaka species (Norscia *et al.*, 2006; Patel, 2006; Charrier *et al.*, 2007), spending most of their time resting and devoting a substantial amount of time to feeding activities

and locomotion. Activity budget nevertheless changed with seasons. It is generally suggested that the cool dry season represents a period of food scarcity for animals, which they compensate for by reducing their energy expenditure, travelling less and resting more. In a recent joint research project, the content of litter traps regularly distributed along the transects was collected and weighted every two weeks throughout one year. It was found that plant species could be grouped according to their temporal pattern of leaf loss (Ranaivoson *et al.*, 2010; see also Razakanirina, 2010). Several trees, lianas and vines lost their leaves more or less regularly throughout the dry season while others were characterized by delayed leaf loss or on the contrary by precocious leaf fall. One consequence is that leaves are available throughout the year, although as different sets of species varying in quantity, diversity, and presumably, nutritional quality. This at least could explain why sifakas are able to increase the diversity of consumed plants (and adopt a more opportunistic strategy) during the dry season, a period normally described by the scarcity of food resources.

Future work on seasonal variations in the diet's nutritional and chemical content will allow us to examine the role of qualitative aspects in food choices (Moss, 1991; Dearing *et al.*, 2000) and further examine potential differences between genders with

regard to the importance of energy conservation for female sifakas (Wright, 1999; Charrier *et al.*, 2007).

Conclusion

Better knowledge of the ecology and the villagers' social perception of this flagship species may contribute to conservation of other diurnal lemurs, by incorporating the villagers' symbolic perception of their natural environment. Investigating the interactions between this species and plants of the coastal dry forest ecosystem will undoubtedly result in better conservation decisions for Antrema. From an evolutionary ecology standpoint, the studies we have planned for the next years at Antrema will also contribute to better identify the selective pressures that have been driving the evolution of prosimian typical life-history traits such as reproductive synchronization or dominance-based feeding priority of females over males in gregarious species (Wright, 1999; Dewar and Richard, 2007).

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References

- Altmann, J. 1974. Observational study of behavior. Sampling methods. *Behavior* 49: 227-267.
- Charrier, A.; Hladik, A.; Simmen, B. 2007. Feeding strategy and social dominance in female sifakas (*Propithecus v. verreauxi*) living in a Didiereaceae forest in southern Madagascar. *Rev. Ecol. (Terre Vie)* 62: 257-263.
- Dearing, M.D.; Mangione, A.M.; Karasov, W.H. 2000. Diet breadth of mammalian herbivores: nutrient versus detoxification constraints. *Oecol.* 123: 397-405.
- Dewar, R.E.; Richard, A.F. 2007. Evolution in the hypervariable environment of Madagascar. *Proc. Nat. Acad. Sci. USA* 104: 13723-13727.
- Ganzhorn, J.U. 1992. Leaf chemistry and the biomass of folivorous primates in tropical forests. Test of a hypothesis. *Oecol.* 91: 540-547.
- Garbutt, N. 2007. *Mammals of Madagascar: A Complete Guide*. Yale University Press, New Haven.
- Gauthier, C.A.; Deniaud, J.L.; Leclerc-Cassan, M.; Rakotomalala, M.; Razafindramanana, S.; Renson, G. 1999. *Proc. 2nd Int. Symp. Biogeography, diversity and endemism in Madagascar*, Paris.
- Gauthier, C.A.; Huguet, S.; Rakotondravony, D.; Roger, E. 2001. Diagnostic physico-éco-biologique de la station forestière à usages multiples d'Antrema (péninsule de Katsepy). Parc Zoologique de Paris, Muséum national d'Histoire naturelle, Paris.
- Groves, C.P.; Helgen, K.M. 2007. Craniodental characters in the taxonomy of *Propithecus*. *Int. J. Primatol.* 28: 1363-1383.
- Harpet, C.; Jeannoda, V.; Hladik, C.M. 2000. Sacred lemur sites in the Sakalava region of North-West Madagascar: updated data and implications for sustained development and conservation programs. *Rev. Ecol. (Terre Vie)* 55: 291-295.
- Harpet, C.; Navarro, L.; Ramanankirahana, R. 2008. Rôle et implications des croyances et des savoir-faire locaux dans les programmes de conservation: exemple d'un site à lémuriens sacrés au cœur de la Station Forestière à Usages Multiples d'Antrema (Pays Sakalava, Madagascar). *Rev. Ecol. (Terre Vie)* 63: 289-292.
- Hladik, A. 1980. The dry forest of the West coast of Madagascar: climate, phenology, and food available for Prosimians. Pp. 3-40. In: P. Charles-Dominique; H.M. Cooper; A. Hladik; C.M. Hladik; E. PagPs; G.F. Pariente; A. Petter-Rousseaux; J.J. Petter; A. Schilling (eds.). *Nocturnal Malagasy Primates. Ecology, Physiology, and Behavior*. Academic Press, New York.
- Hladik, C.M. 1977. Field methods for processing food samples. Pp. 595-601. In: T.H. Clutton-Brock (ed.). *Primate Ecology: Studies of Feeding and Ranging Behavior in Lemurs, Monkeys, and Apes*. Academic Press, London.
- Irwin, M.T. 2008. Feeding ecology of *Propithecus diadema* in forest fragments and continuous forest. *Int. J. Primatol.* 29: 95-115.
- Lehman, S.M.; Mayor, M. 2004. Dietary patterns in Perrier's sifakas (*Propithecus diadema perrieri*): A preliminary study. *Am. J. Primatol.* 62: 115-122.
- Meyers, D.M.; Wright, P.C. 1993. Resource tracking: food availability and *Propithecus* seasonal reproduction. Pp. 179-92. In: P.M. Kappeler; J.U. Ganzhorn (eds.). *Lemur social systems and their ecological basis*. Plenum Press, New York.
- Mittermeier, R.A.; Ganzhorn, J.U.; Konstant, W.R.; Glander, K.; Tattersall, I.; Groves, C.P.; Rylands, A.B.; Hapke, A.; Ratsimbazafy, J.; Mayor, M.I.; Louis Jr., E.E.; Rumpler, Y.; Schwitzer, C.; Rasoloarison, R.M. 2008. Lemur diversity in Madagascar. *Int. J. Primatol.* 29: 1607-1656.
- Mittermeier, R.A.; Ganzhorn, J.U.; Konstant, W.R.; Glander, K.; Tattersall, I.; Groves, C.P.; Rylands, A.B.; Hapke, A.; Ratsimbazafy, J.; Mayor, M.I.; Louis Jr., E.E.; Rumpler, Y.; Schwitzer, C.; Rasoloarison, R.M. 2006. *Lemurs of Madagascar*. Conservation International, Washington.
- Moss, R. 1991. Diet selection. An ecological perspective. *Proc. Nutr. Soc.* 50: 71-75.
- Muller, P.; Velo, A.; Raheliarisoa, E.O.; Zaramody, A.; Curtis, D.J. 2000. Surveys of sympatric lemurs at Anjamena, North-West Madagascar. *Afr. J. Ecol.* 38: 248-257.
- Norscia, I.; Carrai, V.; Borgognini-Tarli, S.M. 2006. Influence of dry season and food quality and quantity on behavior and feeding strategy of *Propithecus verreauxi* in Kirindy, Madagascar. *Int. J. Primatol.* 27: 1001-1022.
- O'Connor, S. 1988. Une revue des différences écologiques entre deux forêts galeries, une protégée et une dégradée, au centre sud de Madagascar. Pp. 216-227. In: L. Rakotovo; V. Barre; J. Sayer (eds.). *L'équilibre des écosystèmes forestiers à Madagascar*. Actes d'un séminaire international. UICN, Gland.
- Patel, E.R. 2006. Activity budget, ranging, and group size in silky sifakas (*Propithecus candidus*). *Lemur News* 11: 4.
- Ramanankirahina, R. 2004. Rythme d'activité et régime alimentaire de *Propithecus verreauxi coronatus* et d'*Eulemur mongoz* dans la Station Forestière d'Antrema. Mémoire de DEA, Univ. Antananarivo, Faculté des Sciences, Dept Biologie Animale.
- Ranaivoson, T.N.; Razakanirina, H.; Roger, E.; Rajeriarison, C.; Hladik, A. 2010. Structure de l'habitat de *Propithecus coronatus* et disponibilités alimentaires dans la station forestière à usage multiple d'Antrema: Application de la méthode des tris de litière et interprétations des adaptations des espèces arborescentes et lianescentes. AETFAT Congress April 25-30. Antananarivo, Madagascar.
- Razafimahefa, M.A. 2001. Caractérisation des habitats de *Propithecus verreauxi coronatus* dans la station forestière à usages multiples d'Antrema (Katsepy): cartographie, typologie, étude ethnobotanique. Mémoire de DEA, Univ. Antananarivo, Faculté des Sciences, Dept Biologie et Ecologie Végétale.
- Razakanirina, H. 2010. Suivi phénologique global et statut de conservation de 4 espèces végétales (*Strychnos decussata*, *Diospyros ferrea*, *Gardenia decaryi* et *Capurodendron gracilifolium*) consommées par *Propithecus verreauxi coronatus* dans la forêt de Badrala (Antrema). Mémoire de DEA, Univ. Antananarivo, Faculté des Sciences, Dept Biologie et Ecologie Végétale.
- Simmen, B.; Hladik, A.; Ramasiarisoa, P. 2003. Food intake and dietary overlap in native *Lemur catta* and *Propithecus verreauxi* and introduced *Eulemur fulvus* at Berenty, southern Madagascar. *Int. J. Primatol.* 24: 948-967.
- Simmen, B.; Tarnaud, L.; Bayart, F.; Hladik, A.; Thiberge, A.L.; Jaspard, S.; Jeanson, M.; Marez, A. 2005. Richesse en métabolites secondaires des forêts de Mayotte et de Madagascar et incidence sur la consommation de feuillages chez deux espèces de lémurs (*Eulemur* spp.). *Rev. Ecol. (Terre Vie)* 60: 297-324.
- Sinclair, I.; Langrand, O. 2008. *Birds of the Indian Ocean islands*. Struik, Cape Town.
- Tattersall, I. 1986. Notes on the distribution and taxonomic status of some subspecies of *Propithecus* in Madagascar. *Folia Primatol.* 46: 51-63.
- Thalman, U.; Kümmerli, R.; Zaramody, A. 2002. Why *Propithecus verreauxi deckeni* and *P. v. coronatus* are valid taxa. Quantitative and qualitative arguments. *Lemur News* 7: 11-16.
- Wright, P.C. 1999. Lemur traits and Madagascar ecology: Coping with an island environment. *Yrbk Phys. Anthropol.* 42: 31-72.