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Berenty Reserve: A Research Site in Southern Madagascar

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3.1. Introduction

The forest reserves of Berenty Estate were established by the de Heaulme family in consultation with local Tandroy clans, beginning in 1936 when the de Heaulmes founded a sisal plantation beside the Mandrare River (Jolly, 2004). Some 5000 ha of spiny forest were felled, but 1000 ha remain as original forest reserves. The reserves comprise several different parcels, including a spiny forest parcel called Rapily and two large areas of gallery forest, Bealoka (100 ha) and the main Berenty Reserve (200 ha). These two gallery forest reserves were natural “islands” of extremely rich habitat formed by ancient oxbow lakes or an entire river arm. The forests are dominated by *Tamarindus indica*, the tamarind tree (Figures 3.1 and 3.2). Berenty has the semiarid climate of Madagascar’s southern domain. Only along rivers with their high water tables can tamarind forest survive; elsewhere, there is the surreal succulent vegetation of Madagascar’s spiny forest. (Figure 3.3).

Originally, the gallery forest was divided from the spiny forest by the steep banks of the old riverbed, easily traversed by lemurs, but with sharply different vegetation at top and bottom of the bank. Now the reserves are almost wholly isolated by sisal fields. The “islands” of gallery forest might seem too small to matter for conservation, but two overflights of the Mandrare Valley in 2004 showed that they are the only gallery forests remaining below the headwaters, except for two much smaller sacred forests near Ifotaka and a tract of tamarinds across the Mandrare River from Berenty that has little undergrowth and sparse canopy (Jolly, pers. obs.). Elsewhere there are isolated tamarind trees but no actual blocks of this forest type. Southern gallery forests are clearly one of the most threatened forest types of Madagascar (see Sussman et al., this volume).

3.2. Climate

The climate of southern Madagascar alternates hot wet summers, with temperatures above 40 °C at midday, and cold dry winters, when temperatures fall below



FIGURE 3.1. Berenty tamarind with the de Heaulme forest guards, 1963. Pencil drawing by Alison Mason Kingsbury.

10 °C at night. Rainfall varies erratically from 300 cm to 900 cm per year, if calculated in lemur-years beginning October 1, which group all of a wet season together (Figure 3.4). Conventional years, starting January 1, group the end of one wet season with the beginning of the next and so blur the degree of variation. Even lemur-years mask some of the variation, as in 1991–1992, when two thirds of the season's rain fell during a 3-day storm in January, with the drought bringing crop failure and human famine. El Niño years usually mean drought for the south of Madagascar as for southern Africa, but variation in latitude of winds may result in exceptionally wet El Niño years instead. Ringtailed lemurs, like the other plants and animals, adapt their breeding and growth to the alternation of wet and dry seasons (Figure 3.5), but their life-history strategies can only be understood in the light of recurrent catastrophic years (Gould et al., 1999; Wright, 1999; Richard et al., 2002; Jolly, this volume).

3.3. Berenty Habitat Zones

The main Berenty Reserve contains about 200 ha of gallery and scrub forest connected on the west to a corridor of spiny forest and on the east by a very narrow



FIGURE 3.2. The same tree in 2005. The lowest branch to the left has broken short, and small branches to the right have broken off, but the tree continues to flourish. Diameter at breast height in 2002 was 127 cm. Photo: A. Jolly.

interface to the 150-ha Akesson/Kaleta forest. Its four habitat zones embrace a fivefold difference in ringtailed lemur population density (Figures 3.6 and 3.7).

Starting from the north, the 40-ha lobe called Ankoba had been largely cleared for Tandroy local farms at the time the de Heaulmes settled at Berenty. The de Heaulmes attempted to grow crops in this zone. Old drainage ditches traverse the forest floor. However, after some years they gave up farming there, having found it was not suitable as sisal nursery fields. The original tamarind trees (*Tamarindus indica*) remained because neither Tandroy nor French cut down tamarinds. The de Heaulmes also planted an alley of *Pithecellobium dulce*, the monkey pod tree, “foreigner’s tamarind” or *kilimbazaha*. These leguminous trees are excellent food for sifaka and lemurs, with protein-rich flowers and pods. They also function as nurse trees that shelter wild seedlings planted by feeding lemurs, unlike the tamarinds that inhibit seedlings (Blumenfeld-Jones, this volume). Ankoba is now a mature second-growth forest 50–60 years old, with canopy at 10–15 m and some emergent acacias to more than 20 m. Ringtail density is around 500/km²; sifaka and brown lemurs are also extremely dense in Ankoba. Troops based

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FIGURE 3.3. *Alluaudia procera* spires rise above other succulent and thorny plants in a spiny forest reserve of Berenty Estate. Oxcarts fetch water to provision villages many kilometers from the river. Photo: A. Jolly.

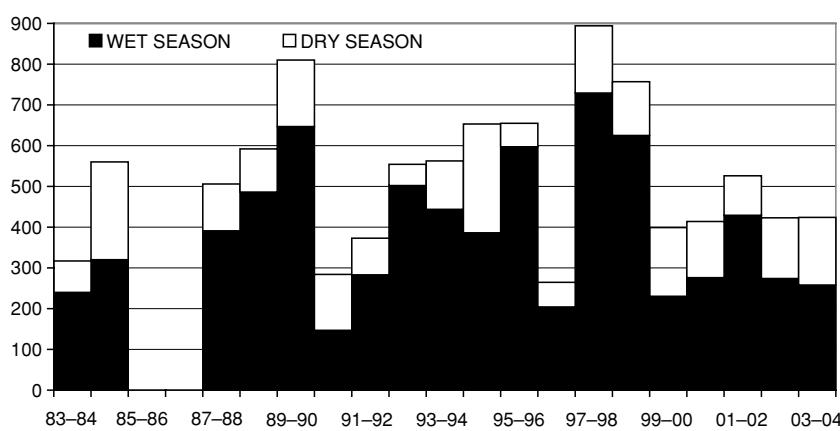


FIGURE 3.4. Rainfall at Berenty in millimeters for "Lemur-years." These begin October 1 as infants are born, showing the October–March wet season and succeeding April–September dry season. "Drought years" are those with wet season rainfall under 450 mm: that is, 1983–1984, 1984–1985, 1990–1991, 1991–1992, 1996–1997, and four of the five years since October 1999. Data for 1983–1985 courtesy S.M. O'Connor; data for 1987–2004 courtesy C. Rakotomalala.

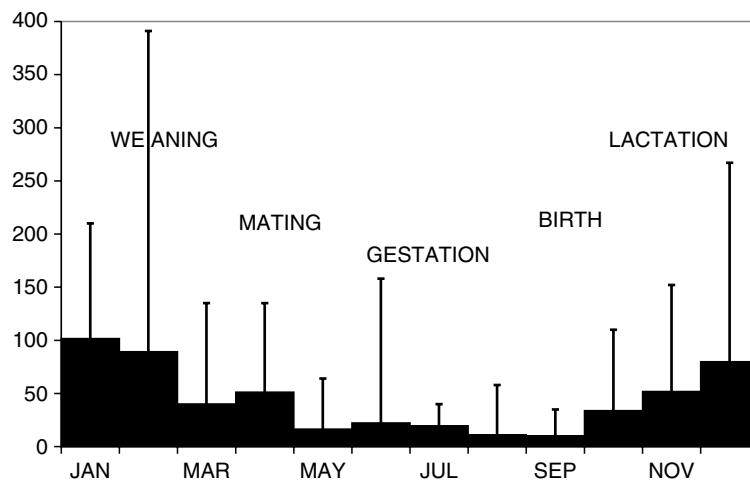


FIGURE 3.5. Mean monthly rainfall at Berenty in millimeters, with *Lemur catta* breeding seasonality. T-bars show maximum. Minimum in December and February is 5 mm, in other months 0 mm. Data for 1983–1985 courtesy S.M. O'Connor; data for 1987–2004 courtesy C. Rakotomalala.

within the forest range outward to the planted vegetable and fruit garden to the north and to open areas with introduced trees including neem (*Azadirachta indica*) and kantsa-kantsa (*Leucaena leucocephala*).

South of Ankoba lies the Malaza section of the forest. Malaza is the 100-ha area first chosen by Blumenfeld-Jones and Budnitz as their main study area (Budnitz and Dainis, 1975; Budnitz, 1978; Mertl-Millhollen et al., 1979; Blumenfeld-Jones, this volume) and studied by the Jolly team since 1989. Jolly's original study troop of 1963–1964 ranged within Malaza (Jolly, 1966). For the purposes of analyzing lemur demography and behavior, the 100 ha of Malaza are subdivided into four habitat zones: front, gallery, scrub, and spiny forest.

The “front” is a part of Malaza's western edge. This area has been inhabited since the 1940s: the modern tourist buildings derive from the original sisal factory. The lemurs of the front sleep and usually siesta in the gallery forest, spending the first and last hours of activity feeding on native trees. They then range for most of the day among planted trees and original tamarinds between the houses. They feed on neem (*Azadirachta indica*), *Cordia rothii*, Persian lilac (*Melia azedarah*), *Cassia* spp., *Eucalyptus* flowers, *Bougainvilea* buds, sisal flowers, and until 2005 *Leucaena* (Simmen et al., this volume; Soma, this volume; Crawford et al., this volume on the deleterious effects of leucaena). *Leucaena* is being removed from the front zone in 2005, though it will be left for study at the north end of Ankoba. Water is always available here. Since the growth of tourism in the 1980s and especially the 1990s, there is some garbage and offered food. Deliberate banana feeding increased from the 1980s until 1999, when it was

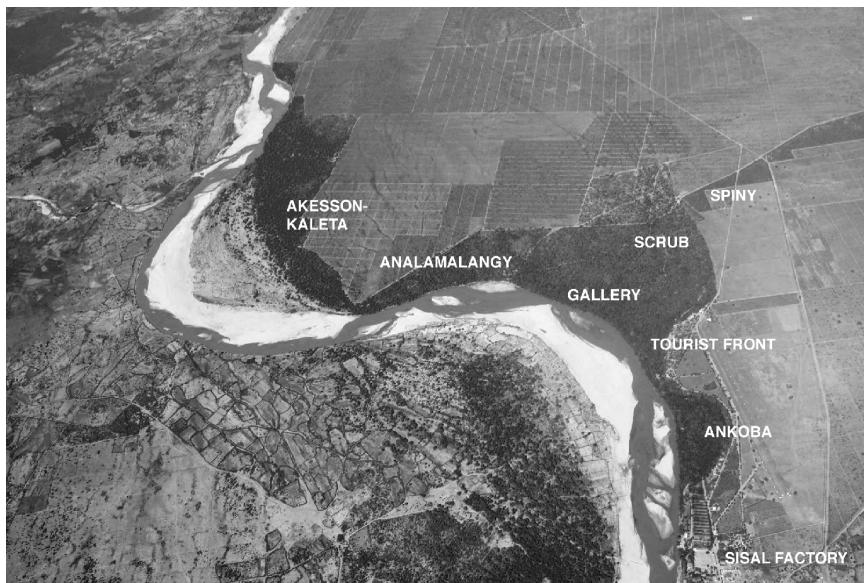


FIGURE 3.6. Air photo of Berenty, taken from the north. Tracks of the old river arm that embraces the reserve can be seen leading through the sisal toward the south (top) of the picture. The Ankoba lobe is a 50-year-old secondary forest. The main 100-ha Malaza lobe shades from the front with its introduced trees and tourists, through rich gallery forest and drier scrub. Above the ancient river bank lies a corridor of spiny forest. A cattle drove divides Malaza from the unstudied areas of Analamalangy and the Akesson-Kaleta Reserve. Courtesy of Barry Ferguson and the Centre Ecologique de Libanona, Taolagnaro.

banned. The ban is mostly successful, but lemurs still enter buses and bungalows to raid fruit the tourists planned on eating themselves.

East of the tourist front is lush gallery forest along the Mandrare River, dominated by tamarinds (*Tamarindus indica*), called *kily*, with emergent acacias (*Acacia rovumae*), called *benono* ("the many-nippled," from the thorn bases on their trunks.). Tamarind forest grades into open canopy forest, largely dominated by *Neotina isoneura*, which in turn grades into transitional brush and scrub as one moves south from the river. (For detailed vegetation maps, see Blumenfeld-Jones, this volume.) For the purposes of assigning lemur troops, we distinguish gallery from scrub, with the criterion that if $\geq 50\%$ of the sky is covered, it is gallery. If more than 50% of the sky is open, it is scrub. The scrub zone still contains isolated tamarinds but with a variety of lower, thorny, and succulent species, including *Salvadorea angustifolia*, and various euphorbs, including the invasive smothering vine *Cissus quadrangularis*.

The transition from scrub to spiny forest is dramatically sharp. The reserve is bounded on the west by the ancient bank of an old river arm, about a 7-m nearly

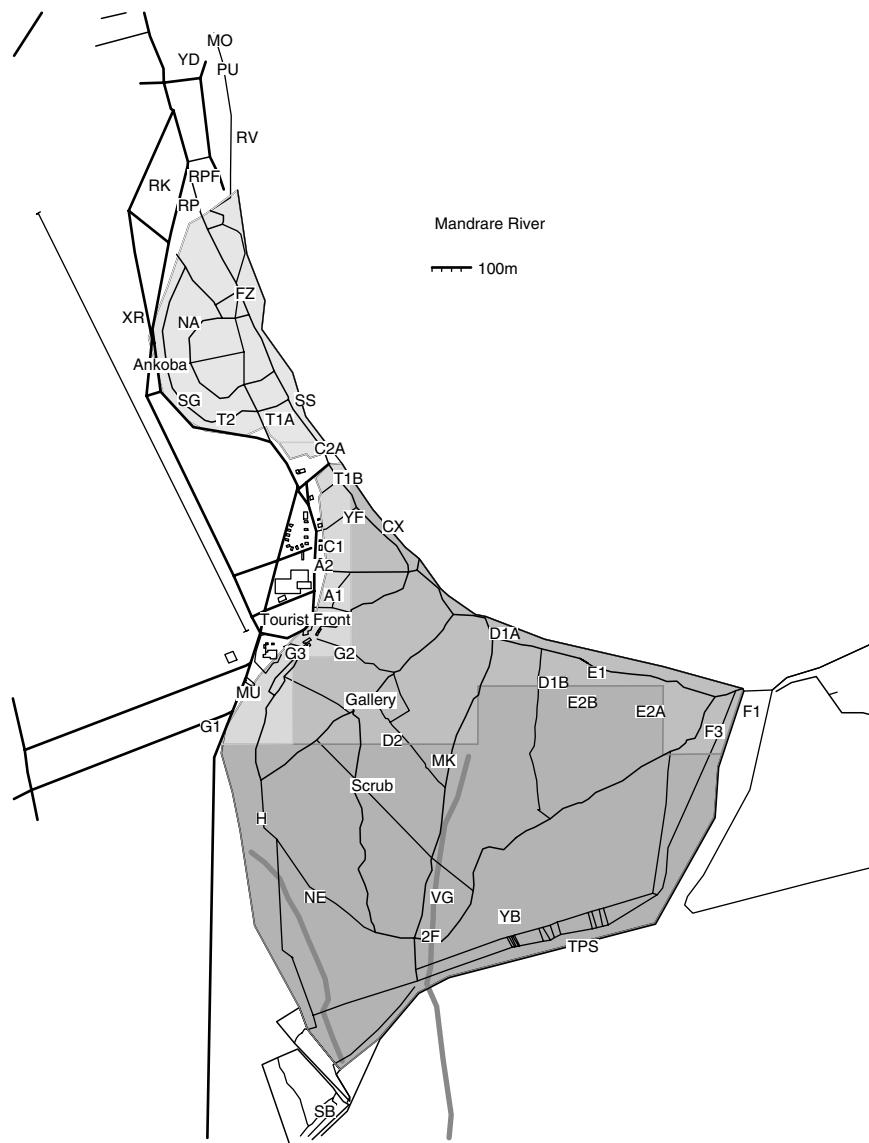


FIGURE 3.7. Ankoba and Malaza lobes of Berenty Reserve, showing habitat categories and the very close spacing of *Lemur catta* troops. Two-letter abbreviations are approximately at the center of the troop ranges. Ankoba from 2004 complete census, Malaza (Front, Gallery, and Scrub) from the 2000 complete census. Map prepared by G. Williams.

vertical scramble. Below lies scrub with some large tamarinds rooted in the water table of the old riverbed (Mertl-Millhollen, this volume; Blumenfeld Jones, this volume). At the top of the bank is thicket dominated by *Alluaudia procera* (fan-tiototse) and other xerophytes.

Malaza's western boundary is a cattle drove to the river, with no undergrowth but a nearly continuous canopy of acacias. Beyond lies the approximately 60-ha parcel called Analamalangy. Again, this has gallery forest next to the river and scrub behind. However, a large part of the central section is covered by *Cissus quadrangularis*. This parcel has not been fully censused although ringtails, sifaka, and browns all live there.

A second cattle drove marks the boundary to the 150-ha Akesson-Kaleta reserve. This resembles Berenty, but with much more open undergrowth, because it was more recently subjected to cattle grazing.

None of the boundaries that humans assign to these zones are a barrier to lemurs. However, it is possible to distinguish troops whose core feeding areas fall in different habitats. Troops have quite regular day ranges, at least within a single season. We choose the daytime range as their habitat. "Front troops" range outside of the forest to the west for most of the day but sleep in adjacent closed-canopy gallery forest. "Gallery troops" spend the day near the river but may sleep further south in tamarind trees among the scrub. "Scrub" troops feed in scrub and spiny forest and also sleep there. "Ankoba troops" range both within Ankoba forest and in the human occupied land to west and north.

Any troop occasionally may make a 1- or even 2-km excursion out of its normal day range. Also, if key resources are only located outside its normal range in a given year or season, it may travel there (see Mertl-Millhollen, this volume). In areas as small as Ankoba or Malaza, the lemurs seem to be well aware of feeding locations and travel routes throughout the forest lobe. What keeps them bounded is the pressure of other groups (Pride, this volume).

3.4. Fauna

There are six species of lemurs at Berenty: *Propithecus verreauxi*, the white sifaka; *Lemur catta*, the ringtailed lemur; *Eulemur fulvus rufus x collaris*, hybrid brown lemurs (introduced in 1975); *Lepilemur leucopus*, the white-footed lepilemur; *Microcebus murinus*, the gray mouse lemur; and the newly identified *Microcebus griseorufus*, the gray-and-red mouse lemur (Rasoloarison et al., 2000). All of these live in all habitat zones except that the brown lemurs do not enter the spiny forest (so far), and the gray-and-red mouse lemur seems to be confined to spiny forest.

Berenty holds southern Madagascar's largest colony of the Madagascar giant fruit bat, *Pteropus rufus*, one of whose staple foods is sisal flowers from the surrounding fields (Long, 2002). Other mammals include *Setifer setosus*, the spiny tenrec; *Tenrec ecaudatus*, the large tenrec; *Microgale* sp., the shrew-like tenrec; *Eliurus myoxinus*, the Madagascar tree-rat; and *Viverricula indica*, the Indian

civet. There are many *Rattus rattus*, the scourge of Malagasy small mammals (Crowley, 1995; Goodman, 1995). The forest is too small to hold *Cryptoprocta ferox*, the fossa, but domestic dogs and cats take its place as significant lemur predators.

Fifty-two species of resident birds have been recorded out of a total of 99 species seen, of which 41% are endemic to Madagascar (list compiled by M. Pigeon, in Goodman et al., 1997). The giant ground couas (*Coua gigas*) are particularly noticeable, as they are extensively trapped elsewhere. The two male color morphs of the Madagascar paradise flycatcher have been intensively studied in the Bealoka parcel of gallery forest to determine how they maintain their genetic polymorphism (Mulder et al., 2002). Lemur predators include *Polyboroides radiatus*, the harrier hawk; *Buteo madagascariensis*, the buzzard; and the endemic black kite, *Milvus migrans*.

Reptiles have been little studied at Berenty, but it is one of only two known localities for the burrowing snake *Pseudeoxyrhopus kely*, the other one being at Mandena on the east coast in a wholly different type of forest. Tortoises and turtles include *Geochelone radiata*, the Madagascar radiated tortoise; *Pyxis arachnoides*, the spider tortoise; and the terrapin *Pelomedusa subrufa*. All three are widely distributed in the south, although the radiated tortoise is heavily trapped for illegal export. Two hundred confiscated radiated tortoises have been released by the Water and Forest Department in the Rapily spiny forest reserve parcel of Berenty Estate (Crowley, 1995).

No exhaustive plant list exists, although it is under active study. Simmen and colleagues have drawn up a list of plants eaten by *Lemur catta* (this volume), and Blumenfeld-Jones (this volume) describes the changing structure of Berenty gallery forest. There is the continued problem of invasive plants, especially the euphorb liana *Cissus quadrangularis*, and the toxic tree *Leucaena leucocephala* (Crawford, this volume).

3.5. Ringtailed Lemur Studies at Berenty

The first scientist to study in Berenty forest was Alison Jolly, in 1963–1964. The de Heaulme family welcomed her and inaugurated their tradition of hospitality to visiting scientists. There are now seven places reserved for students in the complex called “Naturaliste.”

Peter Klopfer of Duke University visited in 1969. He then supervised a group of Duke PhDs at Berenty the early 1970s: Robert Sussman, Norman Budnitz, Kathryn Dainis (Blumenfeld-Jones), Lee McGeorge (Durrell), Jay Russell, and Anne Mertl (Millhollen). At the same time, Alison Richard, Pierre Charles-Dominique, and Marcel Hladik did shorter studies at Berenty in 1970 while concentrating on other sites. Jean-Jacques and Arlette Petter also visited.

With the political difficulties for foreigners in the late 1970s research slackened, beginning again in 1983 with a detailed ecological comparison of Berenty and Bealoka by Sheila O’Connor and a study of birds by Mark Pigeon. Jolly

began studies with Earthwatch, notably including the first visit of Hantanirina Rasamimanana.

The recent era of intensive lemur work started in 1989 with the arrival of Naoki Koyama, of Kyoto University, and of Jolly and Rasamimanana. Since then, both the Japanese and the Anglo-Malagasy group have been present at Berenty for every birth season. PhDs and PhD candidates include Chiemi Saito, Ryo Oda, Shinichiro Ichino, Takayo Soma, Lys Rakototiana, and Ethan Pride. About 40 undergraduate and master's level students, almost half of them Malagasy from the Ecole Normale Supérieur, have done 2–6 month field projects at Berenty. The non-Malagasy include Japanese, French, Italians, British, Canadians, and Americans. Earthwatch has sent 120 short-term Earthwatch volunteers, and a few particularly dedicated volunteers have returned for several years of more intensive fieldwork.

George Williams has drawn up the base map of Berenty Reserve that comes with a program (MAP) for analyzing lemur day ranges, home ranges, and other desired data. Since 2000, Kathryn Blumenfeld-Jones and Anne Mertl-Millhollen have also returned to their 1970's study site.

In 1992–1994, Helen Crowley became the first manager of Berenty Reserve, funded by the Wildlife Trust and by the de Heaulmes. Her management plan remains the chief attempt to survey research done and to draw up recommendations for the future. Berenty as a small island of forest is threatened by edge effects, invasive species including the brown lemurs (Pinkus, this volume), lowered water table from many causes, and from the natural succession of tamarind trees as well as from the changing human context. Berenty Reserve will need continued active management in the future.

If someone had done a population and habitat viability study of Berenty 70 years ago when the reserve was founded, it would have seemed extremely unlikely that such a tiny fragment could survive the biological and political changes of the coming decades. However, in spite of the dilemmas posed by maintaining this small forest, there now seems every hope that lemur research—and the lemurs themselves—will continue to flourish at Berenty.

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