MADAGASCAR'S LEMURS

Determining the effects of habitat disturbance on feeding and reproductive behaviour

Red-bellied lemur (Eulemur rubriventer) – one of the 13 species of lemur found in Ranomafana National Park, Madagascar

Summary of the research project

This project researches the behavioural ecology of lemurs in the tropical rainforest of Ranomafana National Park in Madagascar. Since 1986, researchers in Ranomafana have studied the Milne-Edwards sifaka *(Propithecus diadema edwardsi)*, an endangered primate species with high-priority conservation status. The aims of the research are to investigate the effect of habitat disturbance on the reproductive and feeding behaviour of the sifaka (shee-fak after the sound of their call). These studies provide detailed behavioural and ecological information on lemurs and increase our understanding of the population dynamics of endangered primate species living within a protected area, helping us to better understand the unusual evolutionary processes which have led to the diversity of primate species found within Madagascar's rainforests. Results of this project will benefit primatologists, behavioural ecologists, conservation biologists, and resource management planners by providing a detailed understanding of the demographic and ecological needs of these primates.

Research Location

Madagascar is an island nation in the Indian Ocean off the south-eastern coast of Africa. It is the fourth largest island in the world. Madagascar's long isolation from neighbouring continents has resulted in a unique mix of plants and animals, many of which are found nowhere else on earth. Some ecologists refer to Madagascar as the "eighth continent". Eastern Madagascar (where Ranomafana National Park is situated) is home to tropical rainforests, while the west and south are home to tropical dry forests, thorny or spiny forests, deserts and xeric (dry) shrublands. Due to scarcity of water resulting in a lower human population density, Madagascar's dry deciduous forests are less impacted than the eastern rainforests or the high central plateau. There has been some slash-and-burn activity, locally called 'tavy', in the eastern and western dry forests and in the central high plateau, reducing forest habitat and applying pressure to some endangered species.

The research takes place in Ranomafana National Park which lies to the east of the high plateau in South East Madagascar.

Fianarantsoa, Madagascar

Components of the Research Ecosystem

Endemism

Madagascar is home to 5% of the world's plant and animal species, 80% of which are endemic (unique) to Madagascar. Madagascar severed land ties to Africa more than 100 million years ago. This vast span of time, coupled with the size of the land-mass and a great variety of landforms, has enabled the forces of evolution to create a huge range of biologically diverse animals and plants, many of which are found nowhere else on earth. Among its most notable examples of biodiversity are lemurs, three endemic bird families and six endemic baobab tree species. Madagascar is also home to more than half the world's chameleons, including the huge Parson's Chameleon, the world's largest at up to 60cm.

Parson's chameleon (Calumma parsonii) is the world's largest chameleon

Meet the Scientist

Dr. Patricia C. Wright is a Professor of Anthropology at the Stony Brook University in the United States, and Director of the Institute for the Conservation of Tropical Environments (ICTE). In 1986, in the area that is now Ranomafana National Park, Dr. Wright rediscovered a population of the greater bamboo lemur (*Hapalemur simus*) (previously thought to be extinct) and also discovered a species new to science – the golden bamboo lemur (Hapalemur aureus). These discoveries led to the creation of Ranomafana National Park. Her research since the discovery has focused primarily on behaviour, ecology, and conservation of the lemurs occurring in the park. Dr. Wright is a leading figure in conservation in Madagascar and was awarded a knighthood by the Government of Madagascar.

Lemurs

Lemurs are one of the most primitive groups of primates which have evolved into around 30 species which only occur on Madagascar and the Comoros Islands to the east of Madagascar. There are 13 species of lemur found within Ranomafana National Park; seven are diurnal (day-active) and five are nocturnal (night-active). Six of these species are listed as endangered or critically endangered by the International Union for Conservation of Nature and Nature Resources (IUCN) – see **www.iucnredlist.org**. As these species represent an "ancient" primate lineage (an isolated group that persisted in Madagascar, while the rest of the world changed around them) they are extremely interesting scientifically. They exhibit behavioural patterns and respond to their environment in ways that are different from monkeys and apes, their "more modern" primate relatives.

Since 1996, research suggests that the overall population size of the endangered Milne-Edwards sifaka may be declining. This is disturbing information because all groups that are studied live entirely within the national park and should therefore be protected from human disturbance (aside from tourists and scientists). Predation by the fossa (the largest carnivore in the park) appears to play an important role in population size, and it is possible that the disturbance of the park's borders has increased fossa density within the park. The selective logging, which occurred in the late 1980s, may also be having an effect. Studies of habitat disturbance have shown that there is often a time lag between the actual disturbance and the response of the animal and plant communities to this disturbance.

The Milne-Edwards sifaka (Prothipecus edwardsi) is the focal species of Dr. Wright's research at Ranomafana

The brown or rufus mouse lemur (Microcebus rufus) is one of seven species of mouse lemur, all of which were only recently known to science. The pygmy mouse lemur (Microcebus myoxinus) is the world's smallest primate, at only 30 grams when fully grown

There are less than 30,000 Milne-Edwards sifaka left in the world. Data on the behaviour and ecology of this species of lemur helps to increase our overall understanding of the park ecosystem in two ways. Firstly, as the largest primate within the park, the sifaka is at particularly high risk of local extinction in the face of habitat disturbance and therefore serves as a good indicator species for the overall primate community at Ranomafana. Secondly, as the sifaka is a generalist, eating leaves, fruits and seeds, differences in the quality of the forest in different areas of the park will be indicated by differences in its diet.

Climate

Humidity:	50% to 100%
Temp. range:	4°C to 31°C
Altitude:	850m to 1,500m
Rainfall:	2500mm to 4000mm

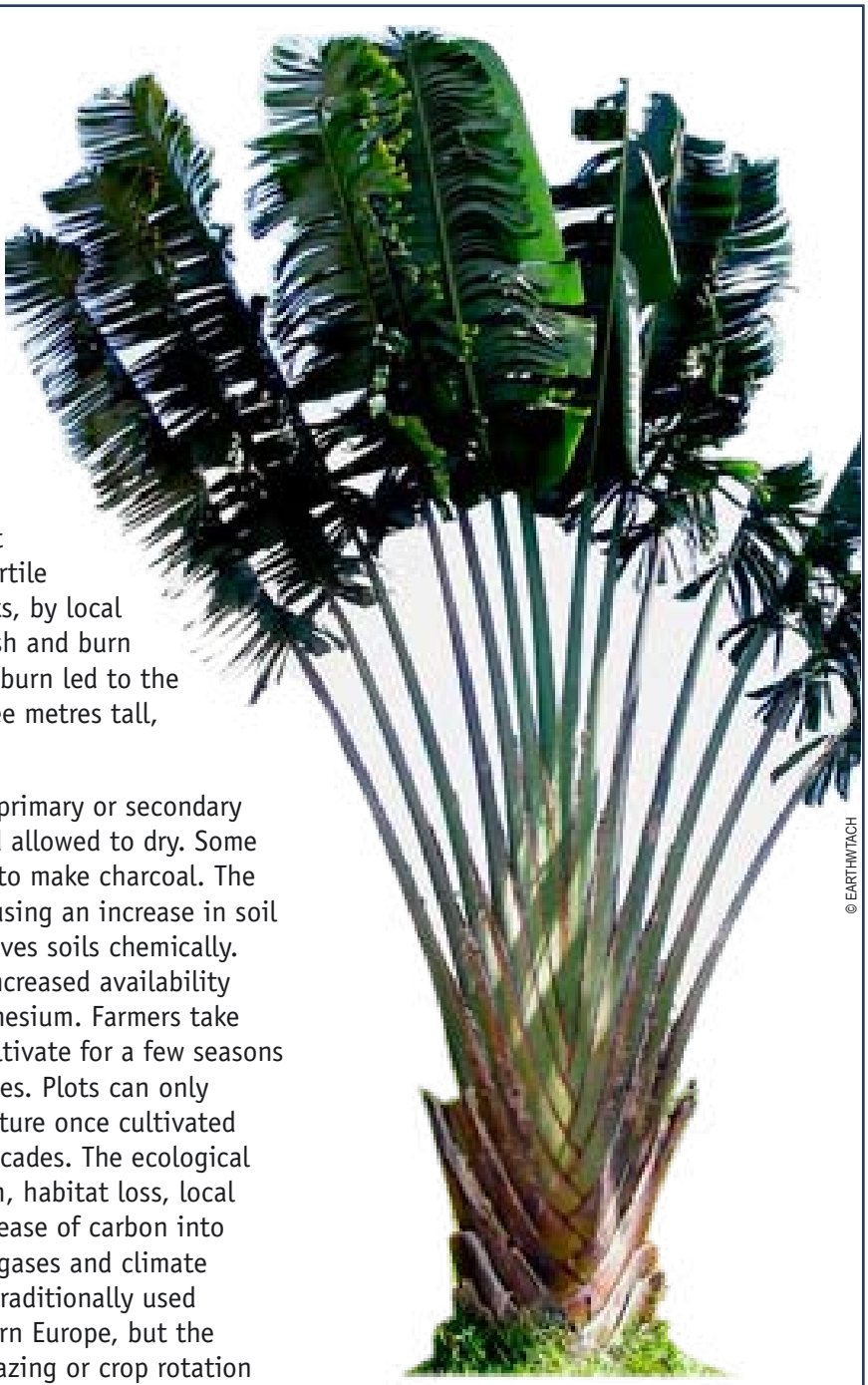
Rainforest

Ranomafana encompasses 430,000 ha^2 of low montane rainforest, which varies in altitude from 800m-1,300m. The forest contains more tree stems (trunks) per hectare than found in most rainforests in Africa and South America. There are no venomous snakes, few poisonous plants, and no large carnivores. The only complaint is the blood-sucking leeches that appear when it rains.

Habitat Loss – Slash and Burn

Each year more and more of the unique forest habitat in Madagascar is cleared to expose fertile soil for the cultivation of agricultural products, by local communities practising what is known as slash and burn agriculture. Habitat loss caused by slash and burn led to the extinction of the elephant bird, which at three metres tall, was the largest bird that ever lived.

In the practice of slash and burn, an area of primary or secondary forest is selected, and the vegetation cut and allowed to dry. Some of the cut timber is gathered for firewood or to make charcoal. The rest of the cut vegetation is then burned, causing an increase in soil pH and stimulating nitrification, which improves soils chemically. In the ash that settles on the soil, there is increased availability of phosphorus, potassium, calcium, and magnesium. Farmers take advantage of these nutrient-rich soils and cultivate for a few seasons before abandoning the land as fertility declines. Plots can only be used once as the soil is useless for agriculture once cultivated and the recovery of forests may take many decades. The ecological impacts of slash and burn include soil erosion, habitat loss, local extinction or threatened populations, and release of carbon into the atmosphere (contributing to greenhouse gases and climate change). A form of slash and burn has been traditionally used in the temperate coniferous forests of Northern Europe, but the forest cutting was followed by sustainable grazing or crop rotation practices (where different crops are planted in different seasons, encouraging soil fertility).



The ravinala tree (the Malagasy name means 'leaf of the forest') is the national tree of Madagascar

The leaf-tailed gecko (Uroplatus) resembles a leaf to deter predators

Status, Designation and Management

Ranomafana National Park was designated a protected area in 1992 due to the discoveries of new lemur species by the Principal Investigator, Dr. Patricia Wright. The Government of Madagascar has made an application to UNESCO (United Nations Environmental, Scientific and Cultural Organisation) for Ranomafana to be made a World Heritage Site, recognised internationally for its endemic biodiversity. This should increase protection of the ecosystem within the park. The park is managed by the Malagasy Government Wildlife Department, known as ANGAP.

Objectives of the Research Project

Investigating Reproductive Behaviour:

Understanding group dynamics, mate choice, reproductive success, and female dominance in sifaka in areas of disturbed and non-disturbed forest can show us the effect habitat disturbance is having on reproductive behaviour and whether this is a cause of the decline of the species.

Group Dynamics: Primates are highly social animals, often living in groups with complex, hierarchical, dynamic structures. However, the particulars of primate group structures and dynamics vary considerably among species. Age, sex, and kinship relationships often form the basis for different group dynamics.

Mate Choice: Primates mate with particular individuals based on factors like hierarchy and competition between females for males and between males for females. Sometimes mate choice can be affected by behavioural traits such as familiarity and parenting abilities.

Eastern wooly lemurs (Avahi laniger)

Reproductive Success: Reproductive success is the number of young successfully raised. In primates, this is generally achieved by females having few young, and investing a great deal of time and effort into rearing them.

Female Dominance: Primates, as (mostly) group living animals tend to form what are known as "dominance hierarchies". Animals higher in the hierarchy tend to displace lower ranked individuals from resources (e.g. from mates, space, food). They tend to have higher reproductive success (either by mating more often, or by having more resources to invest in their offspring). The hierarchy is not fixed and depends on a number of changing factors (such as age, sex, aggression), and may also depend on the support of others. The rank is learned through play and agonistic and affiliative interactions. In most primates, males are dominant, but in some lemur species (such as the Milne-Edwards sifaka), females are dominant.

Black and white ruffed lemur (Varecia variegata variegata)

Investigating Feeding Behaviour

Understanding food availability, food selection, feeding rates, and energy intake in sifakas in areas of disturbed and non-disturbed forest can show us the effect habitat disturbance is having on feeding behaviour and whether this is a cause of the decline of the species.

Food Availability: Food availability is one of the basic factors affecting primate density and social ecology. It is classed as the amount of food available in the animals' range area, and is affected by the plant species present, the season and the fruiting or growth success.

Food Selection: Primates often feed selectively. Choosing high quality plants and plant parts that give optimum energy is a useful strategy. This may mean that an individual forages further afield to find higher quality fruit or seeds.

Feeding Rates: Primates will spend certain times of the day feeding on different things and different percentages of the day will be spent on foraging for fruits, seeds, leaves or whatever the particular species feeds on. This is to ensure that energy and nutrient intake is maximised.

Methods

To attain the above objectives, the following methods are used:

Behavioural Sampling

Primatologists study primates by observing and recording their behaviour. The primatologist follows groups of lemurs, recording their behaviour at different time intervals. For example, every five minutes, the observer records whether the lemur is eating, resting, feeding, travelling or interacting with fellow lemurs. This gives an overall picture of the percentage devoted to different activities at different times of the day and in different habitats. An example of the behaviour recording sheet (or ethogram as it is known by primate specialists) is shown here.

Using behavioural observations, in disturbed and undisturbed forest areas, Dr. Wright is able to determine the effect of habitat disturbance on reproduction and feeding. Different behaviours are recorded that allude to the dominance hierarchy of a group, the feeding rates of individuals, and mate choice in females. Primatologists habituate a group of primates and learn to recognise the different behaviours.

Interval Sampling of one Focal Animal

Troop number: 12
Focal Animal: 82 / Rosie - Female Juvenile
Date: 12/5/06
Observer: A. McKinnon
Location at Start: Plot 9
Starting Time: 06:32

Time	Behaviour	Actor/ Recipient	Proximity
1	Drinking	Actor	Females 91 and 13 2m distance
2	Social Grooming	Recipient 91 groomer	91 in contact Male 18 5m away.
3	Social Grooming	Recipient 91 Groomer	91 in contact Male 2m away
4	Social grooming	Recipient 91 groomer	91 in contact Male 2m distance
5	Threat behaviour	Actor to male 18.	Male 18 in 91 4m distance
6	Climbing	Actor	Male 18 6m 91 and 13 4m.
7	Foraging	Actor	Male 18 10m 91 and 13 3m
8	Foraging	Actor	Male 18 15m 91 and 13 5m
9	Eating (leaves)	Actor	Male 18 >20m 91 and 13 6m
10	Eating (leaves)	Actor	Male is out of sight. females 6m

Guidelines:
Time – observe the focal animal every two minutes and note the behaviour
Actor/recipient – note whether the focal animal performed or received the action. When possible, note the ID, age, sex of the other animal
Proximity – note other individuals near the focal animal

Botanical Sampling

The researchers record data on the abundance and availability of plant species used as food by lemurs, by ranking the number of flower buds, flowers, unripe fruits, ripe fruits, leaf buds, new leaves, and mature leaves for 25 trees known to be used for feeding. Rather than count every flower on a tree, the researcher will give the tree a rank between 0 and 4, where 0 indicates no flowers and 4 indicates the tree is full of flowers.

To investigate diet quality (nutrient availability and toxin levels), chemical analyses will be performed on samples of the top five foods consumed by study animals. Plant specimens are collected and dried before being sent to Germany for expert nutrient and toxin analysis.

Orchids

A researcher measuring the DBH (diameter at breast height) of a tree to determine age and growth of the forest

Tree frog (Boophis)

Results

Click here for sample datasets and statistics exercises

Click here for guidelines on how to do statistics

Applications of the Data – Conservation Management

Primatologists, behavioural ecologists, conservationists, and natural resource managers benefit from the results of this study. This research helps scientists better understand the evolution of female dominance, the life history of rainforest lemurs, and the relationship between lemur behaviour and ecology. This project has been able to document how new sifaka groups are formed, and has determined that female-female aggression can lead to formation of new social groups (in many other primates, aggressive interactions between males drive group dynamics). The Ranomafana National Park Management Plan is based in part upon information on sifaka population density, territory size, and habitat requirements – data that Earthwatch has collected over the past eight years. These data help estimate how many sifaka exist in the eastern rainforest of Madagascar, and help conservationists estimate the habitat needs for a viable population.

The research team works closely with the Malagasy government wildlife division to better manage the park. The research has determined that selective logging in the 1980s has led to changes in soil quality and the forest's tree composition and distribution of species. The way that these ecological differences have led to changes in lemur behaviour is currently being investigated and results should impact on whether logging is allowed in future.

A community forest restoration nursery. Saplings are raised and replanted to restore the forest for community use.

Glossary

Endemic Species – unique to a defined place or region. Islands are especially likely to develop endemic types or species because of their geographical isolation, which allows diverse speciation of animals that are distinct from those on mainland continents.

Indicator Species – offer a signal of the biological condition of an ecosystem, and can indicate that (for example) pollution has entered the food web.

UNESCO World Heritage Site – The United Nations Educational, Scientific and Cultural Organisation (UNESCO) seeks to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity.

Useful websites and sources of information

General lemur information:
www.wildlifesearch.com/lemur.htm

Lemur feeding ecology:
www.primates.com/lemurs/overfeed.html

UNESCO World Heritage Site:
whc.unesco.org/en/about/

IUCN Red List of Threatened Species:
www.iucnredlist.org/

Information about Ranomafana (in French): **www.parcs-madagascar.com/ranomafana/index.htm**

Institute for the Conservation of Tropical Environments: **http://icte.bio.sunysb.edu/pages/affiliated_institutions.html**

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