EAZA Mangabey Best Practice Guidelines

*Cercocebus spp., Lophocebus spp. a*nd *Rungwecebus spp.*

Old World Monkey Taxon Advisory Group

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EAZA Preamble

Right from the very beginning it has been the concern of EAZA and the EEPs to encourage and promote the highest possible standards for husbandry of zoo and aquarium animals. For this reason, quite early on, EAZA developed the “Minimum Standards for the Accommodation and Care of Animals in Zoos and Aquaria”. These standards lay down general principles of animal keeping, to which the members of EAZA feel themselves committed. Above and beyond this, some countries have defined regulatory minimum standards for the keeping of individual species regarding the size and furnishings of enclosures etc., which, according to the opinion of authors, should definitely be fulfilled before allowing such animals to be kept within the area of the jurisdiction of those countries. These minimum standards are intended to determine the borderline of acceptable animal welfare. It is not permitted to fall short of these standards. How difficult it is to determine the standards, however, can be seen in the fact that minimum standards vary from country to country.

Above and beyond this, specialists of the EEPs and TAGs have undertaken the considerable task of laying down guidelines for keeping individual animal species. Whilst some aspects of husbandry reported in the guidelines will define minimum standards, in general, these guidelines are not to be understood as minimum requirements; they represent best practice. As such the EAZA Best Practice Guidelines for keeping animals intend rather to describe the desirable design of enclosures and prerequisites for animal keeping that are, according to the present state of knowledge, considered as being optimal for each species. They intend above all to indicate how enclosures should be designed and what conditions should be fulfilled for the optimal care of individual species.

Preface

It has been 15 years since the first Husbandry Guidelines have been published for mangabeys. This is the first edition of the Best Practice Guidelines for mangabeys based on the experience and invaluable contribution of 24 institutions keeping the following species: Agile mangabey (*Cercocebus agilis agilis*), Golden-bellied mangabey (*Cercocebus chrysogaster*), Sooty mangabey (*Cercocebus atys*), White-crowned mangabey (*Cercocebus lunulatus*), Red-capped mangabey (*Cercocebus torquatus*), Grey-cheeked mangabey (*Lophocebus albigena albigena*) and Black crested mangabey (*Lophocebus aterrimus*).

We hope you will find these Best Practice Guidelines appealing and easy to read. All the efforts are needed to support mangabey populations in zoos and in the wild; a critical situation for both areas. As was the case with the Husbandry Guidelines, we need to mention that these Best Practice Guidelines are by no means definitive. We hope that through research our knowledge on mangabey care will advance so we can provide the most updated information in future editions.

Mangabeys are easier to be kept in actual bigger and naturalized enclosures, and in many cases they can be mixed with other species, enriching the facilities and animal's life. So we hope that more European zoos will engage in the mangabey preservation task by showing this attractive species to the public.

Acknowledgements

We would especially like to thank Albert Jiménez, Biologist from the University of Barcelona, who worked so hard in preparing this resulting document with a summary of mangabey genera for these guidelines and introducing all the updated data gathered during the revision process. We also want to thank those involved in the previous edition, namely: Jean Luc Berthier, Sian Waters and Malgorzata Arlet as with them we initiated the compilation on mangabey information also here included. Last but not least, thank you to Katharina Herrmann who encouraged us to edit the Best Practice Guidelines reviewing and amending the text.

Executive Summary

The current document details knowledge regarding the biology, management and keeping of the polyphyletic group of mangabeys (*Cercocebus spp., Lophocebus spp. and Rungwecebus spp.*) from the field and within zoos. As will become clear, per species there is information lacking regarding many aspects of their biology and ecology. Hence, the document is set up in such a way that, where appropriate, information can be interpreted from other mangabey species.

Section 1: Biology and Field data
This section covers an extensive overview of current knowledge regarding the taxonomic classification, morphology, natural distribution, conservation status, nutrition, behaviour and more of all the relevant species and subspecies.

Section 2: Management in Zoos and Aquariums
This section details Best Practice of management and keeping of mangabey species in zoos. Including topics on enclosure design, specifically focussed on appropriate barriers and enclosure complexity. Furthermore it includes information on optimal feeding practices, use of enrichment, social management and veterinary practices. Throughout are examples of current practice presented. Here it should be emphasized that these guidelines should be seen as a living document as knowledge will only increase through experience and research.

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Section 1: Biology and field data

1.1 Taxonomy

Mangabeys pertain to the:

Order:	Primates
Suborder:	Haplorrhini
Parvorder:	Catarrhini
Superfamily:	Cercopithecoidea
Family:	Cercopithecidae (Old World Monkeys)
Subfamily:	Cercopithecinae
Tribe:	Papionini

The systematics of the mangabey taxonomy continues to be a subject for discussion amongst many primate taxonomists. Historically, two genus of mangabey have been defined (the genus *Cercocebus* and *Lophocebus*), but in December 2003 a new species of mangabey was described, namely the Kipunji or Highland mangabey, endemic to Tanzania. This mangabey was firstly placed in the *Lophocebus* genus but after genetic and morphological consideration, the Kipunji was assigned a new genus, *Rungwecebus* (Jones, 2005). The cluster of mangabeys was firstly considered to be monophyletic (Strasser, 1987), however more recent molecular studies consider mangabeys to be a polyphyletic group of primates (Davenport et al., 2006; Gilbert et al., 2009) distinguishing two clades, namely *Cercocebus* & *Mandrillus* and *Papio, Lophocebus* & *Theropithecus* (Gilbert et al., 2009). Furthermore, molecular investigations suggested a close phylogenetic relationship between *Rungwecebus* and *Papio*, as evidence of introgressive hybridization has been found (Olson et al., 2008; Zinner et al., 2009). Burrel et al. (2009) hypothesized that *Rungwecebus* originated due to an ancient hybridized lineage between *Lophocebus* and *Papio*. More recently, including samples from the Southern populations of *R. kipunji*, Roberts et al. (2009) suggested that the genus *Rungwecebus* is indeed a sister lineage to *Papio*, however that the population in the Southern Highlands experienced recent introgressive hybridization. The haplotype found in the populations in Ndundulu are therefore considered to be the true, non-introgressed genome of *R. kipunji* (Roberts et al., 2009).

While Grubb et al. (2003) did not list any subspecies of *Lophocebus albigena*, Groves (2007) published a revision of the group in the light of the Phylogenetic Species Concept and raised the three subspecies recognized by Groves (1978): *L. a. albigena*; *L. a. johnstoni*; and *L. a. osmani*, to full species rank. He also described the mangabeys of Uganda as a fourth species, *Lophocebus ugandae*.

The following species and subspecies of mangabeys are presently recognised:

Genus ***Cercocebus*** – white-eyelid mangabeys

- *Cercocebus agilis* (Milne-Edwards, 1886) – Agile mangabey
- *Cercocebus atys* (Audebert, 1797) – Sooty mangabey
- *Cercocebus lunulatus* (Temminck, 1853) – White-naped mangabey
- *Cercocebus chrysogaster* (Lydekker, 1900) – Golden-bellied mangabey

- *Cercocebus galeritus* (Peters, 1879) – Tana River mangabey
- *Cercocebus sanjei* (Mittermeier, 1986) – Sanje mangabey
- *Cercocebus torquatus* (Kerr, 1792) – Cherry-crowned mangabey

Genus ***Lophocebus*** – crested mangabeys
- *Lophocebus albigena albigena* (Gray, 1850) – Grey-cheeked mangabey
- *Lophocebus albigena johnstoni* (Lydekker, 1900) – Johnston's mangabey
- *Lophocebus albigena osmani* (Groves, 1978) – Osman Hill's mangabey
- *Lophocebus aterrimus aterrimus* (Oudemans, 1890) – Black crested mangabey
- *Lophocebus aterrimus opdenboschi* (Schouteden, 1944) – Opdenbosch's mangabey
- *Lophocebus ugandae* (Matschie, 1912) – Uganda mangabey

Genus ***Rungwecebus***
- *Rungwecebus kipunji* (Jones, 2005) – Highland mangabey

Based on certain characteristics in morphology, behaviour and ecology one can distinguish the different mangabey species roughly into two different groups (Napier and Napier, 1985; Table 1), namely:
- **Semi terrestrial** species – which, as the name suggests, are semi terrestrial and have a stiff gait, light pelage and quite a long but not very supple tail.
- **Arboreal** species – which are strictly tree-dwellers, having supple movements, very dark pelage and a long, ruffled tail.

Table 1. Characteristics of semi terrestrial and arboreal mangabeys.

Semi terrestrial *Cercocebus*	**Arboreal** *Lophocebus, Rungwecebus*
Marked sexual dimorphism	Less sexual dimorphism
Mainly ground foragers	Rarely feed on the ground
Multi-male and multi-female groups	Multi-male and multi-female groups
Group size 10-90 animals	Group size approximately 20 animals
Varying pelage colouration	Dark pelage
Natal hair and skin differences	Natal skin differences
Pale or white eyelid patch	No eyelid patch
Menses visible	Menses less visible
Post-conception perineal swelling	No documented post-conception perineal swelling
Common features	
Oestrus cycles (~30 days) characterized by perineal swellings ~5.5 month gestation	
Formidable canine teeth and jaws to access hard nuts (out-competes other primates)	
Omnivorous, opportunistic feeders with fruit being an important part of the diet	
Ischial callosities and cheek pouches	

1.2 Morphology

***Cercocebus agilis* – Agile mangabey**

Brownish olive to gray-olive, clearly speckled hairs with two light bands on foreparts, often fading out on hindparts; median dorsal zone tending to be darker; hands very dark brown; tail becomes lighter distally and is light below, underside, to chin, and inner surfaces of limbs paler, unspeckled. Cheeks white, because of light bases of backswept cheek hairs. Crown slightly darker, nearly always with a whorl or centre parting in front, bordered in front with a short fringe. Face black; eyelids pale, not white.

Brent Huffman, Ultimate Ungulate Images, ARKive

Sexual size difference as in *C. atys;* adult males weigh between 7 and 12 kilograms with a length of 42 to 62.5 centimetres, females weigh between 5 and 7 kilograms and a length of 44 to 53 centimetres, very similar to other *Cercocebus* species (Hill Osman, 1974; Rowe, 1996).

Nick Gordon, ARKive

***Cercocebus atys* – Sooty mangabey**

It has the darkest pelage form of *Cercocebus*, smoky gray, with only occasionally a trace of a dorsal stripe, generally no whorl on crown; crown hairs have a straw-colored band and black tip. Their faces are flesh-coloured – pink to gray except for their white eyelids (Hill Osman, 1974; Rowe, 1996). The marks on the nape, more typical of ***C. lunulatus*** may be weakly expressed.

There is a notable difference between the measures of both sexes. Males weigh 7 to 12 kilograms with a length of 43 to 60 centimetres, while females weigh between 4.5 to 7 kilograms with a length of 47 to 60 centimetres (Kingdon, 1997).

Natal pelage

Born grey with a yellow tinge to the hair especially around the sides and abdomen. The skin on the face, hands and feet is very pale. At the age of 4 months the adult coloration is complete (Field, 1995).

Cercocebus lunulatus **– White-naped mangabey**

Their coat is brownish gray and it is distinguished from the *C. atys* by its lighter colour, and pure white under parts. Their faces are flesh-coloured - pink to gray except for their white eyelids (Hill Osman, 1974; Rowe, 1996). A dorsal very distinct dark stripe is well expressed and there is a clear white mark on the nape (Hill Osman, 1974).

White-naped mangabeys weigh between 4 to 9 kilograms, males have a length of 55 centimetres or more and females between 45 to 47 centimetres (Hill Osman, 1974).

Taide Pérez, Barcelona Zoo

Natal pelage

Born without the patch on the back of the head and no dorsal stripe. The skin on the face, hands and feet is pale. At approximately four days the dorsal stripe is observed and at about 10 weeks of age the white crown begins to appear (Field, 1995).

Leigh-Anne Dennison

Cercocebus chrysogaster **– Golden-bellied mangabey**

Robustly built; rich, dark speckled reddish brown, sharply set off from yellowish creamy cheeks, throat, and inner surfaces of limbs, becoming bright red-gold on chest and belly; tail speckled at root only. Usually no whorl or parting on crown; cheek whiskers long, swept back. The upper eyelids are white (Hill Osman, 1974). Sexual size difference marked.

The Golden-bellied mangabeys' neck and the upper surface of its back is a golden-brown colour with black, giving a general greenish effect. There is no crown patch. The hair on the belly is longer. The upper eyelids are white (Hill Osman, 1974).

Natal pelage

The gold band of hair develops at the edge of the hairline on the forehead at approximately 8 weeks of age. This band of gold increases in size and moves back toward the nape of the neck creating the adult pelage. At the age of 14 weeks, the skin of the face, hands and feet begins to darken. The non-pigmented area on the eyelids is discernible at 20 weeks (Field, 1995).

***Cercocebus galeritus* – Tana River mangabey**

Inconspicuously speckled gray-yellow with long, loose, wavy pelage; limbs unspeckled; forearms, hands, and feet dark; underside yellowish white, fluffy-haired. A centre parting on crown beginning immediately behind forehead, with very long, dark hair diverging from it on either side; this hair becomes very long , >100 millimetres, back toward middle of crown. Cheeks and temples whitish. Tail with a slight, pale tuft. Hands and feet dark brown. Face black and eyelids bright white.

Julie Wieczkowski, ARKive

This species has a broad skull, high crowned, with deeper suborbital fosse and small teeth compared with ***C. agilis***. Male length is between 49 to 63 centimetres and 62 to 76 centimetres for the tail, weighing between 9.6 to 10.2 kilograms. Females have a length around 44 to 53 centimetres with a 40 to 60 centimetres long tail and weigh between 5.3 to 5.5 kilograms.

G. McCabe & D. Fernández

***Cercocebus sanjei* – Sanje mangabey**

Speckled gray; underside, but not inner surfaces of limbs, pale orange. Tail with pale tuft. Hands and feet darker. Long crown hairs swept back, up and sideways to give a "bouffant" appearance, set off in front by thin black brow seam. Face pale grayish, becoming pink around eyes and on nose. Eyelids not strikingly white.

They are about 50 to 65 centimetres long, excluding tail; weighing about 7 to 9 kilograms.

***Cercocebus torquatus* – Cherry-crowned mangabey**

Dark gray, with sharply demarcated white underside and inner surfaces of limbs, this zone extending forward to chin, sides of neck, and cheeks. Tail with white tuft. Crown dark red, outlined by a white collar and temporal line. Eyelids bright white. The under parts are white (Rowe, 1996). The upper parts are slaty-grey. A darker spinal line is always present (Hill Osman, 1974).

Tim Knight, Audubon Zoo, New Orleans

Males have a length of around 47 to 67 centimetres and weigh between 7 to 12.5 kilograms. Females have a length of 45 to 60 centimetres and weigh between 5 to 8 kilograms. (Kingdon, 1997).

Natal pelage

Born with pink hands, feet and face. Their head pelage is auburn and back pelage is brown-grey. There is no indication of white hair on the face, neck or tail tip. The white eyelid patch is not present. By 2.5 months the red cap is present but not full, and white hairs are appearing on the face. Hands and feet are turning grey. At 4 months the infant has a full red cap and the white pelage of the face and neck. The skin is gradually turning grey. At 5 months of age adult colouration is almost complete (Field, 1995).

***Lophocebus albigena albigena* – Grey-cheeked mangabey**

Mantle light gray, sometimes with fawn tones; midline of nape and withers usually noticeably browner, darker, darker; black of crown and body mat grayish; underside brown; with short, whitish or black hair on the cheeks (Rowe, 1996). Crown hair is long and scruffy, often forming two little tufts above brows.

Grey-cheeked mangabeys males weigh between 6.8 to 7.7 kilograms and have a height of 51 to 62 centimetres. Females weigh between 5.5 to 5.9 kilograms and have a height of 50 to 56 centimetres (Rowe, 1996).

Natal pelage

Born with black hair. The skin on the face, hands and feet is lighter than in adults (Field, 1995; Deputte, 1986)

***Lophocebus albigena johnstoni* – Johnston's mangabey**

Mantle darkish brown, distinct from the jet black of the crown but not always from the body tone; withers hardly or not darkened; arms blackish; underside dark brown; cheeks light gray-brown, passing to white inferiorly, but very thinly haired. Crown hair backswept but with long eyebrow tufts.

***Lophocebus albigena osmani* – Osman Hill's mangabey**

Mantle rusty brown or tobacco brown, with midline not much darker; black of body with brownish tinge, only crown being jet black; underside yellowish gray, with a yellow tinge anteriorly; arms tend to be paler than body, but hands black, cheeks bright gray white or golden white; crown hair less scruffy, more swept back, without hornlike tufts above brows. It is the really sexually dimorphic: males average somewhat larger than other taxa, whereas females average noticeably smaller than all others.

***Lophocebus aterrimus* – Black crested mangabey**

Fur coarse, entirely black, with no shoulder cape; no brow fringe or eyebrow tufts; cheek whiskers thick, elongated, swept back with a slight outward curve, and gray in colour contrasting with black of body; a tall, thin central tuft on crown. Skull tends to be round, more gracile.

GaiaZOO, Kerkrade, the Netherlands

There are no significant differences in length between the sexes: 45 to 65 centimetres with an 80 to 85 centimetres long tail, though regarding the weight the male is around 6 to 11 kilograms and the females between 4 to 7 kilograms.

Natal pelage

Born with pale pink face that they keep until one month of age; afterwards they become progressively pigmented.

***Lophocebus opdenboschi* – Opdenbosch's mangabey**

Fur longer, more lax than in ***L. aterrimus***; cheek whiskers relatively short, but thick, not curved, not lighter than body; crown crest broad, pyramidal, laid back. It has a very small and narrow skull compared with ***L. aterrimus***, but within the range of ***L. albigena johnstoni***.

Duncan Wright, Kibale, National Park

***Lophocebus ugandae* – Uganda mangabey**

This species is similar yet dramatically smaller than ***L. albigena albigena***, with a shorter skull, smaller face and reduced sexual dimorphism. It has a pale chocolate mane and breast, with a darkish brown mantle, often not too much lighter than body colour (Groves, 1978), contrasts more with the general body colour than that in ***L. albigena johnstoni***.

***Rungwecebus kipunji* – Highland mangabey**

The fur is as long and brown with off-white chest coloration down the abdomen and the distal portion of the tail is off-white. There is a broad, upright crest of hair on its head. The cheek hair is long (Jones et al., 2005). Elongated shoulder pelage occurs more prominently in some males. The skin color of the face, hands and feet is uniformly black but they do not possess pigmented areas on the upper eyelid areas (Ehardt and Butynski, 2006). The ischial callosities are pink.

Tim Davenport, ARKive

1.3 Physiology

Very little is known about physiological parameters of either wild or captive mangabey species. For captive animals, through collating global data, Species360 has established reference values for body temperature for a few of the mangabey species. The information, obtained from ZIMS (Teare, 2013), is displayed in Table 2.

Table 2. Body temperature values (°C) of three mangabey species under captive conditions, information obtained from ZIMS (Teare, 2013).

Species	Mean	Reference interval	Median	Lowest sample	Highest sample	*N* samples	*N* animals
L. aterrimus	38.9	36.9 – 41.0	38.9	36.4	40.8	91	22
C. chrysogaster	38.8	36.8 – 41.3	39.0	34.9	40.6	59	14
C. torquatus	38.9	36.4 – 40.4	38.9	34.9	41.6	180	38

1.4 Longevity

Understandably, life expectancy is very much species dependent and is approximately around 20 years of age for wild mangabeys. In captivity their life expectancy increases considerably, which could increase to approximately 26 years for males and 24 years for females. Table 3 displays different records of life expectancy for wild populations of different species, whereas Table 4 displays the oldest recorded ages for zoo-housed mangabeys based on studbook data.

Table 3. Life expectancy in the mangabey genera.

Species	Type	Maximum longevity (years)	Reference
C. agilis	Wild	19 - 21	Max Planck Institute, 2006
C. atys	Wild	18	Rowe, 1996
C. lunulatus	Wild	25 - 30	
C. galeritus	Wild	19	Rowe, 1996
C. torquatus	Wild	25 - 30	Rowe, 1996
L. aterrimus	Wild	32.7	Nowak, 1999
L. albigena	Wild	32.6	Nowak, 1991

Table 4: Oldest recorded ages for zoo-housed mangabey species based on studbook data.

Species	Maximum longevity males (years)	Maximum longevity females (years)
C. lunulatus	26.7	34.7
C. chrysogaster	26	26
C. torquatus	26.7	30
L. aterrimus	37.1	36
L. albigena	33	38

1.5 Zoogeography, Conservation and Ecology

1.5.1 Cercocebus agilis

Distribution

From Rio Muni east via the Makokou District (Northeastern Gabon) across the Oubangui to the Garamba National Park and the Semliki River, Northeastern Congo-Zaire (Figure 1).

Habitat and ecology

This species is generally found in periodically flooded swamp forest (Quris, 1975), although in Dzangha-Sangha, Central African Republic, animals spend most of their time in terra firma mixed forest, and were never observed along the Mondika River, nor in swampy forest along the Ndoki (Shah, 2003). This species is generally found in periodically flooded swamp forest (Quris, 1975), although in Dzangha-Sangha animals spend most of their time in terra firma mixed forest, and were never observed along the Mondika River, nor in swampy forest along the Ndoki (although their ranges went within close range of these areas) (Shah, 2003).

Group size ranges from 8 to 22 animals, and they spend less time on the ground than other *Cercocebus*; which is 15 to 20% of their time (Shah, 2003). The majority of the time is spent in the lower strata (0 to 10 metres) (Quris, 1975; Shah, 2003). Home range was recorded as circa 303 hectares at Dzangha-Sangha (Shah, 2003), and 198 hectares in Gabon (Quris, 1975).

The ***C. agilis*** has a strong dietary preference for fruit, seeds, and monocotyledon shoots.

Population

The population density of this species in Gabon has been recorded at 6.7 to 12.5 individuals per km^2 (Quris, 1975), low densities have also been recorded elsewhere in the range. The population trend remains stable.

Conservation status

Classified as Near Threatened on the IUCN Red List (personal communication, Christoph Schwitzer) and listed on Appendix II of CITES. Threatened by habitat loss caused by deforestation for timber and firewood. It is also locally hunted for meat and they are persecuted for crop raiding. (Hart et al., 2008a).

1.5.2 Cercocebus atys

Distribution

The ***C. atys*** ranges in Senegal, Guinea Bissau, Guinea, Sierra Leone, Liberia and Côte d'Ivoire to the Nzo-Sassandra system (Figure 2).

Habitat and ecology

It is found in primary and secondary forests, gallery forest, swamp forest including mangrove and mosaic habitats in the Guinean Forest Zone. This species is largely terrestrial but will also use the forest canopy. In Guinea it is known from woodland savanna. This species is known to raid farms. They are tolerant of some degree of habitat degradation in the absence of hunting. Their diet varies significantly throughout the year. The foods eaten and the amount ingested of each food differs monthly and seasonally. Diet diversity is relatively low when compared to other mangabeys. In one field site, year round food items include invertebrates, fungi and one plant food – *Acoglottis gabonensis* seeds (McGraw et al. 2014). In other sites their diet consists of fruits, seeds and animal prey, mainly insects (Rowe, 1996).

Population

There have been very few recent surveys for ***C. atys*** in Senegal and Guinea-Bissau, but it is not thought to be common. In the absence of hunting, this species used to be relatively widespread in farm/bush and secondary forest in Sierra Leone.

Conservation status

Classified as Endangered on the IUCN Red List (personal communication, Christop Schwitzer) as it is presumed to have declined by 20 to 25% over the past 27 years, impacted by both hunting and habitat loss. It is more widespread and more secure in this part of the species' range than ***C. lunulatus***. (Oates et al., 2008a).

1.5.3 Cercocebus lunulatus

Distribution

The ***C. lunulatus*** ranges through the eastern part of the range from the Nzo-Sassandra system to the Volta River. It has recently been recorded from the south-western Burkina Faso (Galat and Galat-Luong, 2006) and from south-western Ghana (Oates et al., 2008b) (Figure 5).

Habitat and ecology

It is found in primary and secondary forests, gallery forest, swamp forest including mangrove and mosaic habitats in the Guinean Forest Zone. This species is largely terrestrial but will also use the forest canopy. In Guinea it is known from woodland savanna. This species is known to raid farms. They are tolerant of some degree of habitat degradation in the absence of hunting.

Population

The white-naped mangabey has a restricted range, patchy distribution and is not known to be abundant anywhere. The population is decreasing fast.

Conservation status

Classified as Critically Endangered on the IUCN Red List (personal communication, Christoph Schwitzer) and listed on Appendix II of CITES. This species was considered one of the 25 most endangered primates in the world in the last decade. Threatened by habitat loss caused by deforestation for timber and firewood. This mangabey is locally hunted for meat, and this is an increasingly important threat with ongoing forest fragmentation. Although they are tolerant of a wide range of habitats, hunting of this species for meat and persecution from crop raiding are major threats. (Oates et al., 2008b).

1.5.4 Cercocebus chrysogaster

Distribution

This species is found south of the Congo River, in the central Congo Basin, where currently believed to be endemic to the Democratic Republic of the Congo. The precise northern, southern and eastern range limits are not fully known, but based on current records the western limit is the Congo River, the northern limit could be the Lulonga River, and the eastern limit the Lomami River (Gautier-Hion et al., 1999) (Figure 4).

Habitat and ecology

This species occurs in seasonally inundated lowland and upland rain forest and may occur in gallery forest (Gautier-Hion et al., 1999); sometimes also recorded in secondary forest, and are apparently an agricultural pest in some areas. It is a diurnal species in which group size that probably averages about 15 animals (Gautier-Hion et al., 1999), although J. Eriksson (in Ehardt in press) estimated group size at often more than 100 animals.

Population

This is a poorly known species, and there is a paucity of information available on its population status but it seems to be decreasing. It appears to be very patchily distributed across its range, and there are very few records.

Conservation status

Classified as Endangered on the IUCN Red List (personal communication, Christoph Schwitzer) and listed on Appendix II of CITES. Major threats to this species include hunting (both for meat and the pet trade); they may also be at risk from localized habitat loss. (Hart et al., 2008b; Inogwabini and Thompson, 2013).

1.5.5 Cercocebus galeritus

Distribution

This species is restricted to patches of gallery forests along the lower part of the River Tana in Kenya from 20 to 40 metres above sea level. It has an extent of occurrence of 60 km along the riverside, from Nkanjonja to Hewani. The area of occupancy is considerably smaller (Butynski and Mwangi, 1994).

Habitat and ecology

Wahungu et al. (2005) found that the abundance of the mangabey was highly correlated with the spatial characteristics of the forests. This species is restricted to riverine gallery forests and adjacent patches of bush. It is a semi-terrestrial species that may be found in groups of 13 to 36 individuals, sometimes combining to form aggregations of 50 to 60 animals. In 1974, 86 groups were recorded (Butynski and Mwangi, 1994). These mangabeys feed on seeds, leaves and fruit. Like many *Cercocebus* species, they regularly eat hard seeds and nuts such as *Acasia robusta* and *Phoenix reclinata,* which are available for 1/3 of the year (Wieczkowski, 2013).

Population

This species is common within its small range. In 1994, the global population was estimated to number 1,000 to 1,200 individuals. The population appears to be somewhat below the 1975 estimate of 1,200 to 1,600 individuals. The population is decreasing and has declined by roughly 10 to 30% since 1975 (Butynski and Mwangi, 1994).

Conservation status

Classified as Critically Endangered on the IUCN Red List (Christoph Schwitzer) and listed on Appendix I of CITES. Threatened by deforestation for agricultural land and timber, burning of adjacent grasslands preventing forest regeneration, overgrazing of forest understory by livestock, and changes to the flow of the Tana River and water table by damming and irrigation projects. (Butynski et al., 2008).

1.5.6 Cercocebus sanjei

Distribution

Known from the Mwanihana Forest Reserve, on the eastern slopes of the Uzungwa Mountains, Tanzania. It ranges from 400 to 1,300 metres above sea level.

Habitat and ecology

This species is often found in the lower understory of submontane and montane forest, and spends ~50% of its time foraging on the forest floor (Ehardt et al., 2005; Ehardt and Butynski, 2006). It frequently moves through and utilizes disturbed areas and mosaic habitat (Ehardt et al. 2005). Mean group sizes range from 15 to >40 animals (Wasser, 1993; Ehardt et al., 2001; Ehardt et al., 2005). The diet of this species is strongly concentrated on fruit, nuts and seeds, as well as herbaceous material (Ehardt et al., 2005). In the Mwanihana forest in Tanzania, they spend 50.6% of their diet feeding on ripe fruits, 29.6% on seeds, 6.8% on woody plant pith, 6.5% on fungus, 3.1% on young leaves and 1.2% on flowers (Pages and Ehardt, 2013).

Population

Current population estimate likely does not exceed 1,300 individuals (Ehardt et al., 2005). Split into two distinct subpopulations: the largest subpopulation (ca. 60%) occurs within the recently established Udzungwa Mountains National Park and the remaining ca. 40% in Udzungwa Scarp Forest Reserve (Ehardt et al., 2001; Ehardt et al., 2005).

Conservation status

Classified as Endangered on the IUCN Red List (personal communication, Christoph Schwitzer) and listed on Appendix II of CITES. Threatened by continuing deforestation for timber and charcoal production. It is also threatened by hunting, including with dogs. (Ehardt et al., 2008).

1.5.7 Cercocebus torquatus

Distribution

This species ranges in coastal forests from Western Nigeria into Southern Cameroon, and throughout Equatorial Guinea (Rio Muni), and Gabon (Gautier-Hion et al., 1999) and the Gabon-Congo border on the Atlantic shore (Maisles et al., 2007). Its southern limit is south of the Ogooue River in Gabon. There have been unconfirmed reports of its occurrence into Benin, and if it ever did occur it may now be extirpated (Campbell et al., 2008) (Figure 3).

Habitat and ecology

This species is primarily found in high forest, but it also occurs in mangrove, gallery and swamp forest (Maisles et al., 2007). It can also be found in young secondary forests and around cultivated areas. Group size has been reported to be between 14 and 23 animals (Equatorial Guinea). It is primarily a frugivorous species with a component of animal protein (mainly reptiles).

Population

Although seemingly widespread, and sometimes locally abundant in scattered localities, the species now appears to be absent in areas with even low to medium hunting pressure (Maisels et al., 2007). It was already considered to be uncommon in Nigeria in 1982, and J. Oates (cited in Maisels et al., 2007) suggested that they may be naturally less common in Cameroon and Nigeria because of competition with drill *(Mandrillus leucophaeus)*.

Conservation status

Classified as Endangered on the IUCN Red List (personal communication, Christoph Schwitzer) and listed on Appendix II of CITES. Threatened by habitat loss and hunting for meat throughout most of its range. In places it is considered to be an agricultural pest. (Oates et al., 2008c).

1.5.8 Lophocebus albigena albigena

Distribution

This species is found in equatorial Africa, from the Atlantic coast of Cameroon to central Uganda (Nigeria to Kenya and Tanzania to Angola) (Rowe, 1996) (Figure 6).

Habitat and ecology

Found in dense, evergreen forest, but also inhabits swamp forest (Wolfheim, 1983; Rowe, 1996). Their diet consists mainly of fruits (59%), leaves (5%), flowers (3%), animal prey (11%, including reptiles). Figs are the preferred fruit of the 63 species of plant eaten. They reportedly raid crops (Rowe, 1996).

Population

This species is widespread and common throughout much of its range. Densities are estimated to be between 18 and 77 animals per km^2, and 10 to 20 individuals per km^2 are usual in the mixed primate communities of Cameroon and Gabon.

Conservation status

Classified as Vulnerable on the IUCN Red List (personal communication, Christoph Schwitzer) and listed under CITES Appendix II. Threatened by habitat loss due to logging and clearing of forests for agriculture and also hunted for bushmeat. This species is dependent on intact primary forest, and less adaptable to habitat changes than other forest monkeys. (Oates et al., 2008d).

1.5.9 Lophocebus albigena johnstoni

Distribution
From Congo-Zaire, to the Oubangui (north of the River Congo) southeast to Kabambare (4º13'S, 27º07'E) and the Burundi, and east to Busoga, at the source of the Victoria Nile, Uganda.

Conservation
This subspecies is classified as Near Threatened on the IUCN Red List (personal communication, Christoph Schwitzer).

1.5.10 Lophocebus albigena osmani

Distribution
From Cross River, across Sanaga River to Edea and inland to the Batouri District.

Conservation
Currently classified as Data Deficient on the IUCN Red List (personal communication, Christoph Schwitzer). Requires further investigation.

1.5.11 Lophocebus aterrimus

Distribution

This species is found south of the Congo River in the Democratic Republic of the Congo, in lowland rainforest areas of the Southwest Congo Basin and into Angola (Gautier-Hion et al., 1999). The subspecies ***L. a. aterrimus*** is found in the central Congo Basin whereas ***L. a. opdenboschi*** is found in North-eastern Angola and South-western Democratic Republic of the Congo (Machado, 1969) (Figure 6).

Habitat and ecology

This species is found in primary and secondary moist forests. In Salonga National Park, it has been observed in swamp forests, but does not occupy swamp in Lomako (McGraw, 1994). It utilizes all forest levels (especially the middle canopy layers), but seldom descends to the ground (Horn, 1987a; McGraw, 1994). Its diet consists largely of fruits and seeds, with high rates of nectarivory in some months of the year in Salonga; foraging activity is concentrated in the early morning (Horn, 1987b; McGraw, 1994; Gautier-Hion and Maisels, 1994).

Population

Although widespread, its population size is not really known and further details are needed. Densities of 70 individuals per km^2 have been recorded in some localities. The population is decreasing.

Conservation

The black crested mangabey is classified as Vulnerable on the IUCN Red List (personal communication, Christoph Schwitzer) and listed on Appendix II of CITES. It is subject to intensive, uncontrolled hunting for its meat in most parts of the range, and it is also vulnerable to loss of forest habitat. (Hart et al., 2008c). The IUCN Red List classification extends to the two respective subspecies also, both ***L. a. aterrimus*** and ***L. a. opdenboschi*** (personal communication, Christoph Schwitzer).

1.5.12 Lophocebus ugandae

Distribution

This is Uganda's only endemic primate. It lives in forests along the northern and north-western shores of Lake Victoria, including Mabira Forest, Bujuk, Bukasa Forests and Sango Bay; also in the forests along the eastern side of the Albertine Rift, especially Kibale.

Conservation

Currently classified as Vulnerable on the IUCN Red List (personal communication, Christoph Schwitzer).

1.5.14 Rungwecebus kipunji

Distribution

Endemic to southern Tanzania. Populations exist in Mount Rungwe and Mount Livingstone (often referred to as Rungwe-Livingstone) in the Southern Highlands, from 1750 to 2450 metres above sea level, and 350 kilometres away in Ndundulu in the Udzungwa Mountains, from 1300 to 1750 metres above sea level (Jones et al., 2005).

Habitat and ecology

Habitat ranges from degraded montane and upper montane forest from 1,750 to 2,450 metres in Rungwe-Kitulo, to pristine submontane forest in Ndundulu (Davenport and Jones, 2005; Jones et al., 2005; Jones, 2006; Davenport et al., 2006, 2008). In Rungwe-Kitulo, the canopy is often broken and between 10 to 30 metres with emergents to 35 metres. The Kipunji prefers steep-sided gullies and valley edges and is rarely found far from streams (Davenport and Butynski, in press). Ridges and open areas are usually avoided. The forest has been greatly reduced by logging (Lovett, 1986; McKone and Walzem, 1994; Machaga et al., 2004; Davenport, 2005, 2006). Thick undergrowth is typical, with the tree fern *Cyathea manniana*, wild banana *Ensete ventricosum*, and large stands of bamboo *Sinarundinaria alpina* common in the south and south-east of Mt. Rungwe and the north-west of Livingstone (Davenport and Butynski, in press; Gereau et al., in press). The species rarely frequents the bamboo and leaves the forest only to raid nearby crops. In southern Mt Rungwe, annual rainfall ranges from circa 185 to 280 centimetres and there is a distinct but short dry season from June to October. In Ndundulu, the *Parinari excelsa*-dominant forest is undisturbed and the canopy is unbroken, reaching a height of between 40 and 50 metres (Jones, 2006).

Population

Surveys were undertaken by Davenport et al. (2008) estimated some 1,042 individuals in Rungwe-Kitulo, ranging from 25 to 39 individuals per group and 75 individuals in Ndundulu, ranging from 15 to 25 individuals per group. The total kipunji population was thus estimated to be 1,117 animals in 38 groups. The Ndundulu population may no longer be viable and the Rungwe-Kitulo population is highly fragmented in degraded habitat (Davenport et al., 2008).

Conservation

Classified as Endangered on the IUCN Red List (personal communication, Christoph Schwitzer). Threats are considerable and their future is already in jeopardy. Logging, charcoal-making, hunting and unmanaged resource extraction along with degradation are common in the forests. Fragmentation threatens to split the population into three small isolated subpopulations (Jones et al., 2005; Davenport and Jones, 2008).

Figure 5: Natural distribution of ***C. agilis***.

Figure 4: Natural distribution of ***C. chrysogaster***.

Figure 3: Natural distribution of ***C. atys***.

Figure 2: Natural distribution of ***C. lunulatus***.

Figure 6: Natural distribution of ***C. torquatus***.

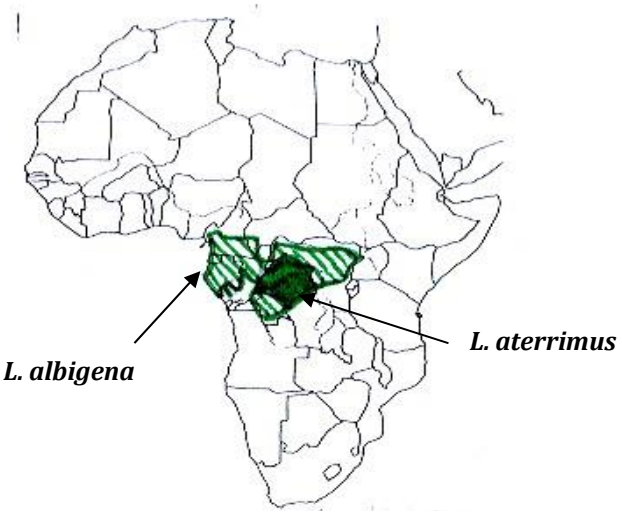


Figure 1: Natural distribution of ***L. albigena*** and ***L. aterrimus***.

1.6 Diet and feeding behaviour

1.6.1 Feeding Ecology

Mangabeys are mainly frugivorous. However, their diet is highly diverse and can also include seeds and nuts, invertebrates, fungi, flowers and leaves. Many fruits and nuts can be very hardy, yet mangabeys are skilled in cracking these using their powerful jaws and thick incisors. Fruits are sometimes rubbed on a branch until the skin breaks, and feeding then concentrates on the broken part (Chalmers, 1968). ***C. galeritus*** showed various food-related behaviours including rubbing, peeling or dissecting the food, fingers, lips and teeth were used to manipulate the food items (Homewood, 1978). Interestingly animal matter may have a larger role in mangabey nutrition as one might think; during observations of a semi-habituated group of 74 ***C. torquatus*** mangabeys in Sette Cama, Gabon one adult male was observed to consume an unidentified crab species. Crab remains were frequently spotted on the beach, hinting to a substantial place of crabs in the diet of this particular group (Cooke, 2014). Furthermore, a wild group of ***L. albigena*** was found to predate on squirrel (*Funisciurus sp.*) and bushbaby (*Galago alleni*) (Poulsen and Clark, 2001). Insect larvae are also consumed obtained from rotten fruit, by breaking rotten branches or stripping away bark to search for insects underneath (Chalmers, 1986; Janmaat et al., 2006).

Cercocebus mangabeys mainly forage on the forest floor, but sometimes also in the understory or arboreal layer (Dolado, 2016, Homewood, 1978, Mwawende, 2009). For ***C. galeritus***, feeding occurred at all canopy heights, although most of the feeding was recorded on the ground or in the understory (72%) while the rest of the feeding occurred high up in the trees (27%) (Homewood, 1978). ***L. aterrimus*** observed near Lake Tumba, Zaïre concentrated their feeding between 12 metres and 30 metres and almost all their food items were obtained from branches in the trees (Horn, 1987a). For ***C. torquatus*** feeding took place mainly on the ground (50.8%) but also in the canopy (27.6%) (Dolado et al., 2016). Of all feeding time, ***C. sanjei*** spent 68% on the forest floor and 19% of the time was in the arboreal layer (Mwawende, 2009).

Fruit availability varies over the year with wet and dry periods and therefore knowledge about the fruiting state of trees is very useful. Observations on ***C. atys*** and ***L. albigena*** indicate that these two species approached and visited trees that were fruiting more frequently than empty trees regardless of visual confirmation of the trees' fruiting state (Janmaat et al., 2006). It is therefore suggested that these species have some kind of spatial memory, with particular reference to fruiting of trees at a particular time of the year, which is highly beneficial for food intake.

There is some evidence that several mangabey species change their ranging behaviour to deal with the changing fruit availability. ***C. torquatus*** groups in Cameroon changed their ranging area according to the fruiting of certain tree species (Mitani, 1989), as did two groups of ***C. sanjei*** in Mwanihana (Laizzer, unpublished data, referenced in Rovero, 2009). ***C. torquatus*** in Sette Cama, Gabon used different parts of their habitat over the season to get enough food (Cooke, 2012) and this same group also showed fission-fusion dynamics related to fruit availability (Dolado et al., 2016). ***L. albigena*** deals with seasonality by switching from mainly eating fruits to a diet consisting of seeds, flowers and young leaves (Poulsen et al., 2001) (Figure 7). ***R. kipunji*** switches its diet to leaves and pith, but also

eats unripe *Ficus* fruits and stems (Bracebridge, 2012). ***C. galeritus*** showed a similar strategy by increasing the diversity of their diet in fruit-lean periods (Homewood, 1978).

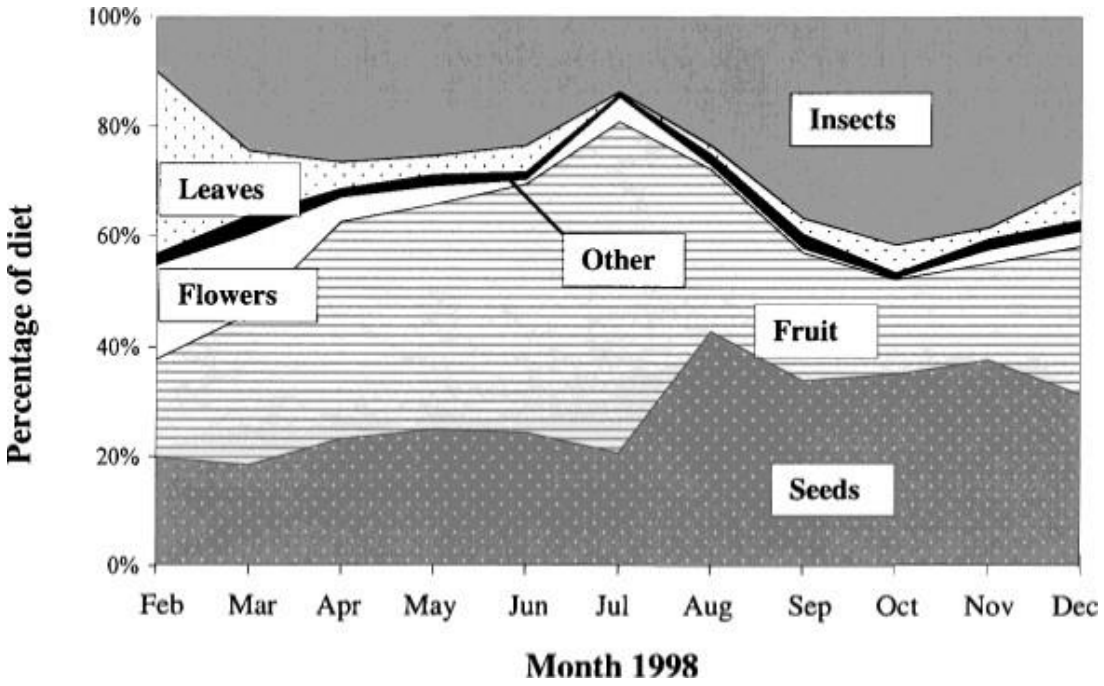


Figure 7: graph from Poulsen et al. (2001). Variation in food items consumed per month. Percentages were calculated as the number of scan samples that a food item was eaten divided by the total number of scan samples for the month. The food item was only counted once per scan sample, regardless of the number of monkeys eating it.

When trees bear no fruits or buds anymore ***C. atys*** ate *A. fragrans* fruits that had fallen to the ground. ***L. albigena*** ate fruits from *Ficus* that were still in the tree. Some *Ficus* species change colour when ripe while *F. sansibarica* colour change is unrelated to ripening. ***L. albigena*** touched and smell these fruits frequently to assess the ripeness showing that they rely on visual, tactile and olfactory clues to find appropriate food items (Janmaat et al., 2006).

Water is obtained mostly from fruits but when fruit density decreases, ***C. galeritus*** drank water from tree holes by inserting their arm in the hole and licking the water from their fur (Wahungu, 1998). ***C. galeritus*** spend considerable time turning the litter layer for insects, grubs, bird and reptile eggs and dry seeds within the forest (Wahungu, 1998). Of the fruits feed on by ***C. galeritus*** in the Tana river basin in Kenya, they were found to mainly feed on *Ficus sycomorus* followed by *Sorindea madagascariensis, Sterculia appendiculata* and *Phoenix reclinata* (Wahungu, 1998). Although selection of fruits was dependent upon rainfall and thus seasonal, ***C. galeritus*** stayed year-round in the same habitat relying entirely on coastal gallery forest habitat (Wahungu, 1998). Four tree species covered 70% of the eaten fruits for ***C. torquatus***: *Sacoglottis gabonensis*, *Guibourtia tessmannii*, *Hyphaene guineensis* and *Manilkara fouilloyara* (Dolado et al., 2016).

1.6.2 Diet

As stated earlier, mangabey diets can be highly diverse. Although diets can alterate between seasons, several studies have estimated dietary compositions for a number of mangabey species (Table 5).

Table 5: Dietary composition of wild diets of different mangabey species.

Species	Food item consumed	Percentage of the total diet
L. aterrimus	Fruit	56.7%
Horn, 1987	Nuts and seeds	30.5%
	Insects	1.6%
	Immature leaves	3.3%
	Flowers	4.2%
C. torquatus	Fruit	79.2%
Dolado et al., 2016	Seeds	17.1%
	Invertebrates	2.7%
	Other	1%
C. sanjei	Fruit	78%
McCabe et al., 2013	Fungi	11%
	Seeds	9%
	Animal matter	2%
	Plant structural parts	0.7%
	Flowers	0.01%
C. galeritus	Fruits and seeds	81%
Homewood, 1978	Buds and flowers	2%
	Shoots and stems	12%
	Young leaves	2%
	Animal prey	2%
	Other	4%

1.7 Reproduction

1.7.1 Developmental stages to sexual maturity

Females of ***C. atys*** show first sexual skin swelling at an average of three years of age and conceive approximately one year later giving birth at an average of 4.7 years. This one year of adolescent sterility is similar to that reported for other primate species (Gust et al., 1990).

Conceptions in all age groups occur more frequently from October through March (Gust et al., 1990).

1.7.2 Age of sexual maturity

In ***C. atys*** puberty is reached by males at about six years when the canines are fully grown and the male voice changes – the characteristic, loud call being heard for the first time (Napier and Napier, 1985).

1.7.3 The menstrual cycle

In mangabeys the menstrual cycle lasts for about 30 days and is related to the sexual swelling (Napier and Napier, 1985) of the sex skin synchronized with ovulation. So increasing tumescence and reddening of the perineal region and subsequent detumescence are directly associated with underlying hormonal events. Similar to other species, maximum tumescence corresponds with occurrence of ovulation (Gust et al., 1990).

1.7.4 The post-conception perineal swelling

Captive females of *Cercocebus sp.* show a postconceptional perineal swelling that peaks at the end of the first trimester after conception which looks like the ovulatory swelling. Compared to a normal ovulatory cycle, this swelling stays at the maximum tumescence for longer and detumescence is slower. The post conception perineal swelling is documented only in the semi-terrestrial species and not in the arboreal group (Field, 1995).

Pregnancy swelling may function to confuse paternity if females mate with more than one male during and after conception, potentially increasing the total amount of male care an infant receives or decreasing the chances that an infant will be the victim of male infanticide (Kinnaird, 1990).

- In ***C. atys*** the beginning of the postconceptional swelling according to Kinnaird (1990) is near the end of the first trimester of the pregnancy or approximately 35 days after conception and reaches maximum swelling at approximately 49 days (Gordon et al., 1991).

- In ***C. galeritus*** the perineal swelling occurs after the second month of pregnancy (Kinnaird, 1990).

1.7.5 The gestation period

Gestation varies in the two groups: semi-terrestrial around 168 days and arboreal 177 days (Napier and Napier, 1985) (Table 6).

- Captive studies of ***C. atys*** report mean gestation length of 167 (Kinnaird, 1990) to 169 days (Kinnaird, 1990).

- Mean gestation length reported by Kinnard (1990) for the other species of captive *Cercocebus* are similar – for ***L. a. albigena*** 176 days and 168 days for ***C. torquatus***.

- The Tana River mangabey has the longest gestation period in the mangabey group – 180 days (Kinnaird, 1990).

Table 6: Gestation length in the mangabey genera.

Species	Gestation length (days)	Reference
C. agilis	180	Kinnaird, 1990
C. atys	167 – 169	Kinnaird, 1990
C. lunulatus	152 – 180	Field, 1995
C. chrysogaster	174 – 177	Field, 1995
L. a. albigena	175 – 177	Napier and Napier, 1985; Kinnaird, 1990; Deputte, 1992

1.7.6 The birth and inter-birth interval

Data on mangabey reproductive parameters is sparse. The interval from birth to the first visible sign of swelling has been recorded for a few species (Table 7).

Table 7: Reproductive intervals, both time from birth and first swelling and inter-birth, for different mangabey genera. Either average or range displayed in months.

Species	Birth to first swelling (months)	Inter-birth (months)	Reference
C. agilis	6 – 10	18 – 24	Gust et al., 1990
C. atys	4.7	16.6	Gust et al., 1990
L. a. albigena	3.9 – 4.7	33	Wallis, 1983

Duration from parturition to resumption of swelling is similar in primiparous and multiparous females with offspring surviving to over 1 year of age (Gust et al., 1990).

1.7.7 Infant development

At about three to four weeks of age, infants start eating solid fruit. Transportation is done in ventro-ventral position. Between four and six weeks of age, infants start playing and starts grasping and mouthing and by six weeks of age, the infant will leave its mother's arms for the first time, but remaining quite close to her. Between six and 14 weeks of age, exploration of the infant's immediate surroundings starts, but remains confined to an area quite close to its mother. Movement during this time also becomes more independent and includes running, walking and jumping. However, when high branch movement or troop movement is required, the infant will still cling to its mother ventrally.

Social play starts at 16 weeks old and in a few weeks the mother starts to refuse nursing the infants, actively discouraging such interactions. The father of the infant does not interact with his offspring during the first weeks (Schlee and Labejof, 1994).

Captive male sooty mangabeys carry infants in certain circumstances; particularly deposed alpha males can carry infants in the presence of the new alpha male. This behaviour is likely to protect the infant from aggression (Busse and Gordon, 1984). Attacks on infants and infanticide by newly ascended alpha males are known, with some attacks even proving fatal for the infant (Busse and Gordon, 1983). The reason for such attacks is consistent with male behaviour aimed at increasing his chances of passing his genes by killing the offspring of a female and subsequently mating with that female (Busse and Gordon, 1983).

1.7.8 Life history

- Individual weight gain curves for mangabeys of both sexes show **an early peak** around two years of age.

- Males have a later growth spurt peaking between four and six years of age.
- Females do not have a second clear growth spurt but their weight steadily increases until puberty at the age of five years. For females there is a close relationship between weight and the occurrence of their first sexual swelling (Deputte, 1992).

1.8 Behaviour

1.8.1 Activity

Observations on a wild group of ***L. albigena*** showed that during the day the monkeys spent their time mostly on feeding, travelling, grooming and resting. Feeding activity peaks around 8 - 9 A.M., 12 - 1 P.M. and 4 - 5 P.M. Following the last feeding peak time spend traveling increased, presumably to go to their sleeping sites in the trees. At dusk most activities cease until dawn (Chalmers 1968) making these mangabeys primarily diurnal primates.

Another observed wild group of ***L. albigena*** spent 40% of their time on feeding, about 30% on travelling and around 10% on resting and social behaviour. Before sleeping, resting and social behaviour increase at the expense of feeding and travelling (Poulsen and Clark, 2001).

Captive ***C. atys*** mangabeys spend most of their time on the ground during daytime. They spend around 35% of their time on feeding, followed by approximately 20% of their time on self-directed behaviours such as grooming. In the early morning there is a lot of travelling, sexual presentations, feeding and self-directed activity. During late morning travelling is minimal, object manipulation is most frequent as is time spend drinking. During the early afternoon, ***C. atys*** perform high levels of agonistic interactions and self-directed activities, while during late afternoon feeding and play behaviour peaked. During the last daylight hours, traveling peaks again together with self-directed behaviours (Bernstein 1976).

1.8.2 Locomotion

Cercocebus mangabeys are more terrestrial and therefore mainly walk or run on the ground on four legs during travel and foraging. When foraging in the understory or shrub layer they will also climb and leap from tree to tree. ***C. atys*** spends most of the time on the ground or in the shrub layer and move only rarely through forest strata layers above 15 metres height (McGraw 1998). The locomotor activity performed most often was quadruple walk (McGraw, 1998). *Lophocebus* mangabeys are arboreal and mainly travel by leaping from tree to tree and by climbing (Chalmers 1968; Stern 2005).

Neumann and Zuberbühler (2016) found that in a habituated group of ***C. atys*** in Taï National Park, Ivory Coast travel speed and change of direction was subject to a complex interaction of social parameters and vocalizations. Differences in vocal rates were mediated by the social environment, yet the only vocalization parameter independent of the social environment that could predict future travel speed was the number of vocalizations produced in a sub-group; this usually slowed down travel speed (Neumann and Zuberbühler, 2016).

1.8.3 Predation

Crowned hawk-eagles (*Stephanoaetus coronatus*) prey on different monkey species, including mangabeys (Struhsaker and Leakey, 1990; McGraw, 2002). Some mangabey species are preyed upon by leopards (*Panthera pardus*) and chimpanzees (*Pan troglodytes*) (Stern, 2005; Rovero, 2009).

In Kibale National Park, Uganda, ***L. albigena*** groups were found to spend approximately 6.4% of their time on vigilant behaviours whilst isolated males in the same area were found to spend 13.7% of their time on vigilant behaviours, which then may be a reaction to an increased chance of predation due to the solitary lifestyle (Olupot and Waser 2001).

1.8.4 Social behaviour

It is known that ***C. atys*** has a social organization that is characterized by large multi-male/multi-female groups (Bergmüller et al., unpublished results cited in Range and Noë, 2002; Range and Fischer, 2004). These large groups can contain from around 100 to as many as 120 individuals in the wild, but can be somewhat smaller, having been observed in a different study to range from 20-48 individuals (Galat and Galat-Luong, 1985; McGraw and Bshary, 2002; Range and Noë, 2005).

There are two categories of males within ***C. atys*** group. Some males are full-time residents of the group while others are more transient, alternating between several weeks of residence within the group and several weeks of absence (Range et al., in press cited in Range, 2005). Males disperse from their natal group while females tend to stay in the same place (Range, 2006).

Within wild ***C. atys*** groups there is a stable linear dominance hierarchy of females (Range and Noë, 2002; Range, 2006). Evidence hints that this hierarchy affects a female's food intake, with higher-ranking individuals foraging more efficiently as they are centrally placed in the group and do not need to be as aware of predators as those on the periphery (Range and Noë, 2002). In captivity, the dominance hierarchy is not matrilineal or kin-based. Starting at 1.5 to two years of age, infants approximate their mother's rank until an age of three years, although remaining slightly below them in rank until that point (Gust and Gordon, 1994; Gust, 1995; Range and Noë, 2005). From the age of three, young ***C. atys*** exhibit a drive to move up the rankings of dominance and begin to do so (Gust, 1995). Also at this time, the rank of the infants of both sexes surpasses their mothers' and by five to six years of age, males outrank all of the females (Gust and Gordon, 1994; Gust, 1995). Wild juvenile females show some stability with respect to the ranking of their mothers while males do so initially, but over time this correlation declines (Range, 2006). Female rank does not depend on age or size of an individual and there is no correlation between the ranks of sisters (Gust and Gordon, 1994; Stahl and Kaumanns, 1999). However, in wild populations, adult females show affiliation with those similar to them in rank (Range, 2006). There is also evidence that allo-grooming in captivity serves both hygienic purposes as well as other purposes which may include tactile communication (Pèrez and Baró, 1999).

In captivity, there are four ways in which juvenile ***C. atys*** advance in the hierarchy of dominance and do so without the help of relatives of the same maternal line. Hierarchical mobility occurs by directly confronting higher-ranking individuals, joining an aggressor against a higher-ranking individual, challenging a higher-ranking individual and enlisting the help of another high-ranking individual, or challenging a higher-ranking mangabey and enlisting the support of an adult male to help in the challenge (Gust, 1995). Outsiders to a conflict are more likely to assist one party when they outrank the other two mangabeys involved (Range and Noë, 2005).

Aggression is typically not severe and normally does not result in serious injury, although rare wounding and even death has been known to occur (Gust, 1995). In captivity, submissive behaviour is most often signalled by avoidance (Bernstein et al., 1983). In addition, captive males were observed to almost never be the target of aggression from other group members (Bernstein et al., 1983). Post-aggression behaviour is characterised by the fact that the victim approaches an aggressor and presents his or her hindquarters, which reassures the aggressor (Gust and Gordon, 1993).

Mangabeys appear to have a wider group spread because of food dispersion and the method of foraging. They commonly explore microhabitats of dead wood looking for arthropods, and they can walk several hours to particular points in the forest looking for blooming trees or other special kind of preferred food (Arlet, unpublished data). They transfer between groups but there is no general rule, many factors influence migratory behaviour (Smuts et al., 1986). No all-male groups have been observed, but sometimes two males can travel alone for one-two days (Arlet, unpublished data).

1.8.4.1 Social communication

Directly related to group spread is the frequency of occurrence and loudness of cohesive vocalisations.

- Members of the group of ***L. a. albigena*** give the loudest calls compared to other African tree dwellers. Adult males also give loud calls audible over great distances, which play some role in the group cohesion (Struhsaker, 1979).

- Wild ***C. atys*** emit 19 different vocalizations. The most common vocalization is the "grunt," which is uttered in many different contexts by both sexes including while foraging, during social interactions and in dominance relations. Males often "grunt" several times in a row while females vary in the spacing of their "grunts." "Twitters" are uttered in similar contexts to "grunts" but mostly in foraging contexts and only by adult females and both sexes of juveniles. "Screams" are uttered in contexts of conflict by adult females and juveniles but only rarely by adult males. Other agonistic calls include the "growl," the "grumble," the "hoo," the "intense threat," and the "wau" (Range and Fischer, 2004). Only adult males emit "whoop gobbles," usually in contexts involving contact with other sooty mangabey groups or predators (Range and Fischer 2004). Alarm calls are given in the presence of predators and are responded to by other group members climbing into trees and scanning for the predator (Range and Fischer, 2004). Sooty mangabeys observe one another and follow the gaze of others. In a captive study, sooty mangabeys would recognize where a conspecific was looking and would redirect their gaze in the same direction (Tomasello et al., 1998).

1.8.4.2 Male social relations

Relations among mangabey males are more aggressive and less affiliative than among females. The reason for this may be that most males are unrelated and male reproductive success is largely determined by competition for females.

The outcome of male-male competitive interaction is a dominance hierarchy, based on the direction of approach-retreat interactions (Smuts et al., 1986).

- In captive groups of ***C. atys*** serious wounding between males have been primarily connected to a rank challenge for the alpha position or rank challenges in new formed groups (Gust and Gordon, 1993). Cases of infanticide have also been observed (Gust and Gordon, 1993).

- In some cases adult male stable groups have been established, even a group of ***L. aterrimus*** with seven males and one breeding female did work well for several years (Tjerk ter Meulen, personal observations) but generally groups with some adult males cannot be kept due to high level of aggression between them.

1.8.4.3 Female social relations

Mangabey females remain in their natal group for life and form the stable core of the social group (Smuts et al., 1986).

Within each group, adult females form linear dominance hierarchies probably based on the direction of approach-retreat interactions. Therefore, this is not a dominance system based on matrilines. However, there is not yet sufficient data from the field regarding female intra-group relations.

- The results of research on captive females of ***C. atys*** state that in newly formed groups, their dominance rank is unstable for a few months and the female is challenged with aggression and wounded (Gust and Gordon, 1991). The females of this species do not affiliate and support adult kin more than others (Gust and Gordon, 1991, 1993, 1994).

- The field study of strategies of female social behaviour in ***L. a. johnstonii*** in Kibale Forest in Uganda (Arlet, unpublished data) showed that non-cycling females can be more aggressive to oestrous females.

1.8.5 Sexual behaviour

Female mangabeys demonstrate sexual and mating behaviour during pregnancy swelling (Kinnaird, 1990). In males sexual behaviour is demonstrated by penile erection, intromission and thrusting, beginning before one year of age and the frequency of this behaviour is higher in the adolescent males.

The copulation posture of the captive sooty mangabey consists of a male holding onto the female by the ankles and hips with the female in some instances looking back toward the male (Gust and Gordon, 1991).

Males between the age of one and four years of age mount mature females at almost three times the rate of sexually mature males (over five years), with the exception of the alpha male.

Adult males (over seven years) exhibit a copulatory rate similar to that of sub adults (5-6 years). Mounts by adult males are disproportionately directed at females displaying maximum tumescence. All other age class mounts are predominantly directed at females exhibiting other stages of swelling (Gust and Gordon, 1991).

Group encounters with non-resident males as well as solitary non-group males are common in the wild, and these encounters sometimes result in copulations with receptive females (Range, 2005).

Section 2: Management in Zoos and Aquariums

2.1 Mangabeys in European Zoos

2.1.1 Why should zoos keep these species?

Mangabeys, being social and diurnal (and some attractively coloured as ***C. torquatus*** or nicely decored as ***L. aterrimus***), are perfect ambassadors species for the threatened fauna and habitat of the Western and Central African rainforest. People education and awareness about the need to improve conservation and preservation of the wild habitats is essential in our days. In the case of the Critically Endangered ***C. lunulatus***, zoos also undertake efforts to build up an *in situ* reserve population, and link their *ex situ* activities to conservation projects in the wild.

List of mangabeys species currently being kept in EAZA collections (Table 8):

- *Cercocebus lunulatus* – White-naped mangabey **(EEP)**
- *Cercocebus chrysogaster* – Golden-bellied mangabey **(EEP)**
- *Cercocebus torquatus* – Cherry-crowned mangabey **(ESB)**
- *Lophocebus albigena albigena* – Grey-cheeked mangabey
- *Lophocebus albigena johnstoni* – Johnston's mangabey
- *Lophocebus aterrimus* – Black crested mangabey **(ESB)**

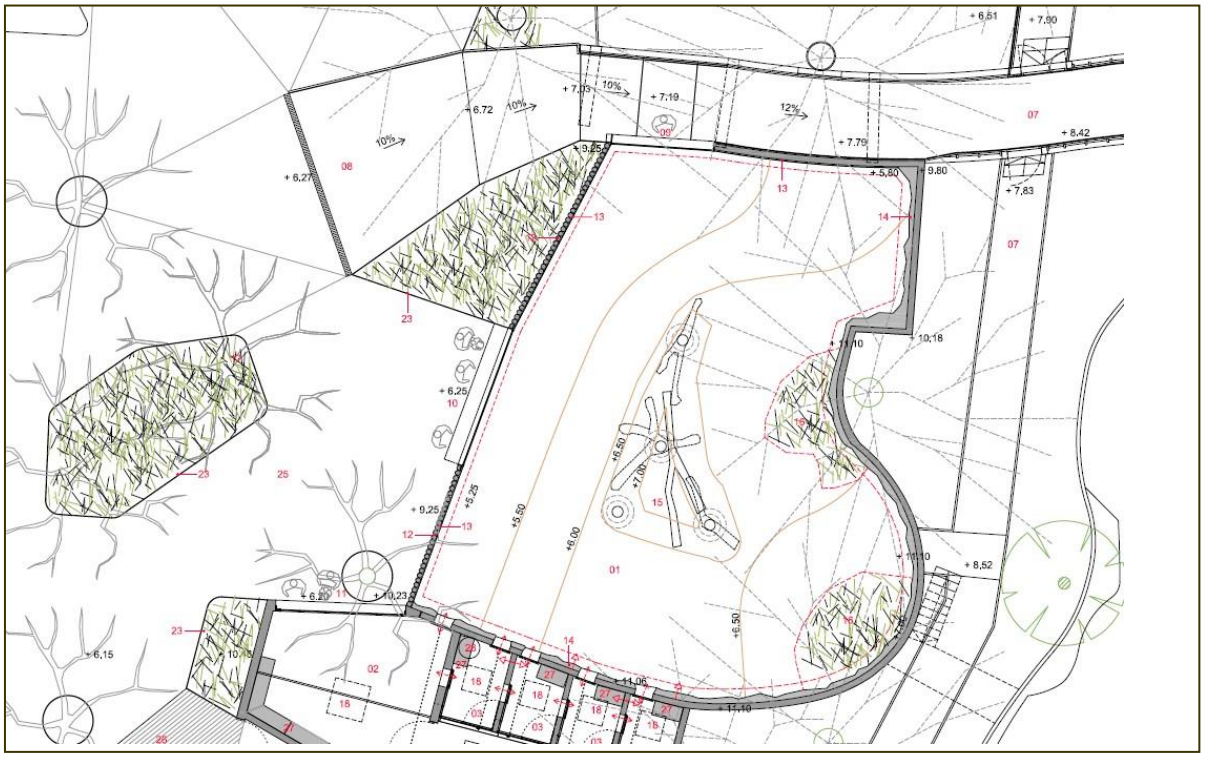
Table 8: Current population sizes of the different mangabey species in EAZA collections (June 2018).

Species	IUCN status	Current EAZA population	Number of holding institutions
C. chrysogaster	DD	9.13.0	6
C. lunulatus	EN	34.51.1	15
C. torquatus	VU	36.26.4	17
L. albigena	VU	1.0.0	1
L. a. albigena	VU	4.7.0	2
L. aterrimus	VU	10.16.0	8

2.2 Enclosure

A combination of inside and outside enclosures is recommended for keeping this species but it should be considered that the climatic conditions within the European region differ considerably. Therefore in the **southern region** inside areas could be smaller and outside bigger as animals will stay outside more frequently. Shadow is also an important and necessary element in such climates and should dominate the exhibit when summer time arrive and the temperatures are higher. On the other hand in the more **Northern** parts of the EAZA region it is to be expected that the animals will spend most of their winter time inside. The size and conditions of the inside accommodations in these regions can be higher. Outside enclosures there should be predominantly sun exposed although shadow is still required. At least two sliding doors are always needed for connecting any space in order to avoid cornering. The enclosure should be at the same level as the visitors or above the visitor access path, to be at a lower level is stressful for the animals.

Young adult males can easily remain in their group, if the installation is large enough, until the situation becomes critical. It is convenient to have a reserve space where you can separate it if necessary.



2.2.1 Indoor Accommodation

It is advisable to provide an inside space for the group **to live together during the day** in the winter, when the climate makes the outside enclosure unsuitable for them. As long as the climate permits, it is preferable that mangabeys have free choice between the uses of this inside room and the outside enclosure. It is preferred that the family unit spends the night together in the same space; therefore this space should be big enough to keep all them.

However, there might be special reasons to separate one or more individuals from the group during the night/day: during introductions or periods of social instability in the group it may be better not to leave the group unobserved together for the night. There may also be veterinary reasons to separate an animal for the night. So, some smaller space (reserve) should be available with double door connected to the main one. Animals can have access to this extra space except when to separate an individual is needed.

The indoor accommodation can be built on the view of the public to facilitate the display of the mangabeys to the public when climate conditions restrict the use of the outside enclosure, and which allows the animals to be inside or outside giving them free choice to do so.

Additional indoor accommodations are useful:

- To provide space for individuals **to be shifted to** when the other areas are being serviced.

- **To introduce** new members into the group. Introductions require an arrangement of at least two rooms, so visual contacts can be established previously to the physical introduction. During the visual contact phase, the interaction between the group and the new animal will show if there is a good chance for doing the physical introduction, or if to delay it while the animals are habituate one each other is advisable. When the animals are actually brought together, the facilities must allow a circular pattern of movement between rooms and should not include places where individuals can be trapped.

- **To permanently separate** an individual when this is necessary, while a destination for them is found and a transfer can take place. Such accommodation should provide proper housing for one or a few individuals even over a longer period if needed.

- **For medical care**. It is preferable that immediate medical care takes place in a separated area on direct contact with the general holding area, so the animal can be back in the group shortly after treatment.

All these rooms should be arranged and connected in such a way that it is always possible to move an animal between any two of the spaces, without limiting the use of the other additional spaces. There should always be at least two passages between any two rooms; so, by opening the appropriate passages, the rooms can be arranged to form a circuit. In such a way one single animal is not able to block the passage between the two rooms, or chase another into a dead end. It is preferable that containment barriers between

combined rooms are such that the animals have free choice between maintaining visual contact and hiding from view while being in the other room.

- **Indoor exhibit on public view should be** 50 m^2 as minimum

- **Off exhibit facilities** do not have to be too large. Approximately 4 m^2 by animal should be enough, considering this enclosure is a sleeping room (2.5 metres). It is better to have more than one indoor area for some situations, e.g.: a pregnant female or in the case of individuals having to be separated for a while. This area must be connected to the main ones to permit visual and olfactory contacts between individuals if needed.

2.2.2 Outside Exhibit Boundary

The minimum advisable size for an **outside enclosure** is 250 m^2 and 4 metres high.

Containment barriers are the primary determinant of the shape and appearance of the exhibit and represent the most expensive portion of an outdoor exhibit. Mangabeys are great jumpers and acrobat.

Combinations of barrier types can be employed, depending on factors such as site conditions, construction access, viewing opportunities, and landscape replication. Aesthetic considerations may encourage some variation in height. However, while not necessarily continuous by type, minimum barrier dimensions should be kept continuously around the enclosure's perimeter. In selecting barrier types, it is important to consider their varying psychological impact on the confined animal.

The concept of flight distance (4 metres) must be considered in enclosure design. There must be adequate depth and visual cover for the animals to establish their individual distances.

The distance between public and fences should be as wide as possible and not less than 1.5 metres. The public should be given restricted viewing from only one or two sides of the enclosure thereby the primates have some off view areas to avoid their feeling of being visually cornered.

Recommendations about containment barriers:

- **Water Moat**
  Mangabeys are excellent swimmers but mostly only use this if they are forced to. So in case of designing the enclosure with water moat it must be at least 5 metres width. Wet moats are very naturally looking and aesthetic barriers, which put more distance between animals and visitors, but require a lot of space. This should be considered when little space is available for the exhibit, because moats will take up space that could otherwise be available to the animals. To avoid any accidents with monkeys jumping in the water from a fight or other reason, and depending on the slope of the moat on the animal's side, it is useful to have some chains, net, or ropes firmly attached to the moat floor or slope. This way if animals slip or fall into deeper water they will be able to grasp it and climb back.

To avoid accidents with monkeys jumping in the water from a fight or other reason, and depending on the slope of the moat on the animals' side, it is useful to have some chains, netting, or ropes firmly attached to the floor or slope of the moat. This way, if animals slip or fall into deeper waters, they can grab onto them and climb back up.

- **Fencing or steel mesh structures**
  Not recommended as the primary barrier between the primates and the public due to the probability of feeding or touching by the public, a second objection against the use of fences is their aesthetic appearance. To avoid primate-visitor contact, the public should be kept at some distance, and visual barriers in the shape of plants or wood for example to allow animals to hide away in case necessary.

  Steel mesh enclosures can be large outdoor exhibits made of structural steel columns and beams with in-fill panels of mesh, or post-and-cable structures with less rigid forms. Because these are total enclosures, barrier distances are limited to the size of the mesh openings. Wire ceilings are handy for enrichments like ropes, and roof feeding is also beneficial for animals. Some zoos have been successful using fences with solid overhangs to avoid escapes. Mangabeys are quite strong and destructive animals; the diameter of the wire must be not less than 3 millimetres and the hole should be about 20x20 millimetres.

  The stainless steel wire rope mesh, available on the market since 2011, facilitates the creation of a very natural environment totally enclosed with this mesh (wire rope diameter advised 2.4 millimetres and aperture 38 x 38 millimetres).

- **Walls**
  Non-climbable walls can be used as a barrier. The texture must be relatively smooth to prevent foot or finger holds. Doors with their hinges, or nuts and bolts, which are used for attaching constructive elements to the walls, may be critical points. Overhangs are recommended to be added to prevent scaling. The layout of the walls should avoid perpendicular or acute angles to adjoining walls.

  Advantages of walls are that they take up very little room and can be less costly than moats or glass walls. The disadvantage is their visibility, which is usually disguised with geologic textures (rockwork), painting techniques, and heavy, protected planting, thereby increasing their cost. Although walls take up very little horizontal room, they minimise the vertical climbing space of the animals. The distance from climbing structures to the walls should be at least 4 metres, to prevent leaping out. For smaller walled enclosures, it is better to make a wire-mesh roof. The minimum height of the walls should be 4 metres.

  Completely enclosed wall space can be very stressful for animals, as they can often hear noises from behind the walls but cannot see anything that is happening. Therefore, each wall should have several windows. An additional disadvantage of the completely enclosed wall is that wind cannot cool the enclosure when temperature is very high.

- **Glass**
  Glass walls are often used as barriers in order to provide close-up visitor experiences, however, they are expensive. To reduce the cost, a potentially good option is to use smaller glass windows built into vertical walls. They protect the animals from food items and other material, which the visitors may throw into the enclosure. In some cases, they can also serve to protect the animals from different infectious diseases, which may be transmitted by visitors or vice versa.

  Sometimes the very close-up contact provided by glass walls can be stressful for mangabeys, provoking constantly display from the monkey to the public and sometimes vice versa. Planting a vegetation belt between the visitors and the glass wall can reduce this.

  To avoid unwanted reflection it is useful to tilt the glass sheets a little bit towards animals or to put a shading overhang above the visitors or to plant thick vegetation behind the public, which could help to diminish the reflection, and as well provide a more naturalistic environment.

  The thickness of the glass sheets (laminated glass) may be about 15-20 millimetres, depending on the sheet size. Minimum height always should be 4 metres. The use of glass walls should be limited to one or two sides of the enclosure, so the animals can have some areas where they retreat from the public view.

- **Dry moat**
  This barrier is not recommended, but if the enclosure or some part of the enclosure is surrounded by a "V" shaped dry moat then the vertical part on the visitor's side has to fulfil the same criteria (distance from climbing structures, minimum height) as in the cases of the other walls. The animals' side of the moat should be shallow and gradually deepening. If the animals can go into the shallow moat, it will give them more extra space.

- **Hot Wire**
  It is only recommended as a secondary barrier and to protect trees inside an enclosure (a hot wire similar to Galagher M400, 15 Kilowatt, and continuous current), although it is well known that electric fences have been successfully used recently as primary barriers for many species. It is very cheap when compared with other types of barriers, so that it would bring extremely large enclosures well within the financial possibilities of many more zoos. Probably the combination of different barriers would be the best, for example, a water moat with hot wire keeps the animals in. The same for walls, sometimes even a simple hot wire makes a difference.

- **Secondary Barriers**
  High voltage electric fencing has been used successfully in primate enclosures to:
  1. Maintain protection around vegetation areas.
  2. Discourage use of moats out-of-view areas,
  3. Reinforcing security on top of barrier walls and fencing.

2.2.3 Shelter requirements

When providing shelter, hiding places or any kind of furniture, do it in enough way so high-ranking animals cannot monopolized them.

- **Shelters** and hiding places are strongly recommended for shade and protection from heavy rain, severe weather or blazing sun. Animals should not be exposed to severe weather without some form of heated shelter. As mangabeys like to retreat off the ground it is preferably to add shelters on different levels.

- **Hiding places or visual barriers** are required because primates like other animals, need their privacy from the public and sometimes from other individuals (mangabeys perhaps have more need for this than other species of primates because of their ways in communication).

- **Dens** are not recommended. For a better management and the wellbeing of the animals it is necessary to have an indoor facility. The design should allow that animals have free access to it all day.

- **Indoor facilities are required**:
  - To provide an off view area where animals can be kept at night in controlled conditions.
  - To permit more efficient observation of the animal on a daily basis.
  - To permit more efficient handling when required.
  - At least three indoor areas with interconnecting slides between them and the outdoor area are desirable.

2.2.4 Substrate

2.2.4.1 Inside areas

For the purpose of easy cleaning, concrete or epoxy floors should preferably be sloped 2 to 4%. Drains should be placed outside the actual enclosure and can be used as urine collector. To allow good cleaning and disinfection, the use of special coatings should be considered, but care should be taken in its choice. Coatings can either make a floor too smooth, forcing the inhabitants to move about in a careful, cramped gait, or too abrasive.

2.2.4.2 Inside exhibit

The same substrate than for inside areas could be used but in this case, covering the floor with a bedding of bark creates a comfortable floor surface for the inhabitants, helps to increase the levels of humidity of the enclosure and provides enrichment when combined with scattered food. In the case of a big exhibit the use of a bio-floor or a thin layer of wood chips can be useful but if it were not very big, then a small layer of bark would be a better option. Make sure to change it frequently in order to avoid pests and decrease infection pressures.

2.2.4.3 Outside exhibit

It is strongly recommended to use only natural substrates. Grass, leaf litter, bark shavings, exposed roots, different vegetation, marshes and packed earth are examples of the complex variety of substrates, which can be used to recreate the natural landscapes that would be found in the wild. For enrichment, it is important to have several types of substrate in an enclosure.

2.2.5 Furnishing and Maintenance

2.2.5.1 Inside Rooms

Spatial complexity is very important to get an enclosure of good quality. It can be attained by using climbing structures at different levels in order to subdivide the main living room. Climbing facilities like wooden pole structures, ropes, nets and platforms optimize the possibilities for the animals to use the entire available space.

Variety in the furnishings and enrichment items offered increase the possible behaviour types. Spatial variety helps to give different areas and spots different functions. Favourite areas for sleeping, playing, feeding etc. can be provided. A corner between walls and screens on the floor, with soft bedding, a platform of 90 x 50 cm^2 or a hammock can be good places for resting. Provide enough furniture to avoid competition between animals.

Access for easy exchange of furnishings and enrichment items and for refilling food-dispensers should be considered:

- For the arboreal mangabeys it is most important to enrich the upper part of the enclosure with ropes, wooden perches or platforms. Fire hose is a more resistant material, which can be used instead of ropes.
- The terrestrial species stay mostly in the middle and lower part of the enclosure therefore the furnishing should be focused on these areas.

It is strongly recommended to offer fresh browse on a daily basis to stimulate their activity.

2.2.5.2 Outside Exhibits

Well-designed, naturalistic enclosures can elicit species-appropriate behaviour, which are primary conditions for the health and well-being of animals. The physical complexity of the enclosure is also a very important issue.

It is advisable that animals have the option of free access to both outside and inside areas during the day, in any season. Additionally, although mangabeys are very social animals they occasionally also need a bit of privacy, visual barriers could provide some “hidden areas” for the animals in front the others or the public.

The sunny and the shaded areas should alternate within the enclosure, so the animals can choose where to go. In warmer climates, such as in the Southern European countries, the emphasis should be on shade during summer- a few small, shaded places will not be sufficient.

2.2.5.3 Vegetation

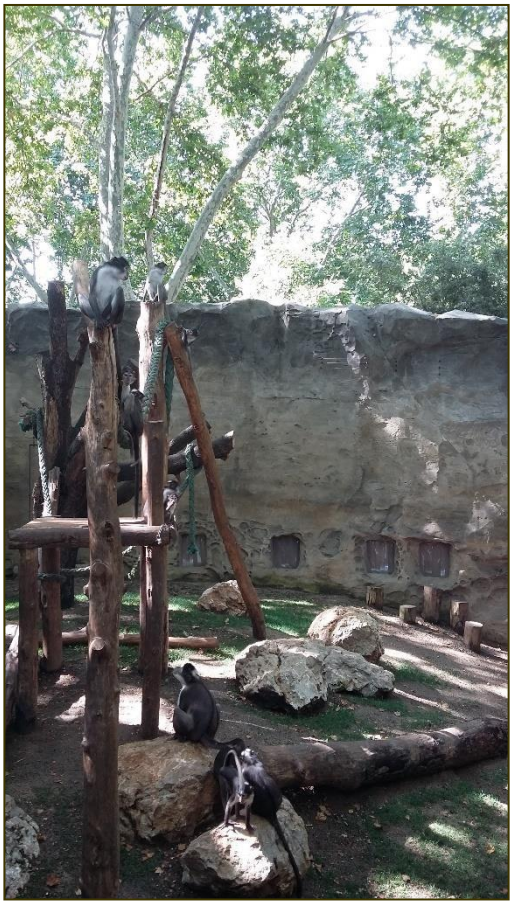
Plants and vegetation are very important for dividing the terrain in a natural way, and provide foraging material for animals. Some bushes, shrubs and trees can be protected by electric fences, fiberglass, or metal bark wraps. If the enclosure is large enough and the vegetation is well chosen and abundant, it may not be necessary to employ such protective measures. Importantly, poisonous plants have to be removed and controlled on a regular basis.

2.2.5.4 Furnishing

Physical complexity includes not only the well-designed topography and the landscape, but also good furnishing as well. In a good, naturalistic outside enclosure use of primarily natural materials is recommended such as deadfall trees, stumps and logs, reversed old roots, and rocks. Branches should be at least 15 centimetres and can serve not only as an important forage food, but also as a very useful furnishing and plaything.

Furniture and climbing structures should be easy to replace. Dead trees, different wooden constructions, vines and ropes are all excellent climbing structures; these could be in the manner of artificial trees, fibreglass poles and fire hoses. Rope nets and sacks are good for climbing and nesting and they can serve as a shade as well.

Because of the mangabeys' destructive nature, natural plants must be protected to prevent them from being damaged; therefore, the furnishing must be stronger.



As other species of monkeys, mangabeys, especially the terrestrial ones, need high structures as they like climbing up to have an overview.

2.2.5.5 Access:

- **Staff**

  Access to the exhibit needs to be provided for daily cleaning, as well as for service that is more infrequent. As exhibits mature and change, their long-term success depends upon the degree of flexibility built in to the original concept. In large outside enclosures, vehicle and equipment access for grading, landscape maintenance, replacement and earthwork machinery should be included. While these service ports may not be used frequently, they will allow for ongoing improvements.

  Windows between the keepers' area and the outside enclosure will allow keepers to keep an eye on the mangabeys. A small area with steel mesh will allow the keepers to individually give extra food or medicine while the animals are outside. This can be very useful when introducing a hand-raised mangabey.

- **Animals**

  Regarding animal access to an outdoor exhibit, more than one animal door and from more than one inside cage should be provided to prevent one animal from denying access to others.

- **Animal doors**
  Doors between animal exhibits must allow either visual contact, limited physical contact or no contact between them to facilitate different management of the individuals when needed. It should also be possible to safely lock the doors in different positions, allowing selective passage.

2.2.6 Environment

2.2.6.1 Temperatures and Humidity

The minimum temperature for allowing access to the outside exhibit should not be lower than 13 °C. If animals stay outside for longer (all day), the temperature should not be lower than 17 °C. It is recommended that the group should have free access to both indoor and outdoor areas especially in inclement weather. If free choice is not possible, then mangabeys on rainy, windy, cloudy days and low temperatures (under 13 °C) should not remain outside for a long period, or kept inside when the group is not stable or the chance of tail necrosis is serious.

During the colder season heating should provide for an average temperature inside of 19 to 21°C and humidity ranging between 50% and 70%.; being the optimal 20 °C with a humidity of 70%. Never put mangabeys out when it is minus zero degrees for a very long time, they are not made for these temperatures and it can cause them the loss of the tip of the tail.

Heating is important and to provide a good indoor temperature during autumn and winter time, but be careful in case of using air heating systems because it will dry too much the atmosphere.

2.2.6.2 Lighting

In addition to the natural light from well protected sky-lights and/or windows (think of the risks of broken glass falling into the enclosures).

When climatic conditions allow for very limited access to the outside area, insufficient exposure to UV light may lead to vitamin D_3 deficiencies. This can be overcome by feeding vitamin supplements, but since vitamin D_3 is not transferred in the milk from mothers to nursing babies, they may still become deficient for this vitamin at a time at which they badly need it. Exposure to UV tube lights can help to solve the problem. It is best to use a very low intensity type of tube light so that it can be switched on for several hours a day without becoming harmful. Remember that the spectrum of such lights quickly changes and that the tubes should be replaced at regular intervals as indicated by the manufacturer. Also the distance between light-tubes and mangabeys is essential. While too short a distance can be harmful, too long a distance will not be effective.

All lights have better to be placed outside the animal's space or protected, to avoid that broken lights fall on the enclosure floor.

2.2.7 Capture and handling facilities

A squeeze cage is recommended because it is less stressful for the animal, easier handling for the keepers and overall creates a safer situation. The squeeze cage should be located in the path that is normally used by the animals so they are used to it. Minimum size of such a squeeze cage should be 55 x 40 x 45 centimetres (Figure 8).

Figure 8: Squeeze cage at Kumasi measuring 83 x 43 x 64 centimetres. Photo by Andrea Dempsey, WAPCA.

2.2.8 Special features

If the zoo can provide any of the following **special features,** it would be useful for research as well as improving knowledge about mangabeys in general.

- Scales for weighing mangabeys;
- Mounted video cameras for continuous monitoring;
- Observation areas for ethologists.

2.2.9 Mixed-species exhibits

There is an increased tendency to house other species together with mangabeys. It enriches the environment of both species and often provides at least one of the species with a much larger area than would be the case when housed separately. Even when housed together outside with great success, it might be difficult to combine the species' in the generally smaller inside facilities. The use of selective passages, either to parts of the enclosure or to neighbouring enclosures, could improve the chances of successfully housing several species together. When designing a new facility it seems wise to leave both options open: Housing the species separately or combined in the inside accommodation. Always make sure to contact the relevant species coordinators for the most recent experiences.

Mixed-species exhibits is a potential solution to the space issues for the Old World Monkey taxon (Kraaij and ter Maat, 2011).

2.3 Feeding

Dietary pointers:
- A balanced and varied diet must be provided.
- The diet should be split into at least three or four feeds per day, in addition to browse, etc.
- Some feeds should be scattered within the enclosure.

2.3.1 Basic Diet

Mangabeys are very adaptable primates, each with their own habitats and seasonal variations. Basing a captive diet on the animal's wild diet is preferable, since this would encompass the morphological, behavioural and physiological adaptations each animal has evolved to process. However, this is not always possible in the captive world. Especially when it comes to browse, nuts, seeds and fruit. In these guidelines we propose a variable way to feed your mangabeys a healthy and appropriate diet while being able to focus on the individual differences of each species if desired.
The first part of the diet is the staple diet, which should vary seasonally with the produce offered, but otherwise remain unchanged. The second part of the diet is the Species diet where you can include food items specific to each species. Some zoos may already do this in the form of an enrichment rota; however this should be strictly part of the diet, and treated as such.

Components of Staple Diet:

Concentrate Pellet

Concentrate pellets are necessary in captive diets to provide the animal with their vitamin and minerals necessary for their metabolic activities. There is no need to mix more than one pellet type, seeing as selectivity may render it impossible to analyse the nutrient intake and may hinder a healthy diet. A leaf-based pellet made for primates is recommended and will promote digestive health as well. Pellets should only be given in quantities necessary to provide the required vitamins and minerals. Between 30 – 60 gram depending on size of the individual (For reference, ***C. torquatus*** should receive around 40 gram per day).

Vegetables

All manner of vegetables are welcome in this diet. We recommend that you divide your vegetables into three groups: leafy greens (lettuce, kale, cabbage etc.), watery vegetables (cucumber, broccoli, pepper, peas, beans, cauliflower, aubergine, etc.) and root vegetables (carrot, sweet potato, kohlrabi, turnip etc.). All vegetables within each group should be treated as interchangeable to encourage seasonality and local produce. Vegetables (and browse) should represent the bulk of the diet.
Most mangabey species ingest fruit in the wild; where some are even described as frugivorous. It is important to know that because of the highly seasonal climate, fruit is only available for one part of the year and no species eats fruits all year long. The nutritional composition of wild African fruit is also very different from the cultivated fruits found within Europe (Oftedal and Allen, 1996; Schwitzer and Kaumanns, 2003). The soluble sugars of cultivated fruits are much higher than wild fruits. The protein and fibre amounts are also both significantly less in cultivated fruits. Sugar, protein and fibre amounts of wild fruits are closer to the values of our vegetables. For this reason, we support the best practice of removing fruits from primate diets.

Browse
Browse should be fed all year round. If your zoo has a harsh winter and cannot find adequate browse during winter, then contact the authors for information on silage. Table 9 includes a list of plants that is used as browse material for the mangabeys at Barcelona zoo. Please be careful when giving browse to mangabeys, because eating too much of any plant could become toxic.

For more information about animals and plants, contact the EAZA Zoohorticulture Group.

Components of Species Diet:

Invertebrates
A variety of invertebrates can and should be given to mangabeys on a regular basis. Crickets, locusts, mealworms, wax worms, snails, cockroaches etc. One handful per mangabey can easily be given per day.

Other animal matter such as meat and dairy are not recommended. Mangabeys have omnivorous digestive systems with some capability for hindgut fermentation (Stevens and Hume, 1995). Their kidneys are not adapted to cope with high protein levels nor are their livers for high saturated fat levels. They would eat very little vertebrate preys in the wild and only do so opportunistically. There is also no evidence that mangabeys require ANY dairy products in their adult lives. Lactose is the main sugar in airy and requires a specific enzyme called lactase for its digestion. All primates have an abundance of this enzyme in their infant life stages, but as weaning occurs, the amount of lactase in the digestive system is heavily reduced. No mammal except humans are known to ingest any dairy products in the wild. Dairy products are not a healthy source of protein or calcium for captive primates and instead contribute to health problems and obesity. Hard boiled eggs can be given on rare occasions or to ill individuals.

Grains
Cooked whole grains can be part of a healthy diet and are easily scattered. Brown rice, barley, quinoa and pulses are all excellent choices in small amounts. Commercial cereals are too high in sugar and are not recommended. Non whole grain grains and bread will cause the mangabeys to be satiated for a very short time and for this reason are also best avoided.

Seeds and Nuts
The commercial seeds and nuts that we use are very high in fats and possibly starches and/or protein. These are vastly different from the wild seeds and nuts, which are tough, hard to chew, high in fibre and protein and fats. For this reason, raw seed and nuts with scale/coating can be given in controlled amounts.

Example of diets:
Amounts presented in Table 10 for the staple diet for ***C. torquatus***, however weights will change depending on species. The proportions reported here should be roughly respected (fresh weight). The species diet, using a rota, is presented in Table 11. Table 12 and 13 present an example of zoo diets for two mangabey species.

Table 9: List of plant species used as browse at Barcelona Zoo (E. Bohigas, unpublished data).

Scientific name	English name
Acer spp.	Maple
Arundo donax	Spanish reed
Betula pendula	European birch
Buxus spp	Box
Carya illinoinensis	Pecan
Casuarina cunninghamiana	Australian pine
Catalapa bignonioides	Catalpa
Celtis spp.	European hackberry
Cercis siliquastrum	Judas tree
Chamaerops humilis	European fan palm
Citrus aurantium	Bitter orange
Cornus florida	Flowering Dogwood
Corylus avellana	Common hazel
Crataegus spp	Hawthorn
Cyperus alternifolius	Umbrella plant
Eleagnus umbellata	Japanese silverberry
Eugenia spp	Eugenia
Fagus	Beech
Ficus carica	Common fig
Fraxinus excelsior	Common ash
Hibiscus spp.	Hibiscus
Ligustrum japonicum	Privet
Ligustrum lucidum	Chinese privet
Miscanthus sinensis	Chinese silver grass
Morus alba	White mulberry
Musa spp	Banana
Nandina domestica	Nandina
Olea europaea	Olive
Pawlonia tomentosa	Foxglove tree
Penisetum purpureum	Napier grass
Philadelphus coronarius	Sweet mock orange
Phoenix dactylifera	Date palm
Photinia spp	Red fotinia
Phyllostachis aurea	Golden bamboo
Phyllostachis flexuosa	Zig-zag bamboo
Pinus palustris	Longleaf pine
Platanus x acerifolia	London plane
Populus alba	Silver poplar
Pyracantha spp	Firethorn
Quercus ilex	Holm oak
Rubus idaeus	Raspberry
Sabal spp	Palmetto
Salix alba	White willow
Sasa paniculata	Japanese Bamboo
Saccharum spp	Sugar cane
Thypha latifolia	Bulrush
Tipuana tipu	Rosewood
Ulmus spp.	Elm
Washingtonia filifera	California fan palm
Yucca elephantipes	Spanish bayonet

Table 10: Example of a staple diet, per animal, for ***C. torquatus***.

Product	Percentage	Weight
Leafeater Pellet	4 – 6%	40 gram
Leafy vegetables	40 – 50%	550 gram
Watery vegetables	25 – 30%	300 gram
Root vegetables	5 – 10%	100 gram
Browse	5 – 10%	50 gram of edible matter (leaves, flowers, etc.)

Table 11: Example of a species diet, per animal, for ***C. torquatus***.

Mon	Tue	Wed	Thu	Fri	Sat	Sun
10 gram inverts	10 gram cooked rice	10 gram inverts	10 gram cooked quinoa	10 gram almonds	10 gram cooked rice	Extra browse

Table 12: Average diet for ***L. aterrimus***, for one animal, at GaiaZOO.

Product	Weight
Primate Diet PT1	50 gram
Leafy vegetables	200 - 300 gram
Watery vegetables	100 – 250 gram
Root vegetables	250 gram
Browse	*Ad libitum*
Lucerne hay	*Ad libitum*
Boiled egg	Once a week
Walnut in shell	Twice a week
Locust	Twice a week
Crickets	Once a week

Table 13: Average diet for ***C. lunulatus***, for one animal, at Barcelona Zoo

Product	Weight
Primate pellets	35 gram
Seed mix	50 gram
Pear	150 gram
Apple	200 gram
Banana	100 gram
Orange	100 gram
Carrot	50 gram
Cucumber	50 gram
Celery	50 gram
Lettuce	100 gram
Tomato	50 gram
Sweet pepper	60 gram
Boiled potato	150 gram
Seasonal fruit or vegetable	100 gram
Lucerne hay	Twice a week
Boiled chopped meat	50 gram once a week
Boiled egg	Twice a week
Bread	Once a week

2.3.2 Water

Clean water must always be provided. Automatic faucet drinkers are strongly recommended for drinking purposes in both inside and outside enclosures. Bowls and tubs are not recommended unless they are for enrichment as they can be easily fouled or tipped over.

In their natural habitat, most mangabey species live close to the water. In the zoo, they can play with water and it can also be a place of refuge during bouts of aggression. A pool is recommended to enrich the mangabeys' enclosure (with an average depth of 0.5 metres).

In case of adding a water path to your enclosure be careful when there are youngsters in the group. Though the parents would take good care and hold their offspring by the tail if they wanted to go, to avoid risks it is recommended not to fill the water path completely.

2.3.3 Food presentation

2.3.3.1 Quantity of diet

The total amount of food given to a mangabey group should be determined based on energy content and depending on the size of the social group. An individual mangabey must ingest enough food to ensure its basic metabolic needs have been reached (BMR), as well as fuelling environmental factors such as movement, behaviours, thermoregulation etc. (FMR). Because captivity is associated with low exercise levels, the difference between BMR and FMR will be relatively low (about 1.5 times). Using the equation provided by Hayssen and Lacy (1985), an average 6.5kg female and 10g male require 350 Kcal/day and 490 Kcal/day respectively.

The following equation is appropriate for all mangabeys:

$0.31(\text{body weight in grams})^{0.755}$=BMR X 1.5 = FMR

Depending on the group composition you may find it beneficial to provide slightly more food than is needed to appease social tension. If your dominant individuals are looking a bit round, it may be time to look for alternative solutions! Often the removal of fruit removes a big part of food-based aggression.

All animal diets should be prepared in a sterile, clean environment that has not been in contact with any animal products as described in (Henry et al., 2010). All utensils used in food preparation should also be clean and gloves should be worn at all times to prevent spread of pathogens. Food is more often than not the determinant of patterns for primate activity (Carlstead, 1996). It is believed to be in the animal's best interest for mental and physical welfare to be fed many times during the day (Henry et al., 2010). Providing many feeds a day will help to increase their foraging time in captivity and reduce abnormal behaviour patterns (Henry et al., 2010). There is also a link shown in humans and lab animals between multiple smaller meals and better control of appetite (Speechly and Buffenstein, 1999). One study also resulted in improved levels of serum cholesterol (Edelstein et al., 1992). This evidence points to splitting the daily feed of macaques into multiple smaller feeds. Three is a good number to aim for, although if your institution can give more feeds than three, then this is preferable.

A study was done at Paignton Zoo Environmental Park on food presentation with Sulawesi crested macaque (*Macaca nigra*) where their daily diets were either cut in pieces or left whole, and scattered or placed in piles. This is a common thought in the ideology that the more pieces there; the easier it will be for all members of the troop to eat enough. This is carried out in most zoos because it is how they have always done it, although there is no evidence to support this ideology. Plowman et al. (2009) showed us that diets actually should NOT be chopped. Results indicated that subordinate members of the troop ingested a larger quantity and diversity of food when food was left whole and not cut up (Plowman et al., 2009). It was mentioned that monkeys are prone to picking up coveted food items first, taking a few bites out of it and then dropping it before grabbing something else, allowing other troop members to then pick it up themselves (Plowman et al., 2009). As well as increasing the welfare of subordinate individuals, leaving food items un-chopped will also save keeper time. It will take much less time to prepare diets, as well as take less time to clean up afterwards. The nutritional content of a fruit or vegetable begin declining immediately after being cut therefore, offering un-chopped food items will also ensure a higher nutritional fidelity.

2.3.3.2 Nutrient recommendations

Estimated nutrient requirements for nonhuman primates developed by the NRC (2003) is the most used guide when creating diets (Table 14).

Table 14: Estimated nutrient requirements for nonhuman primates for mature and growth life stages. Values are per kilogram dry matter. (NRC, 2003).

Nutrient	Mature	Growth
Crude protein	8%	-
n-3 fatty acids	0.5%	0.5%
n-6 fatty acids	2%	2%
NDF	10%	10%
ADF	5%	5%
Calcium	0.55%	-
Phosphorus	0.33%	-
Magnesium	0.04%	-
Iron	-	100 mg/kg
Copper	15 mg/kg	15 mg/kg
Manganese	44 mg/kg	44 mg/kg
Zinc	13 mg/kg	20 mg/kg
Selenium	0.11 mg/kg	0.11 mg/kg
Vitamin A	5000 IU/kg	5000 IU/kg
Vitamin D3	1000 IU/kg	1000 IU/kg
Vitamin E	68 mg/kg	68 mg/kg
Vitamin K	>0.06 mg/kg	>0.06 mg/kg
Thiamin (B1)	1.1 mg/kg	1.1 mg/kg
Riboflavin (B2)	1.7 mg/kg	1.7 mg/kg
Pantothenic acid	20 mg/kg	20 mg/kg
Niacin (B3)	16 mg/kg	16 mg/kg
Pyridoxine (B6)	4.4 mg/kg	4.4 mg/kg
Biotin	0.11 mg/kg	0.11 mg/kg
Folacin	1.5 mg/kg	1.5 mg/kg
Vitamin B12	0.011 mg/kg	0.011 mg/kg
Vitamin C	110 mg/kg	110 mg/kg

2.3.4 Life stage Considerations

2.3.4.1 Gestating

Pregnant females will require larger quantities of food than non-pregnant females. This will provide her with more nutrients and energy. The actual ratio of ingredients does not need to change as long as the diet is adequate. Special attention should be paid to the calcium to phosphorous ratio of the diet. If it is below 1.2:1 then calcium supplements should be added into the diet.

During the first trimester, the diet should remain identical before gestation. During the second until birth, the total energy of the diet should be increased by 14-16% (Kemnitz et al., 1984). Gestating female primates have been shown to have a more efficient digestion process than non-gestating females (Kemnitz et al., 1984). Although it is normal for their appetites to increase during their first trimester, they will actually be metabolizing more energy and nutrients than they normally would, rendering giving extra quantities of food not necessary (Kemnitz, et al., 1984).

2.3.4.2 Lactating

Lactation is the most energetically expensive state for mammals. Energy amounts are estimated to be 23% more than non-gestating females (Ullrey et al., 2003). The actual diet ratio can be kept constant and the total quantity increased. There can also be a slight increase in the proportion of concentrate feeds fed such as the pellets (Ullrey et al., 2003). Keeping the 14-16% increase of the gestating diet and increasing the concentrate feed by 1.5 will be adequate in most cases.

2.3.4.3 Juveniles

In many zoos, young animals that have been weaned are treated as adults and an extra adult diet is provided for them. Infant old world monkeys have been estimated to require 200-300 kcal of GE/BW_{kg}/day where GE = Gross Energy BW=Body weight in kilograms (Nicolosi and Hunt, 1979). Minimum nutrient recommendations for growing animals are specified in section 2.3.3.2**.**

2.4 Social Structure

2.4.1 Optimal Social Structure

The optimal social groupings are multi-male, multi-female groups, because in the wild both sexes actively choose their mates. However, because of the limited space available in zoos there is a higher incidence of male aggressive behaviour. Therefore, forming groups of several males is not recommended if the males have not grown together. Juvenile animals are usually accepted by both sexes. If you feel your enclosure would be good enough to try a multi-male group, please contact the studbook keeper.

It is recommended to keep one male with two or three females which have grown up together and their offspring and, if this is not possible, then to establish a pair of mangabeys, but keep in mind that this is certainly not the best way to keeping them.

It is important to observe the individual behaviour of each animal within the group because hierarchy may move and with good observation, management can be done before some strong aggression happens.

2.4.2 Age of Dispersal / Removal of Young from Groups

Offspring should remain in their group at least until after the birth of the following sibling, to have the chance to observe parental behaviour.

Removal of young females from the natal group should be done when they are three to four years old. At this age they are reaching sexual maturity, although some mating could be observed within young males, and usually there is no pregnancy until one year later.

In theory, males can be kept in the natal group until the age of about six years as long as the father continues to be dominant and no significant aggression occurs between the males.

2.4.3 Introductions

The introduction of a new individual in an established group must be carefully evaluated and planned before being carried out. It should be borne in mind that the males are usually dominant in general over females, who also have their own hierarchy.

When doing introductions of a new individual, it is important to have a great space with flexibility and complexity that allows the animals to be distant from one another, and even out of their visual reach; it will also facilitate that keepers can interrupt the association if aggressions are observed. Before doing a physical introduction, a visual contact is desirable to observe the interactions between individuals.

Although it seems that alliances and kin preferential behavioural interactions are not obvious in mangabey genera (at least in ***C. atys*** (Gust and Gordon, 1993)), they may be important in the maintenance of rank stability – and thus group stability. Therefore, it is recommended that individuals of the opposite sex be introduced to a same sex sibling group. For example, one male (or a few mutually reared males) from one lineage with a group of females from another matrilineage. In that case young animals should be removed at the age of three or four years (at breeding age) to avoid problems when introduced to their new group.

There is not much information about the formation or management of multi-male and multi-female groups. The moderate aggression observed in ***C. atys*** (Gust and Gordon; 1993) and in ***C. lunulatus*** is probably the reason that a non-kin based social system exists in this group. However, serious aggression can occur in mangabey groups, especially in ***C. chrysogaster***. In captive groups of ***C. atys*** serious wounding has been observed primarily due to a rank challenge for the alpha male position, infant being attacked by new alpha male and rank challenges in newly formed groups. Biting of each other's tail tips between sisters is seen in ***L. aterrimus*** (Tjerk ter Meulen, personal observations).

Another issue with mangabey introductions is the position of the keeper during the introduction. That is because often these monkeys have different hierarchies in one group and the keeper could also have a hierarchical position within them. In this case the role of the keeper can be regarded as if this keeper gives support to one of the individuals or groups. This action can cause them stress and damage during the introduction. It is important to observe this situation as objectively as possible because it is hard to notice when you are the mangabey keeper in charge. (ter Meulen, 2008).

Infanticide: It is not recommended to introduce a new breeding male when there are infants in the group. To wait until the young reaches two or three years of age is advisable.

2.4.4 Keeping All-male Groups

Experience so far shows that it is quite difficult to establish long-term bachelor groups If your zoo is facing a problem of excess males in the population, the coordinator may recommend it in that case.

To establish a bachelor group, related males that have grown up together and not been separated since they were born is recommended, young males between the ages of three and five years old are easier to be managed. The presence of females in the neighbourhood should be avoided. Males in bachelor groups could be a potential source of breeding males in the future.

Bachelor groups use to destabilize when animals grow, so this group can be formed as a temporary solution, or as a place for transit while waiting to go to another place as breeding males. In some cases deslorelin acetate (Supralorin® implants; see Chapter 2.5.7.2) can be used for aggression control. This has been effective for other primates in bachelor groups.

2.5 Breeding

2.5.1 Perineal Swelling and Mating

Oestrous cycles range between 30-33 days. Signs of menstruation vary between females, for blood visible and the number of days in duration (usually 2-4 days). Peak swelling (maximum), corresponds when ovulation occurs at approximately 15 days. Keeping track of menses and the amount of perineal swelling on a daily basis cannot only help pinpoint conception but also give an idea of reproductive health.

Females in oestrus stay closer to males. If there are some aggressive interactions between females in the same group, these will probably increase during oestrus. Usually dominant females, if not in a very good relation with other female in the group, attack them when cycling. Therefore if any seasonal incompatibility in the female hierarchy were seen the recommendation would be:

- To separate the higher-ranking female for a while when the lower ranking female is in oestrus to allow her to stay with the male. Do not keep them separated for too long, otherwise it will be difficult to put them back together and some fights will arise.

2.5.2 Pregnancy and Birth

Breeding is not seasonal, births can occur around all the year with a gestation period about 5.5 to 6 months (c.a. 167 days).

During the end of the first trimester (1.5 - 2 months of pregnancy), the females of semi-terrestrial species of mangabeys (*Cercocebus* group) exhibit a **peak perineal swelling** that resembles a normal ovulatory swelling. *Lophocebus* have a small swelling during pregnancy (Tjerk ter Meulen, personal observation).

Sex ratio at birth is approximately 1:1. Birth weight statistics shows a weight of about 400 gram for a newborn mangabey. The natal pelage is similar to adults with a brighter face. After one week, the infant begins to leave mother's body being the age of weaning at 1 year.

- **The period of time between parturition and the resumption of cycling** is, on average, 8.8 months. If the infant survives less than one year, the interval will be shorter.

- **Intervals between births** (if the infant survived over passing the 30 days and was mother-reared) ranges from 8 to 25 months (an average 16.9 months). If the infant died soon after birth or was hand-reared, the interval between births ranged from 5 to 12 months (an average of 8.7 months).

2.5.3 Neonatal Deaths (A. Payne)

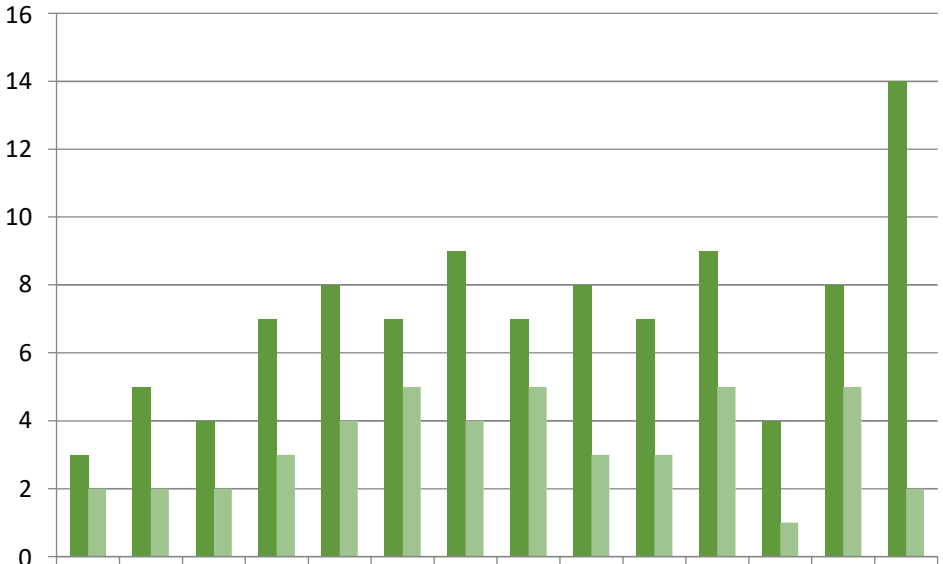
In some species of mangabeys a high mortality in captivity was detected during the last decade. A research was done to try to elucidate the possible causes, see table 15 and 16 for a summarized overview of the statistics. Figures 9 until 12 display the annual number of births and neonatal deaths in the EAZA mangabey populations, and Figure 13 provides the summarized overview.

Table 15: Neonatal deaths including percentage to the total number of births for the different mangabey species populations within EAZA collections during the period 1998 – 2011.

Species	Births (#)	Neonatal deaths (#)	Percentage (%)	Mortality occurs
C. chrysogaster	26	6	23%	Same day
L. a. albigena	88	38	43%	First month
L. aterrimus	60	24	40%	Same day
C. lunulatus	87	47	54%	Same day
C. torquatus	87	16	18%	Same day

Table 16: Percentages of causes of neonatal deaths for four mangabey species within EAZA collections.

Cause of death	*C. chrysogaster*	*L. aterrimus*	*C. lunulatus*	*C. torquatus*
Environmental / Behavioural	-	25%	9%	6%
Euthanasia (medical)	-	4%	9%	-
Infection associated	-	-	2%	-
Injury from exhibit mate	3%	-	6%	-
Premature birth	3%	-	6%	6%
Stillbirth	16%	29%	34%	50%
Unknown	78%	42%	34%	38%

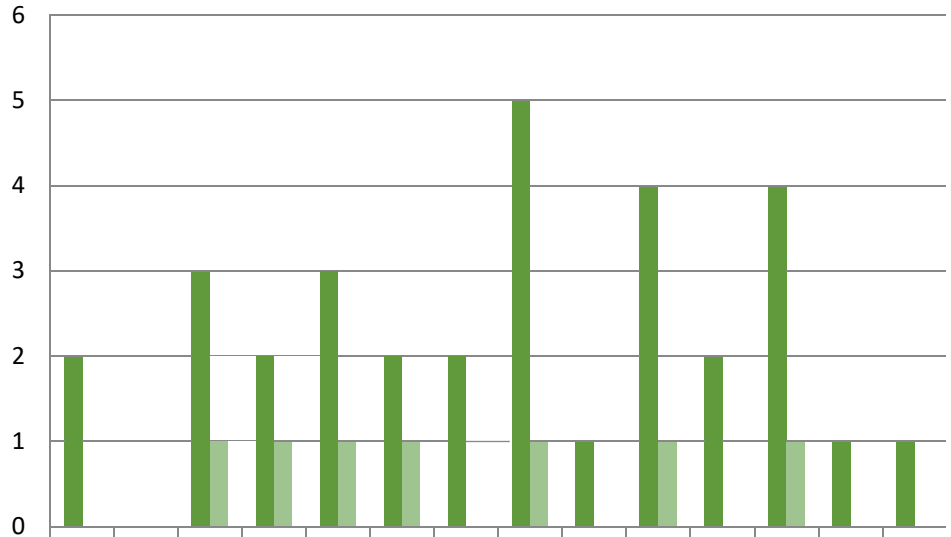


	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Births	3	5	4	7	8	7	9	7	8	7	9	4	8	14
Neonatal deaths	2	2	2	3	4	5	4	5	3	3	5	1	5	2

Figure 9: The annual number of total births and neonatal deaths for the ***C. lunulatus*** EAZA population from 1998 until 2011.

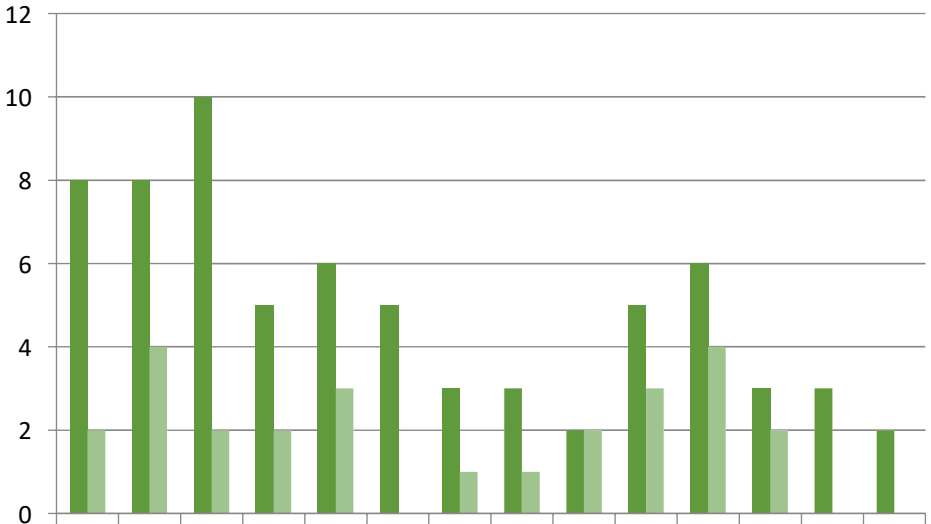
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Births	4	4	8	5	6	5	11	10	10	7	7	6	7	8
Neonatal Deaths	0	0	3	1	1	1	2	2	3	1	0	0	1	0

Figure 10: The annual number of total births and neonatal deaths for the ***C. torquatus*** EAZA population from 1998 until 2011.



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Births	2		3	2	3	2	2	5	1	4	2	4	1	1
Neonatal deaths			1	1	1	1		1		1		1		

Figure 11: The annual number of total births and neonatal deaths for the ***C. chrysogaster*** EAZA population from 1998 until 2011.



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Births	8	8	10	5	6	5	3	3	2	5	6	3	3	2
Neonatal Deaths	2	4	2	2	3		1	1	2	3	4	2		

Figure 12: The annual number of total births and neonatal deaths for the ***L. aterrimus*** EAZA population from 1998 until 2011.

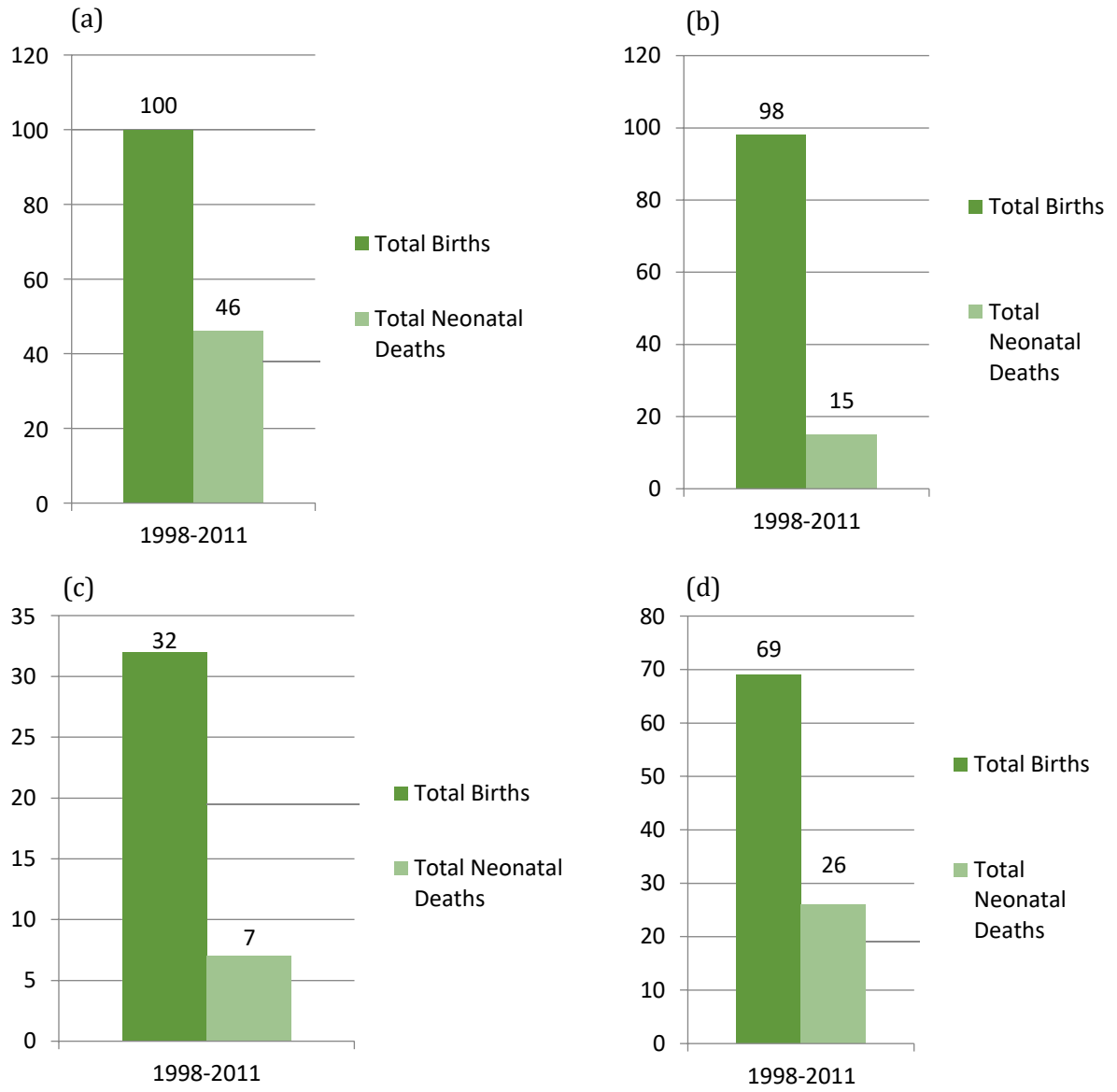


Figure 13: The sum of the number of total births and neonatal deaths for (a) ***C. lunulatus***, (b) ***C. torquatus***, (c) ***C. chrysogaster*** and (d) ***L. aterrimus*** during the period 1998 until 2011.

Observations:

- **Agile mangabey** (*Cercocebus agilis*)
  The number of births in captivity up to 1998 were 8 and infant mortality as in the first six months was 37% (the sample is too small and the percentage not significant).

- **Golden-bellied mangabey** (*Cercocebus chrysogaster*)
  The number of births in captivity up to 1998 was 44 and infant mortality in the first six months was 20%.

- **Grey-cheeked mangabey** (*Lophocebus albigena albigena*)
  The number of births in captivity up to 1998 was 88 and infant mortality in the first six months was 43%.

- **Black mangabey** (*Lophocebus aterrimus*)
  The number of births in captivity up to 1998 was 88 and infant mortality in the first six months was 24%

- **Sooty mangabey** (*Cercocebus atys*)
  The number of births in captivity up to 1998 was 55 and infant mortality was 14.5%. All cases of infant mortality occured after the birth or a few days later.

- **White-naped mangabey** (*Cercocebus lunulatus*)
  The number of births in captivity up to 1998 was 51 and infant mortality was 37.2%. Most deaths occurred within the first two months of life.

- **Cherry-crowned mangabey** (*Cercocebus torquatus*)
  The number of captive births up to 1998 was 110 and infant mortality was 24.5%. Most deaths occurred in the first 4 months of life.

2.5.4 Maternal Behaviour

When there is a pregnancy, knowing the rearing background of the female is essential. Experienced mothers should deliver without problems and take good care of the offspring. Primiparous mothers can show some difficulties at the time of caring for the first offspring, so monitoring their behaviour closely on the first days after birth is highly recommended.

When the primiparous mother is hand-reared or it is known that she has not had the chance to live in breeding groups while other females have bred, some difficulties in nursing and caring for the baby can be expected.

If in a primiparous mother some sign of stress is observed she could be separated with the breeding male and the new born from the group to increase their privacy. If the breeding male also stresses her and there is pressure by other mangabeys in the group due to excess of interaction, she could be temporally separated to be alone with her infant allowing her to cope with the new situation. This process would only last a few days before reintroducing them back into the group.

It is obviously recommended to leave the infant with the mother as much as possible if no aggressive behaviour is shown towards the infant or if the mother does not abandon the

infant. Keeping the infant with the mother inside the group is very important for the individual to reach the adulthood having adequate and competent behaviors and become a good breeder itself.

We should not forget that, in mangabeys, the role of the father is also important, not only as a guard but also as a "teacher" and a "nanny". When a youngster is about half a year old it's not strange for him to spend a lot of time with the father.

2.5.5 Development and Care of Young

- **Physical development:** Mangabey infants cling to the mother and nurse in the first week of life. After approximately a week, the infant begins to take its first steps away from the mother. At the age of one month, the infant spends increasing time walking, climbing and interacting with cage mates (Field, 1995).

- **Age of weaning**. At approximately 2 months, infants are eating a small amount of solid food. Weaning does not occur until 6-8 months of age and youngsters of about 1 year are still observed to nurse on occasion. It is common that, once the nursing is over, the young start to go with other group individuals. The infant separates more frequently from the mother and starts to interact with the others developing social and game skills that are really important in its growing.

Sometimes a female can snatch another one's offspring. In case of observing that this kidnapping is not momentary and the situation keeps prolonged, actions need to be taken in order to return the young to her mother and keep the nursing. It should be noted if this action is repeated and if there is a female that insists on this, she must be separated from the group for a while.

However, it is important to keep the young in their familiar group until they reach sexual maturity so they can learn the species-specific behaviours and have an adequate social role, for example, observing and living with the breeding male.

2.5.6 Hand-Rearing

If the infant is observed to be too weak, with risk of dying, **please contact the coordinator to discuss whether hand-rearing is a recommended option for the animal.** In any case, please remember that hand-rearing is always the last option as hand-reared animals use to present low social skills. In the case of an individual being hand-reared, an early introduction in a social group at the age of 2 or 3 months would be recommended.

It is recommended to observe the mother with her newborn infant during the first week. Sometimes it is necessary to separate the mother and infant from the rest of the group for some days or weeks at the beginning to avoid stress from frequent interactions of other individuals in the group.

Despite there is some experience with hand rearing, it is always better to avoid it. Sometimes primiparous mothers can fail in the rearing process but they learn from the following births.

In case of hand-rearing, a protocol for early introduction has been established and successfully applied (Abelló et al., 2007).

2.5.7 Reproduction control (Y. Feltrer)

There might be circumstances when the use of contraception would be indicated such as certain medical condition where reproduction is contraindicated or to prevent inbreeding. Ensure that you discuss with the relevant programme manager (ESB/EEP) before placing a programme animal on contraception.

Methods of reproduction control or contraception

The optimal reproduction control method would be one that:

- **Is effective -** The method must prevent breeding.
- **Is reversible -** It is important to have the option to let contracepted animals breed again. Reversible contraceptives also allow the lengthening of generation time and/or inter-birth interval by getting the animals to start breeding later in life and/or build in breaks between pregnancies at certain stages of life.
- **Is safe and has no physiological/medical side effects** (so that physical welfare of the animals is not compromised)
- **Has no behavioural side effects and allows as many natural behaviours as possible to be exhibited -** In order to have a population of not just genetically and demographically, but also behaviourally healthy mangabeys, it is desirable for as many individuals as possible to be allowed/able to perform as many aspects of their natural behavioural repertoire as possible.
- **Is easy to use in view of daily animal management and animal welfare -** The less invasive the method and the shorter the anaesthesia, the less traumatic the experience for the animal and the easier the management for the keepers, veterinary staff and curators. The contraception method should also not be too expensive so that it is accessible to all institutions "rich" and "poor".

How to Choose the Appropriate Contraceptive/Population Control Method

A variety of factors such as efficacy and safety of available methods, the animal's age, behavioural and social factors, the practicality of different delivery systems, and the individual's reproductive status must be considered when selecting an appropriate population control method. It is unlikely that the same method of contraception will be the most appropriate choice during all stages of an animal's life.

Current options for population control:

2.5.7.1 Surgical contraception

Because these methods are irreversible, they should only be applied after recommendation from the coordinator and studbook keeper or following veterinary advice.

- *Vasectomy/tubal ligation/hysterectomy*

- Sexual hormone levels and cycles remain intact and sexual behavior is therefore not affected.
- Simple surgical technique.
- Although some vasectomies can be reversed, it should be considered non-reversible.
- For permanent contraception/sterilization, unless contraindicated for medical reasons, vasectomy/tubal ligation/hysterectomy are to be recommended above the long-term use of any of the other contraceptive methods because there is less chance for negative side effects.

- *Castration & ovariectomy/ovariohystorectomy*

- The sexual hormone levels and cycles are affected and therefore sexual behaviour will likely be affected.
- Simple surgical technique.
- It is non-reversible.
- Sometimes indicated for medical and animal welfare reasons such as reproductive tract tumours, endometrititis and pyometras, repeated c-sections, diabetes mellitus, severe spondylosis, etc.
- Castration and ovariectomy should be avoided because the effects it might have on the social and sexual behaviour of the animals.

Reporting requirements: In order to increase our knowledge of the efficacy of contraception methods in the mangabeys it is recommended that all individuals on contraception be reported to EAZA Group on Zoo Animal Contraception EGZAC (www.egzac.org). EGZAC works in association with the American Association of Zoos and Aquariums Wildlife Contraception Center (AZA WCC).

2.5.7.2 Chemical Contraception

- **Types of Chemical Contraception:**
  Progestagen-containing hormonal contraception:
  Melengesterol acetate (MGA) implants
  Medroxyprogesterone acetate (MPA) injections (e.g. Depo-Provera®)
  Norplant (levonorgestrel) implants
  Implanon/Nexplanon (etonogestrel) implants

  Gonadotrophin Releasing Hormone (GnRH) agonist:
  Suprelorin® (deslorelin acetate) implants

- **Placement of Implants**
  For some contraceptive implants the recommendation is to place them between the shoulder blades; however, as an alternative strategy the implants could be placed subcutaneously in the inner part of the arm. Placing implants subcutaneously in the inner arm may decrease migration and facilitate future removal for (1) reversal to breeding or (2) replacement with a new implant. Removing the contraceptive implant will likely hasten reversal and prevent cumulative dosing with multiple implants in place.

- **Progestagen-containing hormonal contraception:**

- *Product Information:* Parenteral progesterone analogues (such as Norplant, Depo-Provera®, Implanon/Nexplanon) share the same contraceptive mechanism of interference with fertilization by thickening cervical mucus, interrupting gamete transport, and disruption of implantation. It is important to note that ovulation and cycling can occur but is unlikely and the degree of suppression is dose dependent.

  Although these products are good contraceptives, and do not require daily medication events, a short anaesthetic procedure is required to place some of these products (except the Depo-Provera® injection). Anaesthesia can be short and the female can be reintroduced to the family group in less than 2-3 hours. The risk of losing the implant can be avoided by correct surgical technique. In some circumstances a crush-cage could be used to place the implants in conscious animals, however, with this method it is more difficult to place the implants SC in an area where the implant can be located later for removal and/or replacement.

- *Dose:* product dependant (see below)

- *Latency to effectiveness:* For the implants, although there is individual variation, threshold concentrations of the hormone should be reached in the blood within 1 to 3 days following intramuscular (IM) insertion and within 1 week following subcutaneous (SC) insertion. However, it the cycle stage is not known then extra time must be allowed; therefore, separation or alternative contraception should be used for at least 1 week (if IM) or 2 weeks (if SC) following insertion. IM injection is roughly equivalent to implant IM insertion and therefore follows similar recommendations (AZA WCC)

- *Oestrous cycles during contraceptive treatment:* Follicular growth may continue and therefore be accompanied by oestrogen production sufficient enough to cause oestrus. Ovulation may also occur even though pregnancy does not ensue.

- *Duration and efficacy and reversibility:* Parenteral progestagens are designed to be reversible. However, in the case of implants, in order to ensure reversibility the implants must be removed

  In a few cases in other primate species implant failure (i.e. unplanned pregnancies) has been reported – although this may have had more to do with under dosing as commercially available human implants are often cut down in size which may result in insufficient dosing, or implanting females in the very early stages of pregnancy.

- *Use during pregnancy:* the use of parenteral progestagens during pregnancy in non-human primates has no apparent effect on the pregnancy, foetal development and parturition.

- *Use during lactation:* Progestagens are sometimes prescribed for lactating females and are considered generally safe for nursing infants (AZA WCC and WHO).

- *Use in pre-puberals or juveniles:* The long-term effects in fertility have not been evaluated therefore its use in pre-puberal animals should be carefully evaluated.

- *Effects on behaviour:* Because progestagens can suppress ovulation it can be expected that courtship and mating behaviour will be affected in some way.

  In some cases progestagens (mostly medroxyprogesterone acetate) have been linked with mood changes in nonhuman primates females in different individual ways and some females have been reported as more aggressive or "cranky".

  Reporting requirements: In order to increase our knowledge of the efficacy of contraception methods in the Mangabeys it is recommended that all individuals on contraception be reported to EAZA Group on Zoo Animal Contraception EGZAC (www.egzac.org). EGZAC works in association with the American Association of Zoos and Aquariums Wildlife Contraception Center (AZA WCC).

2.5.7.3 Products available

a) Progestagen-containing depot injections: Medroxyprogesterone acetate (MPA) injections (e.g. Depo-Provera®)

- It is relatively inexpensive and widely available in the EU and UK.
- MPA is a synthetic derivative of progesterone administered as an acetate salt with anti-estrogenic activity suppressing ovulation.
- It is a fairly non-invasive procedure since it is administered by injection.
- Duration of effect for Depo-Provera injections cannot be predicted and a min/max of 1 month to 38 months has been observed clearly showing a wide range for suppression times. The recommended dose and injection interval for mangabeys is 3-5mg/kg every 2-3 months.

b) Implants of levonorgestrel (Norplant®, Jadelle®, Norplant 2®):

- At the time of writing, Norplant (6 rods of 32 mg levonorgestrel) has been withdrawn from the market in several countries because of problems removing the implants in humans and hence its long term safety. However, "Jadelle" or "Norplant 2" is available in several European countries, excluding the UK, as an implant formed by 2 rods containing 75mg levonorgestrel each (Bayer Schering Pharma).
- The implant is placed as a SC injection (we recommend the inner part of the arm for easy retrieval at a later date). This procedure requires a short anaesthesia.

The two rod system is designed for women. No data is available about its use in mangabeys, however no more than one rod should be enough to achieve contraception in a female mangabey for a period of approximately 3 years (a conservative approach for replacement could be 2.5 years)

c) Implants of etonogestrel 68mg (Implanon and Nexplanon):

- This single-rod implant containing another synthetic progestin etonogestrel is available in most European countries. Each implant costs ~£150.

- It may be effective for as long as 3 years, but replacement every 2 to 2.5 years is a more cautious recommendation.

- The implant is placed as a SC injection (we recommend the inner part of the arm for easy retrieval at a later date). This procedure requires a short anaesthesia.

- The implant is designed for humans. A dose of generally half of the implant has been successfully in medium size Old World monkeys. The implant should be cut in a sterile manner and the rest of implant kept in a sterile container for future use.

- **Gonadotrophin Releasing Hormone (GnRH) agonist contraception:**

  Suprelorin® (deslorelin acetate) implants:

- *Product Information:* GnRH agonists work by temporarily suppressing the reproductive endocrine system and preventing production of pituitary (FSH and LH) and gonadal hormones (oestradiol and progesterone in females and testosterone in males). Therefore deslorelin acetate can be used in both males and females for contraception and in males has also been used to decrease testosterone related aggression. The observed effects are similar to those following ovariectomy or castration.

- *Dose:* GnRH agonists are considered safe and likely reversible contraceptives, but duration of effect is not well established for all species. Although deslorelin can also be an effective contraceptive in males, we recommend its use primarily in females, since monitoring efficacy in females by suppression of oestrous behaviour and perineal swelling is more straightforward. It can be used to ameliorate aggression in males but for that higher dosages than for female contraception are usually required.

  Deslorelin implants are available in two formulations: 4.7mg implant for a minimum duration of 6 month contraception period and a 9.4mg implant for a minimum of 12-month period of contraception. Actual duration of effect may be different for each individual and will likely induce suppression for longer than these stated formulations.

  It must be emphasized that the implants release the GnRH agonist drug at the same rate; therefore, 2 or more implants of 4.7mg will only simply increase the dose given over the same period of time (i.e. the duration of contraception does not increase but the dose of contraceptive drug does).

The implants should be placed SC in the inner arm making a tunnel, the implants cannot be cut or crushed as efficacy might be compromised. This procedure requires a short anaesthesia.

Suprelorin® (deslorelin acetate) is currently distributed in Europe by Virbac Animal Health.

- *Latency to effectiveness:* as an agonist of the GnRH deslorelin acetate first stimulates the reproductive system, which can result in oestrus and ovulation in females or temporary enhancement of testosterone and semen production in males. Down-regulation then follows the initial period of stimulation achieving the contraceptive effect. This period has duration of approximately 3-4 weeks. Due to this initial stimulation phase, it is important to either separate treated animals from opposite sex during the period of enhanced fertility and/or aggression or use another form of contraception in females (megestrol acetate tablets daily1-4 mg/kg PO SID, 7 days before and 7 days after the implant has been placed). Depo-Provera may not be substituted for megestrol acetate as it can block deslorelin down-regulation.

- *Oestrous cycles during contraceptive treatment:* Deslorelin first stimulates then suppresses oestrus in females. In males, initial stimulation may be accompanied by increased aggression or sexual interest.

- *Duration and efficacy and reversibility:* Duration of efficacy or reversibility is not well established for all species. However the duration of effect can in some cases be much longer than the 6 or 12 months minimum duration (2.5-3 years for a 4.7 mg implant not removed in a female white nape mangabey, EGZAC database 2012) and the use of deslorelin acetate in genetically valuable animals should be discouraged or carefully considered.

  This biocompatible implant was not created for removal and will slowly deplete over time (pers. comm., Peptech Animal Health). However, it sometimes may be desirable to remove the implant(s) to better control time to reversal. Recovery time varies by individual, though, so the first signs, e.g., oestrous behaviour or testicular recrudescence, may be delayed even after implant removal. Nevertheless, implant removal is expected to hasten reversal

- *Use during pregnancy:* GnRH agonists should not be used during pregnancy, as they may cause abortion and/or hinder lactation.

- *Use during lactation:* No known contraindications once lactation has been established.

- *Use in pre-puberals or juveniles:* Deslorelin suppression of oestrogen or testosterone may prevent epiphyseal closure of the long bones, resulting in taller individuals. The long-term effects on fertility have not been evaluated therefore its use in pre-puberal animals is not recommended.

- *Effects on behaviour:* The Zoological Society of London has used a deslorelin implant in one female and no negative social implications despite all breeding behaviour

(courtship and copulations) being absent. Some weight gain has also been observed (Y. Feltrer pers. comm.).

- *Precautions:* In general, the effects on weight would be similar to those from ovariectomy or castration (AZA WCC).

Reporting requirements: In order to increase our knowledge of the efficacy of contraception methods in the mangabeys it is recommended that all individuals on contraception be reported to EAZA Group on Zoo Animal Contraception EGZAC (www.egzac.org). EGZAC works in association with the American Association of Zoos and Aquariums Wildlife Contraception Center (AZA WCC).

2.6 Behavioural Enrichment (T. Perez)

Environmental enrichment should be incorporated into the daily husbandry of *ex situ* held primates. Enrichment can be split into several categories: environmental, structural, social, nutritional and cognitive, which may in one form or another all be applicable to mangabeys.

When designing new facilities it is important to take into account the need to apply structural enrichment, considering the installation of flexible and exchangeable structures to facilitate stimulation for the animals. Environmental enrichment can be achieved by naturalizing the facilities, and providing different spaces allowing the animal to choose between them.

The basis for a good psychological and physiological development is to keep the animals in their similar natural specific social grouping, which enriches the behavioural repertoire to be developed by the animal.

Maintaining a sufficient degree of activity in captivity can be also promoted through a varied and dispersed diet in space and time, which will favour equal opportunities between individuals keeping most of them occupied for a while.

Finally, specific programmes can be developed to assess their cognitive abilities, to solve some individual intrinsic problem, to facilitate routine husbandry or intensive management.

Incorporating enrichment programmes must be based on the manipulation of environmental key elements which will facilitate the performance of behaviours that resemble those of the species in the wild (Shepherdson, 1994). The programme must be part of the daily routine in the management of animals, trying to compensate their decrease on " travelling searching for food" due to the spatial limitation with an increase in the activity that accompanies feeding.

Through enrichment we manage to increase the animal's sensory stimulation and their activity, creating environmental diversity, promoting a greater development of the specific and exploratory behaviors, diminishing anomalous behaviors. All this in turn leads to a better perception of animals by visitors and facilitates our educational and conservation message and roles.

- **Structural Enrichment**

The facility's design should provide refuge and different spaces for the animals: sun or shade, shelter from cold or rain, presence of water, avoid the public, distance themselves from their conspecifics. Structures and furniture could also be changed periodically to generate new stimulus for the animals: platforms, vertical and horizontal trunks, branches, ropes, hammocks, swaying perches, etc.

- **Food Enrichment**

Food presented in a novel and diverse way. The diet should be designed so that it includes several daily doses and with variation of some of the foods that make it up.

Part of the food is sometimes supplied in objects making difficult to access to them (depending on avialable time availability can be done by caregivers and /or volunteers).

Mangabeys are very active and destructive so various cheap methods of enrichment are recommended:

- Worms and cereals scattered in the litter, and vegetables, fruits or foliage dispersed on the roof if the latter is of wire, bring an opportunity for the use of another surface area of the enclosure.
- Hanging hessian sacks filled with straw and seeds.
- Changing branches or ropes in regular intervals.
- Provision of browse branches and an intensely varied diets highly recommended as feeding enrichment.
- Use of boxes, toys and more natural plants is also recommended (see chapter 2.3 for a list of appropriate browse).
- **Operant conditioning or training** can be a useful tool in captivity because of its potential in decreasing stress during some routine medical procedures. Usually animals are entertained through positive reinforcement training. The training sessions should be kept short to avoid exhaustion. Additionally time spent training should never exceed time spent in the group.

The best enrichment is usually the new one, but all the new elements before being incorporated to the usual husbandry must be first checked by the curator and the primate care team. If it is considered that it may entail some risk for the animal due to its consistency or design, it should be discarded. If any element of enrichment alters in a negative way or there is a risk in the animals, the session must be suspended and the element removed.

The evaluation on the enrichment can be done by the primate section itself and/or working in collaboration with students from the university, or follow-up with volunteers. Table 17 provides an overview of possible enrichment items that can be used, which can also serve as an evaluation form.

Table 17: Evaluation form for the use of enrichment with zoo-housed mangabeys.

DAY	ITEM	OBSERVATIONS
1	Boomer balls	
2	Buoys filled with pellets	
3	Branches	
4	Branches with jam spread	
5	PVC pipes filled with straw and seeds	
6	Burlap sacks	
7	Fixed jerrycan filled with straw and nuts	
8	Wood brushes	
9	Clothes rolls with some seeds or raisin	
10	Branches	
11	Sacks fulfilled with almonds and straw	
12	Coconuts/pine cones	
13	Boomer balls	
14	Buoys filled with pellets	
15	Trunk fulfilled with mustard	
16	Metalic termite mount	
17	Branches	
18	Hunging buoys	
19	Burlap sacks fulfilled with straw and nuts	
20	Branches with nocilla spread	
21	PVC pipes fulfilled with pellets	
22	Old clothes	
23	Fixed jerrycan filled with straw and nuts	
24	Boomer balls	
25	Branches	
26	Fixed buoys with mix of seeds	
27	sacks	
28	Trunk fulfilled with Ketchup	
29	Metalic termit mount	
30	Old clothes	

2.7 Handling

2.7.1 Individual Identification and Sexing

- **Transponders** are recommended as individual identification methods, even in case they are recognisable by face.

- **Sexing an infant** is not easy, bearing in mind that the clitoris can be somewhat pendulous and pronounced and can resemble a penis. To assist in sexing an infant it is good to remember that the distance between anus and vagina/clitoris is longer than between the rectum and penis.

2.7.2 Transportation

It is mandatory to follow the **IATA** guidelines for air transport, that means:

- Crates must give enough space to the animal for moving, turning and adopting a comfortable position during the transport.

- If the transfer is too long some fresh fruit must be added to the exterior of the crate and to be provided when necessary. Fresh water should be possible to be supplied at all times that required.

- When sending a female with young, it will be better to crate them together to avoid a very stressful situation.

2.7.3 Safety

Mangabeys can be very defensive and their canines are long, sharp and dangerous, so it's not recommended to go into the enclosure with adult males. Be careful in case of entering an enclosure with the animals, they are very active and can seriously harm you.

2.8 Veterinary (V. Almagro, H. Fernández, Y. Feltrer)

2.8.1 Capture and Restraint

It is recommended that keepers use masks and gloves when handling animals.

- **Netting** can be adequate with females or young animals. In some cases **netting** is recommended only in case of female with/and infants. It should be performed calmly, by very experienced keepers to minimize stress and risk to the animals and zoo staff.
- **Squeeze cages**, where available are adequate for all animals (see Chapter 2.2.7).
- **Chemical restraint may be performed via darting** or following physical immobilization. Where possible it must be performed so as to minimize undue excitement. Ideally, the subject should be gently separated from the group into a small enclosure. Premedication with an oral sedative (e.g. midazolam) facilitates darting and induction. Injectable anaesthetics such as dissociative agents (ketamine, tiletamine-zolazepam) are most commonly used. Particularly in larger animals, combination with alpha-2 agonists (xylazine, medetomidine) provides a partially reversible anaesthesia and helps shorten recovery times. Alternatively, tiletamine-zolazepam (Zoletil®, Telazol®) is a safe non-reversable combination, with fast induction but prolonged effect.

2.8.2 Preventive Medicine

An ongoing preventive medicine programme should be in place for all captive primates after they have cleared quarantine. Collections that have not carried out any screening on resident animals should apply the tests performed in quarantine before moving on to implement a preventive medicine program. The preventive medicine program should be risk-based and follow the institution's policy, specifically which for old world monkeys (OWM). A basic preventive medicine program includes:

- **Vaccination**: vaccination against tetanus and or rabies, as determined by risk-based analysis and official guidelines.
- **Endoparasites**: regular stool parasitological examinations (including floatation and larval sedimentation) should be performed on a six month or yearly basis (more often if clinical data warrant it). Antiparasitic treatments should be administered as appropriate. Blind worming is unadvisable.
- **Routine examinations**: routine medical examinations are not warranted in infant or healthy adult mangabeys. However, opportunistic (i.e. when anesthetizing for translocation or wound treatment) exams should be thorough and include complete physical examination, standard haematology and biochemistry, and diagnostic imaging (incl. ultrasound gynaecological examination). Aged or diseased animals may warrant programmed examinations.
- **Opportunistic testing** for tuberculosis, viral and bacterial pathogens is advisable.

- Establishment of a **serum bank** for retrospective investigation is highly recommended.

2.8.3 Sanitary Aspects of Animal Transfers

Animal transfers must be subjected to risk-based health screening. Under Directive 92/65, they can be exempt from pre-shipment tests and quarantine. However, it is strongly advisable to perform a basic set of tests and observe a quarantine period. Animals originating from uncontrolled or unknown conditions should be subjected to intense screening and prolonged quarantine. Further tests and conditions may be required by health authorities.

A basic set of tests for cercopithecines includes:

- General physical examination under general anaesthesia, including a careful assessment of the teeth, eyes, reproductive organs and method of identification (transponder, tattoo, etc.). Whole body X-rays are recommendable.
- Haematology and serum biochemistry profiles.
- Serum and EDTA whole blood samples should be stored at ≤20ºC for future testing if warranted.
- Tuberculosis test: there are several TB tests for primates, although not all are readily available. Standard Mantoux (intradermotuberculinization) is acceptable for screening (a compared assay should be performed). Other acceptable tests are antibody (Primate STAT-PAK®) or interferon gamma (Primagam®) assays.
- Assessment of internal and external parasite burden.
- Stool culture for enteropathogenic bacteria such as *Yersinia*, *Shigella* or *Salmonella*.
- Where pathogenic parasites or bacteria are detected, appropriate treatment should be administered and its effectiveness confirmed by further tests during the quarantine period.
- All incoming primates should be tested for SIV, STLV, and Hepatitis B and C.
- Where these tests are performed pre-shipment, the quarantine period can be shortened considerably. However, post-shipment re-testing for TB, enteric pathogenic bacteria and endoparasites is advisable.

2.8.4 Infectious Diseases

Mangabeys are susceptible to the same infectious diseases like most Old World monkeys. In some cases, these are relevant because of their zoonotic potential. All infectious diseases of mangabeys should be considered potentially zoonotic. Although assays developed for humans can be used for diagnosis in Old World monkeys, extreme caution must be exercised when interpreting results, as false negative results are a major risk; Where possible, Old World monkey-validated assays should be used.

2.8.5 Non Infectious Diseases

Mangabeys have soft skin and therefore injuries to the skin and tail traumas are frequent. Regular checks of the enclosure for sharp edges to be repaired etc and the right temperature of an indoor area at night are strongly recommended. The most common

problem is tail tip trauma due to bite wounds, but also lacerations and abrasions are usual injuries.

Common geriatric diseases warrant special attention. These include teeth problems, cardiac disease, musculoskeletal disease, neoplasm and neurologic problems. Proper diagnosis and management must be ensured to maintain welfare standards.

2.8.6 Quarantine

All primates coming from outside Europe should undergo a period of quarantine. During this period, a variety of screenings can be performed to establish the health status of the incoming animal. If the animal is wild caught, 90 days will be needed to perform all the tests (haematology, general condition, etc.).

During the quarantine period the following procedures should be performed:

- Full clinical examination under a general anaesthetic, including a careful assessment of the teeth, eyes, reproductive organs and method of identification (microchip, tattoo, etc.).
- Haematology and serum biochemistry profiles.
- Further serum samples should be stored at -20ºC to establish a serum bank.
- Assessment of internal and external parasite burden. Faecal tests will be necessary to determine whether internal gut parasites are present.
- Faeces samples should be tested for the presence of pathogenic bacteria such as *Campylobacter*, *Shigella* or *Salmonella* species carried in the gut. Some of these organisms are only shed intermittently, necessitating the examination of several samples.
- Where pathogenic parasites or bacteria are detected, appropriate treatment should be given and its effectiveness confirmed by further tests during the quarantine period.
- Depending on the origin of the animal, a test for tuberculosis is mandatory in EC. Unfortunately, very few individual TB tests are completely diagnostic and further veterinary advice should be taken for each set of circumstances.
- All incoming primates should be tested for SIV (Simian Immunodeficiency Virus), SLTV, SRV, Hepatitis B and C, and Herpes B.
- A nasopharyngeal swab should be cultured from all species to detect carriers of pathogenic bacteria such as *Streptococcus pneumonia* and *Haemophilus influenzae.*
- Vaccination as appropriate.

The tests for SIV, STLV, SRV, Hepatitis B and C and Herpes B could be carried out before an animal is transferred, thus avoiding the unnecessary stress of a transfer if tested positive.

With respect to the other tests (i.e. faecal screens and TB) – even if these are negative pre-transfer – the receiving institution is strongly advised to repeat them during quarantine as some animals may become positive during or shortly after being transferred.

Please be sure to use recommended institutes for your test analysis and please consult your studbook keeper when there are questions about what to do with specific results.

2.8.7 Necropsy protocol

A thorough post mortem examination should be carried out on all primates dying in a collection, whether or not the cause of death is "obvious". Necropsy must include gross and microscopic evaluation of all body systems, including the central nervous system. It is strongly recommended to send the necropsy results to the EEP Coordinator and the ESB Keeper. A template will be developed and added on due time to facilitate better analyses of death causes.

2.9 Recommended research

Even though primates themselves are among the most studied taxa, there is great bias within the primates, or even the group of mangabeys, when it comes to academic attention. For example, whilst ***L. albigena*** has enjoyed quite some academic interest under wild conditions, ***L. aterrimus*** has had virtually no academic interest at all. Furthermore, ***C. chrysogaster*** has seen a number of peer-reviewed publications when it comes to social management in captivity, yet we barely know anything about its conservation status in the wild. Luckily there are a number of zoos pro-actively conducting scientific research focused on mangabeys, however much more is needed in order to optimize captive management, animal welfare and conservation activities for these taxa.

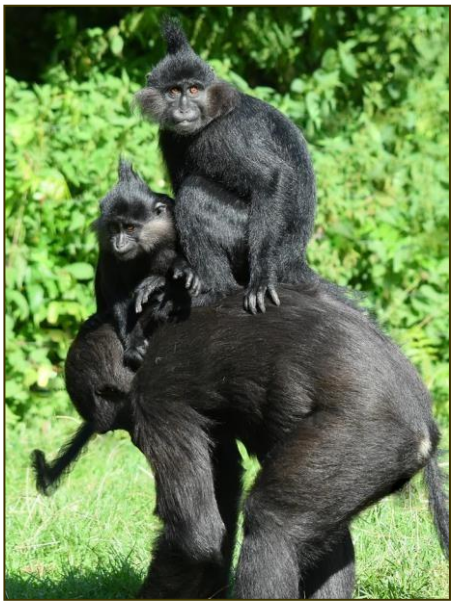
In 2017 the **WAPCA Research Group** (WRG) was formed, a collaboration of both international and West African Universities, to better improve our knowledge on both captive and wild populations of ***C. lunulatus***. Yearly surveys are conducted in primate habitat, both community and government land, to monitor wild populations, their threat levels and to evaluate conservation actions. WRG are using technology such as camera traps, audio recording equipment and Cybertracker to improve data sets. It is important for the WRG to improve capacity and ascertain population abundance as well as presence or absence. WRG are engaged with communities working around the project areas to evaluate the community perception and project success. Studies of the captive population at both Accra and Kumasi Zoo, which are part of the ***C. lunulatus*** EEP, are analyzing the conditions, both behavioral and environmental, for possible future reinforcement of the wild population or reintroduction if necessary.

Contraception

When it comes to population management, it is always of great interest to continually evaluate contraception practices. This includes surgical and hormonal contraception, and their respective effects on individual animal wellbeing, behaviour, group social compatibility, effectiveness and reversibility if applicable. Although single research projects are, of course, very welcome, we may best act by collaborating with or delivering information to EGZAC (European Group on Zoo Animal Contraception: http://www.egzac.org/).

Mixed species exhibits

As stated before, mixed species exhibits can provide great opportunities for increasing space availability for the mangabey programmes (Kraaij and ter Maat, 2011). There are a number of zoos currently keeping mangabeys together with other species, however to make the best use of this one needs to empirically evaluate the effectiveness of such an exhibit. Subsequently this information will need to be shared with the greater zoo community.



GaiaZOO is currently evaluating the combination of ***L. aterrimus*** housed with Western lowland gorilla (*Gorilla gorilla gorilla*). These two species have been housed together for 12 years now at GaiaZOO,

however no proper behavioural study has been conducted thus far. Students from the Maastricht Science Programme from Maastricht University, the Netherlands, will conduct behavioural observations focusing on the social compatibility of the ***L. aterrimus*** group, plus including social interactions with *G. g. gorilla*, to be able to state whether such a combination is actually one that is beneficial for animal welfare of both species.

Reproductive success

The European mangabey populations are currently not large enough and all programmes aim to increase in population size. The ***L. aterrimus*** ESB for example has established a plan to put the majority of the population into a breeding situation and thus maximizing reproductive output in 2014 (ter Meulen and Prins, 2014). The larger motivation behind the plan is that there is a highly skewed reproductive success within the population, and even though some animals are being put into a reproductive situation, it does not guarantee actual reproduction. Therefore, it is necessary to have a closer look at the actual factors determining whether a mangabey will or will not reproduce.

GaiaZOO is currently conducting population level analyses for ***L. aterrimus*** and ***L. albigena*** using not only factors registered in the studbook dataset but also using information provided by holding institutions on environmental variables. This study will provide the first few insights into certain factors affecting reproductive output, it provides a foundation for any future research into the reproductive biology of the species in captivity and will eventually improve population management of the respective programmes.

Behaviour

As said, the group of mangabeys is a well understudied group of primates. Behaviour in itself is little known even though it is known that there are certain behavioural characteristics to these species.

Barcelona Zoo catalogued the complete behavioural repertoire of zoo-housed *C. lunulatus*. Information like this is highly useful as it sets a proper foundation for any behavioural research done with the species. In the future the behavioural catalogue will be extended to other mangabey species after evaluating the behaviour of said species. The complete catalogue can be found in Appendix 1 (Mayo-Alesón et al., 2018).

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- *Cercocebus atys lunulatus*
  Taide Pérez, Barcelona Zoo.

- *Cercocebus chrysogaster*
  Leigh-Anne Dennison

- *Cercocebus galeritus*
  Julie Wieczkowski, ARKive

- *Cercocebus sanjei*
  G. McCabe & D. Fernández

- *Cercocebus torquatus*
  Albert Jiménez Tomàs, Barcelona Zoo
  Tim Knight, Audubon Zoo in New Orleans

- *Lophocebus albigena albigena*
  Espace Zoologique de Saint Martin La Plaine Website

- *Lophocebus albigena johnstoni*
  Alain Houle, Primate Info Net

- *Lophocebus albigena osmani*
  Illustrations by ©Stephen D. Nash / CI.

- *Lophocebus aterrimus*
  Gaiapark Kerkrade Zoo, The Netherlands, zooinstitute.com

- *Lophocebus ugandae*
  Duncan Wright, Kibale National Park

- *Rungwecebus kipunji*
  Tim Davenport, ARKive

Appendix 1: Behavioural catalogue of zoo-housed *C. lunulatus*

1. **Individual behaviour:** encompasses a series of actions that individuals do alone, namely without interactions with other individuals.

1.1. Static behaviours: postures the subjects adopt when they stop locomotor activity, regardless of the substrate on which they rest. May include movements of limbs, tail, head ortrunk.

1.1.1. Seated: the subject sits on its anogenital region. The back, normally erect, may be unsupported or resting against a surface. The limbs can be in any position.

1.1.2. Lying down: the entire length of some part of the subject's body (ventral, side or dorsal) rests on the substrate. The front limbs may be in any position and the rear limbs can be stretched out or bent at the knees.

1.1.3. Quadrupedal: the subject is standing, with at least three of its limbs on the substrate. The soles of the feet and palms of hands are in contact with the surface. The back remains parallel to the substrate.

1.1.4. Bipedal: the subject uses its rear limbs to support all of its weight, adopting a biped or semi-biped posture, with the soles of its feet on the substrate. Its front limbs may be loose or resting on a vertical surface.

1.1.5. Hanging: the subject's body is suspended in the air, holding onto an elevated structure with one or two hands.

1.1.6. Resting posture: the subject—lying down or sitting—remains immobile, relaxed and with its eyes closed. If it falls asleep, the individual's body may have spasmodic movements caused by dreams.

1.2. Locomotion behaviours: ways the subjects move depending on the speed at which they are travelling and the surface, horizontal or vertical, they are on. Movement may be forward or backward.

1.2.1. Walking: the subject moves taking steps at a slow speed in quadrupedal, bipedal (generally with support) or tripedal posture, on a horizontal surface.

1.2.2. Running: the subject moves taking steps at a fast speed in quadrupedal or tripedal posture, on a horizontal surface.

1.2.3. Jumping: the subject propels itself by bending its rear limbs and rises into the air in the direction of the site it wants to reach. During the jump, its front limbs may be facing toward the target. Movement can be horizontal or vertical.

1.2.4. Climbing: the subject moves by alternating hands and feet on a vertical surface (a slope, a tree trunk, a metal structure…) or, if the facility permits, the ceiling. Movement may be up or down.

1.2.5. Dropping: the subject grabs onto a horizontal surface with one or both hands and hangs from it a few instants before letting itself drop and putting its rear limbs on the target surface.

1.2.6. Sliding: the subject lets itself slip over a vertical or inclined surface, while circling the support structure with its front limbs.

1.2.7. Resituating oneself: when seated, the subject turns around or moves a few centimetres on its rear quarters.

1.3. Trophic behaviours: actions the subjects do that are related to solid foods and/or liquids.

- **1.3.1. Forage:** the subject explores and/or feels around the environment foraging for possible foods. It may be still or move slowly, while doing other actions like visually inspecting the substrate or surroundings, separating objects and items from the substrate or scratching and rubbing a surface.
- **1.3.2. Food obtaining:** the subject finds food and grabs it with its hands or mouth without ingesting it.
- **1.3.3. Fishing:** the subject uses one of its front limbs to grab the desired food from water, while holding onto something for support with the other hand.
- **1.3.4. Food hoarding:** after obtaining food, the subject stores it in its cheek pouches for later ingestion, puffing out its face from the cheeks to neck.
- **1.3.5. Emptying pouches:** the subject recovers the food stored in its pouches, often pressing on them with its fingers.
- **1.3.6. Transporting food:** after obtaining food, the subject moves to another location holding the trophic item with one or two hands or in the mouth.
- **1.3.7. Inspecting food:** the subject examines the food's aroma (smells it) or taste (sucks it).
- **1.3.8. Preparing food:** the subject manipulates a food before eating it with its hands or teeth. This includes actions such as peeling, cleaning…
- **1.3.9. Eating:** the subject, making use of its hands and mouth, puts solid foods into its mouth, chews and swallows them. Includes actions like shredding or crumbling the item into smaller pieces, provided that they are them inserted into the mouth immediately after this.
- **1.3.10. Drinking:** the subject ingests water it obtains directly with its mouth.

1.4. Excretion behaviours: actions through which subjects eliminate solids and liquids from their bodies.

- **1.4.1. Defecating:** the subject eliminates faeces through the anus. There is no special posture for this action.
- **1.4.2. Urinating:** the subject eliminates liquids through the urethra. There is no special posture for this action.
- **1.4.3. Vomiting:** the subject expels the contents of its stomach through the mouth. This may be done in a bipedal or quadrupedal posture, and the subject leans forward to assist with evacuation. Sometimes, before vomiting the subject holds its ventral area with an arm, while the body has convulsions that are accompanied by a regurgitating sound.

1.5. Body care behaviours: actions through which subjects explore their bodies using either the limbs or mouth, or visually or by smelling. This exploration is never sexual.

- **1.5.1. Exploring:** the subject centres its attention on one part of its body and inspects it visually or by smelling it.
- **1.5.2. Grooming:** the subject focuses on one part of its body and inspects it closely, separating sections of fur using one or both hands. When only using one hand, the other hand is empty or rests on the body part that

it is grooming. If it finds anything foreign on its skin or fur, it removes it with its mouth or fingers, sometimes ingesting it. It generally remains seated.

- **1.5.3. Cleaning:** after exploring things in its environment, on its own body or having contact with food, the subject rubs its hands against an external surface (such as a tree trunk) to remove any food remains or dirt.
- **1.5.4. Cleaning teeth:** the subject removes food from between its teeth, using its tongue.
- **1.5.5. Scratching:** the subject vigorously rubs one part of its body with the nails of its hand or feet.
- **1.5.6. Rubbing:** the subject gently rubs some part of the body using the palm or back of its hand. It may also use an item in the exhibit or from the substrate to do this action.
- **1.5.7. Shaking off:** the subject shakes its body to dry off or to remove something that has fallen onto its fur.
- **1.5.8. Coughing:** the subject expels air by thoracic contractions, while its mouth remains opened.
- **1.5.9. Stretching:** the subject gets up and, in a quadrupedal position, shifts its body weight to its rear quarters while its front limbs remain extended on the substrate. This is generally done after a rest period.
- **1.5.10. Biting nails:** the subject bites its fingernails or toenails.
- **1.5.11. Biting bites:** the subject nibbles the reaction caused by an insect bite to relieve the itching or remove the scab.

1.6. Sexual behaviours: actions during which subjects handle their genitals in a state of sexual excitement.

- **1.6.1. Masturbating:** the male, sitting or bipedal, fondles its penis, grabbing it and/or rubbing it with one or both hands to get an erection and—frequently—ejaculation.
- **1.6.2. Ingest semen:** the male brings the semen to its mouth with its hands or licks it from the tip or the penis, and then ingests it.

1.7. Playing behaviours: actions that subjects, usually infants or juveniles, do without any apparent purpose. These actions are characterised by being spontaneous, exaggerated, repetitive… And by not being accompanied by signs of aggression or stress, such as piloerection or bodytension.

- **1.7.1. Locomotor:** the subject moves by running, jumping or doing acrobatics, on the ground or on the items in the exhibit, repeatedly and in an exaggerated manner.
- **1.7.2. Flips:** the subject jumps backward flipping its entire body without moving places.
- **1.7.3. Spinning top:** the subject hangs with its teeth from a vertical item (like fibre on a rope…) and spins at a fast speed.
- **1.7.4. With object:** the subject grabs and moves branches or other objects around with its hands and/or mouth.
- **1.7.5. Rubbing a rock:** the subject grabs a rock from the substrate, cleans it by rubbing it between its hands and then moves it repeatedly over smooth items in the exhibit, such as the wall or another horizontal surface. It generally remains seated.
- **1.7.6. With rain:** the subject flips and jumps… with the aim of catching and

ingesting the falling rainwater.

1.7.7. Splashing: the subject sits near the drinking trough (which is quite deep) or inside it and hits the water with its hands, making it splatter.

1.7.8. Sprinkler effect: the subject makes water go out of the trough (on the wall, which starts running when the subject presses it) and puts its fingers or one hand over the water outlet, partially blocking the flow so that it comes out forcefully and reaches a certain distance.

1.7.9. Copying: the subject repeats the behaviours of other subjects, without achieving the objective that these behaviours normally have. Example: when other individuals are eating leaves, the subject looks for leaves and holds them, but never ends up eating them, instead throwing them to the ground after a few seconds.

1.8. Exploration behaviours: actions via which subjects examine inedible objects using their hands, sight, smell and taste.

1.8.1. Inspecting: the subject watches, smells or brings inedible objects to its mouth.

1.8.2. Handling: the subject uses its hand to examine inedible objects. This includes actions like rubbing, holding, transporting, touching, breaking…

1.9. Tool-use behaviours: actions in which subjects use a loose object to achieve a goal. This also includes tool preparation behaviours.

1.9.1. Preparing a tool: the subject modifies the object that it will use to perform the behaviour of digging with a twig. To do so, it grabs a leaf with its hands and mouth and then strips the limb, leaving it bare.

1.9.2. Digging with a twig: the subject takes an item (for example, a thin branch) and moves it over its teeth to remove food remains.

1.9.3. Moving something with a tool: the subject uses an object to make another object move indirectly (for example, it inserts a stick into a net to make a hanging buoy move). This is generally done in a playful context.

1.10. Behaviours when in alert situations: actions subjects do in front of an unknown or unexpected stimulus, or that causes alarm. Monitoring is including here as the dominant subjects do this behaviour to control the group and the environment.

1.10.1. Monitoring: the subject, generally the dominant, in a central or elevated position, pays attention to its surroundings while remaining relaxed.

1.10.2. Watchfulness: the subject remains in quadrupedal or bipedal position with a tense body, watching the place from where the stimulus is coming, which may be either visual or auditory.

1.10.3. Pointing with tail: the subject, in a quadrupedal position, moves its tail forward over its back and parallel to it while staring intently at the source of the stimulus.

1.10.4. Restlessness: with its eyes on the source of the stimulus, the subject moves repetitively in the same very small area. The individual changes direction frequently, thus walking erratically.

1.10.5. Fright: due to an unexpected stimulus, the subject stops its behaviour

while its body shudders. If the stimulus is very sudden (for example, a loud noise), the subject will either take off running and hide or run and then stop after a few metres while looking toward the source of the stimulus. If the stimulus is milder (for example, the flapping of a bird's wings) the subject cringes while looking toward the source of the stimulus.When the subject calms down, it goes back to the behaviour it was doing before the stimulus occurred.

1.11. Abnormal behaviours: actions subjects do that are not however typical of their species, do not fit with the context in which they are done and may be indicative of discomfort and/or stress.

1.11.1. Sucking: the lactating female grabs one of its breasts and sucks it.

1.11.2. Arm biting: the individual, in a quadrupedal or bipedal position, and facing the source of stress, brings its arm to its mouth and bites the front of its wrist. The subject does not wound itself. This behaviour is frequently observed along with rocking.

1.11.3. Hair pulling: the subject pulls its hair until extracting it from the skin compulsively, causing bald spots on its body.

1.11.4. Hair eating: the subject, after pulling out its hair, chews it in its mouth and even ingests it.

1.11.5. Rocking: the individual, in quadrupedal position and facing the source of stress, rocks its body sideways repetitively and quickly. The head remains straight while staring at the stressful item.

1.11.6. Thumb sucking: the subject brings its thumb to its mouth and keeps it inside, sucking it.

1.11.7. Pacing: the subject, for no apparent or observable reason, walks repetitively around one part of the exhibit or the entire exhibit. The movement is done at high speed, although the subject does not end up running.

1.11.8. Neck twisting: the subject wanders around the exhibit and, when it reaches a wall, puts its front limbs on it, lifts its head up and then draws a semi-circumference in the air with its head and, with the inertia of the movement, turns its body to keep wandering in the opposite direction.

1.11.9. Leg rocking: the subject crosses its rear legs, holds one leg with the other foot and starts rocking quickly backward and forward.

1.11.10. Striking oneself with stick: the subject takes a thin branch and moves it to the anogenital area, where it starts to hit and/or rub itself gently with it. This behaviour is not done as part of a body care routine, but is instead as stereotypy in a situation ofstress.

1.11.11. Biting something: the subject gnaws or licks some item in the exhibit, frequently the wall or a tree trunk, repetitively.

1.11.12. Head shaking while holding snout: the subject grabs his snout with one hand and moves his head in all directions.

2. Social behaviour: Interaction behaviours between two or more subjects.

2.1. Trophic behaviours: actions that subjects do with the aim of feeding and that include interactive behaviours. Breast-feeding is included here as it involves providing food.

2.1.1. **Following subject with food:** the subject moves behind the route of another individual who has food.

2.1.2. **Asking:** the subject brings its mouth to that of the other individual who is eating, while looking at or smelling the other's food. Sometimes the subject also gently brings its hand to the food the other individual is holding.

2.1.3. **Sharing:** after being asked, the subject who is eating opens its mouth and lets the other individual take part of the food. Sometimes the subject who is holding the food in its hands simply lets the other subject take the food, without doing anything to prevent it, even opening its hand to let the other subject see the food.

2.1.4. **Stealing:** the subject obtains the food held by another individual by pulling on it forcefully. Then the subject runs away quickly.

2.1.5. **Tolerating:** two or more subjects, at a distance that permits physical interaction, eat or drink together without exhibiting agonistic behaviours.

2.1.6. **Breast-feeding:** the baby sucks one of its mother's breasts, holding onto her or sitting. Throughout this behaviour, the baby may change breast.

2.1.7. **Protecting food:** the subject, in possession of a trophic item, remains alert to the others' positions. If any individual starts to approach it, the subject may hide, hold it with a food or take its food to another place further away.

2.2. **Sexual behaviours:** actions done by a male and female in heat (displaying swelling of sexual skin) whose purpose is copulation. To reach this goal, the subjects catch the eye of individuals of the other sex, seek contact or inspect each other.

2.2.1. **Following female:** when the female in heat moves, the male walks behind her. After this behaviour, the female usually exposes her genitals to the male.

2.2.2. **Displaying genitals:** the female, in a quadrupedal position, turns around so her back is facing the male, raises her tail and puts her genitals at the height of the male's face. Sometimes the female, seated, looks at the male and rubs her anogenital region against the surface she is sitting on.

2.2.3. **Inspecting genitals:** the male sits behind the female and looks at, smells or touches, with his mouth or fingers, her genital region.

2.2.4. **Inspecting female's urine:** the male smells, touches or brings to his mouth the urine left by the female.

2.2.5. **Chest smelling:** the female approaches the male, who is sitting, and smells his axillary glands.

2.2.6. **Sex face:** generally a female, watching a male, puts her lips together and stretches them, adopting a facial expression similar to when someone is going to give a kiss.

2.2.7. **Tongue flicking:** generally the male, in a quadrupedal position and facing the female, half opens his mouth, sticks his tongue out partially and moves it quickly in all directions.

2.2.8. **Situating the female:** the male touches or grabs the female's waist or tail with one or both hands, to situate her in the right place before mounting her.

2.2.9. Copulating: the male mounts the female, grabbing onto her hindquarters with his hands and resting his feet on her ankles. The male's pelvis moves back and forth repeatedly.

2.3. Affiliative behaviours: actions via which subjects seek proximity, to establish ties… to maintain group cohesion. There may or may not be physical contact established between individuals.

2.3.1. Following: in response to the other individual's movement, the subject stands up and starts to move behind him.

2.3.2. Approaching: the subject moves, reducing the distance to the other individual. Prior and during movement, the subject looks at the individual it wants to approach.

2.3.3. Lip smacking: the subject, looking at the other individual and opening and closing its lips rapidly, making a face like a forced smile, shows its incisors, which remain together. This may also occur in a sexual context and during submission.

2.3.4. Being close: the subjects remain at a distance no greater than the length of their limbs, while they rest or move.

2.3.5. Being together: the subjects remain while maintaining physical contact and not doing any other social activity.

2.3.6. Resting together: the subjects rest while maintaining physical contact with each other. In general, this happens at night, except for mother and child, who can rest together at any time of day.

2.3.7. Sniffing: the subject approaches another individual and sniffs a part of its body, usually the mouth or genital region.

2.3.8. Grabbing a limb: the subject holds a part of another individual's body with one or both hands, usually the tail.

2.3.9. Requesting grooming: the subject approaches and offers a part of its body to another individual. It frequently looks toward the individual requesting grooming and/or raises its tail.

2.3.10. Allogrooming: the subject inspects one part of the other individual's body closely, separating sections of fur using one or both hands. If it only uses one hand, the other is held loose or rests on the part of the body being groomed. When it finds some foreign item on the skin (dirt, parasites or food remains), it removes it with its mouth or fingers and sometimes ingests it.

2.3.11. Sheltering: commonly in situations of social tension, the subject (usually the mother), in a quadrupedal position, approaches another individual (usually the baby) as much as possible, looking at it (the subject moves its eyebrows and ears) and vocalising at times. Then the other individual runs and grabs onto the subject's ventral area, thus finding shelter. Sometimes the subject sheltering the other raises one of its front limbs and places it behind the other individual's head, to bring it close to its body.

2.3.12. Safety position: a subject, generally a baby, sits between the other subject's legs, usually an adult, with its back facing it.

2.3.13. Hugging: a subject wraps its arms around the body of another individual, either in the ventral, dorsal or lateral areas. The subject being embraced may be in contact with the substrate or above it.

2.3.14. Baby stealing: a subject—generally not the mother—approaches the individual hugging the baby and tries to take it from it, normally by

pulling on a limb.

2.3.15 Carrying:

2.3.15.1 Ventrally: a subject moves carrying the baby, who holds onto the hair of the belly region with its hands and feet. The baby's head is normally facing toward the front limbs of the individually carrying it.

2.3.15.2 Dorsally: a subject moves carrying the baby, who holds onto the hair of the back region with its hands and feet. The baby's head is normally facing toward the front limbs of the individually carrying it.

2.4. Submission behaviours: actions done by subjects so that there is no conflict or to decrease the tension of one or more subjects and re-establish group cohesion.

2.4.1. Presentation: the subject slowly approaches another individual, turns its back in quadrupedal position, raises its tail to show the other its anogenital region and then turns its head toward the other. It frequently also lip smacks.

2.4.2. Double presentation: generally after a conflict, two subjects look at each other's genitals. In adult subjects they remain in quadrupedal position, moving one of their arms over the other's back. For infant or juvenile subjects, there are two possibilities: either the younger individual grabs onto the older subject's ventral region, who remains in quadrupedal position, or the older subject, seated, grabs onto the younger one's hip, bringing it toward it and raising its back limbs until the two bodies are parallel.

2.4.3. Yielding: in response to supplantation, the subject moves away from the site it occupied, letting the dominant subject access the resource.

2.4.4. Fleeing: faced with a threat or attack, the subject that was or is the object of agonistic behaviour walks or runs quickly away in order to get away from the aggressor.

2.5. Playing behaviours: actions the subjects do with no apparent purpose and with no characteristic signs of agonistic situations, such as piloerection or body tension. These types of actions are characterised by being spontaneous, exaggerated and repetitive.

2.5.1. Invitation: the subject jumps onto another, yanks on some part of the other individual's body (frequently the tail) or an object that this individual is holding. Then the subject asking to play may run off or remain stopped, waiting for the other's reaction. At other times, the subject simply starts to do acrobatics, to run or fall backward with its mouth open always looking at the other individual. The subject may also position itself with its mouth open in front of the subject with whom it wants to play and incite it to do so by moving its hand from side to side.

2.5.2. Locomotor: two or more subjects chase each other or run and jump in parallel, coming into contact every so often.

2.5.3. Jumping over subject: one subject jumps from side to side of the other subject, who remains in quadrupedal position. Generally they play merry-go-round after this action.

2.5.4. Merry-go-round: one subject grabs the other round the waist and starts to spin at great speeds. When they finish, the subjects may seem dizzy.

2.5.5. **Fighting:** two or more subjects wrestle, hit or bit each other.

2.5.6. **With object:** two or more subjects handle one or more objects like branches, ropes...

2.5.7. **With urine:** the subject gets below the individual who is urinating and jumps to grab what falls.

2.5.8. **Carrying play:** during a playful interaction, the subject moves carrying another individual by the belly or back.

2.5.9. **Sexual:** the subject, generally an infant or a juvenile, simulates copulating with another subject.

2.5.10. **Swing:** the subject, generally an infant or a juvenile, hangs from the tail of another individual, who remains seated in a high place, and swings from one side to another.

2.5.11. **Provocation:** similar to an invitation to play, but occurs with an infant or a juvenile doing it to an adult subject. The younger subject hits the older individual, jumps over it or pulls some part of its body. Immediately after this behaviour, the provoking subject runs away at top speed, anticipating a possible attack from the other individual.

2.6. **Avoidance behaviours:** actions subjects take to decrease contact or proximity with one or more other individuals.

2.6.1. **Pushing away:** the subject pushes another subject away gently with some part of its body, usually the hand.

2.6.2. **Moving away:** the subject, frequently dominant, moves away to increase the distance between it and another individual. This generally happens when another individual had approached the first subject seeking its company or to groom it...

2.7. **Dominance behaviours:** actions via which one subject displays or claims its status as dominant over the subordinate.

2.7.1. **Displaying:** the subject moves through the exhibit, walking among all the other subjects, staring at them. It sometimes stops and adopts a pointing with tail position.

2.7.2. **Hip holding:** the subject grabs the other individual's hip and approaches it. Then the subject may climb onto the back of the submissive subject.

2.7.3. **Mount:** the dominant subject climbs onto the back of the subordinate individual.

2.7.4. **Supplantation:** the subject, by its mere presence, takes the place of the individual, who cedes the space, leaves the resource behind or stops its activity.

2.7.5. **Ending conflict:** when faced with a situation of social tension, the dominant subject moves quickly to the site of conflict, remains still in a quadrupedal position and stares intently at the subjects involved, until its presence puts an end to the conflict. It occasionally may slap the others.

2.8. **Threat behaviours:** series of actions in which one or more subjects, before attacking, warn one or more other individuals of their state of

tension.

2.8.1. Threat pointing with tail: the subject, looking at the other individual, moves its tail forward in a quadrupedal position. This also occurs sometimes in dominance contexts.

2.8.2. Staring: the subject tenses its neck and flattens its ears against its head, staring intently at the other individual. The eyebrows raise and at times move up and down quickly. The mouth may be open or closed, but the individual does not bare its teeth.

2.8.3. Baring teeth: the subject, with a tense body, opens its mouth and bares its top and bottom teeth for an extended period of time to the other individual. It remains seated, bipedal or in a quadrupedal position.

2.8.4. Yawning: the individual tilts its head back, closes its eyes and opens its mouth as wide as it can, revealing both its top and bottom teeth. The mouth closes again quickly. The subject remains seated, bipedal or in a quadrupedal position.

2.8.5. Head shaking: the subject shakes its head from side to side, with the mouth open and baring its top and bottom teeth. The movement is so sudden and strong that the front limbs occasionally rise from the substrate.

2.8.6. Nodding: the subject moves its head up and down while looking at another individual.

2.8.7. Charging: the subject moves suddenly and quickly towards another individual. Before coming into contact, it stops.

2.8.8. Biting object: the subject, staring at another individual, opens its mouth and shows its teeth and bites an object (for example, a stick) or item in the exhibit (for example, the fence). This generally occurs between adult males.

2.9. Attack behaviours: actions in which one subject assaults another, using limbs and/or teeth. They involve physical contact. The aggressor subject may be the one attacking or the one defending itself. There are signs of tension, such as piloerection.

2.9.1. Pouncing on: the subject runs toward another individual and into it, with enough force to move it and/or cause pain.

2.9.2. Chasing: the subject runs behind another subject. During the race, the subject running behind the other may hit or grab the other one.

2.9.3. Pining down: the subject grabs another subject and makes it stay against the floor.

2.9.4. Slapping: the subject hits another subject with an open hand.

2.9.5. Pulling: the subject grabs a body part of the other individual and pulls it or grabs it forcefully.

2.9.6. Biting: the subject presses its mouth and teeth into another subject, applying a force that can cause pain and/or inflict wounds.

2.9.7. Fighting: involves continual force with hands, feet or other body part without movement.

2.9.8. Redirecting: when attacked by an aggressor, generally a dominant, the subject attacked then attacks a third individual, an object or itself.

3. Interspecific behaviour: behaviours in which subjects interact with

individuals from another species.

3.1. Watching: the subject maintains visual contact with an individual, although it seemsrelaxed.

3.2. Observing: the subject visually follows the movements of an individually carefully, although it seems relaxed.

3.3. Guarding: the subject visually follows the movements of an individually carefully, showing tension.

3.4. Following: the subject, watching an individual, moves in its direction, although remaining relaxed.

3.5. Stalking: the subject, watching an individual, moves in its direction, remaining tense.

3.6. Pointing with tail: the individual, in a quadrupedal position and frequently facing the other individual, raises its tail forward over its back.

3.7. Staring: the subject tenses its neck and flattens its ears against its head, staring intently at the other individual. The eyebrows raise and at times move up and down quickly. The mouth may be open or closed, but the individual does not bare its teeth.

3.8. Baring teeth: the subject, with a tense body, opens its mouth and bares its top and bottom teeth for an extended period of time. It remains seated, bipedal or in a quadrupedal position.

3.9. Yawning: the individual tilts its head back, closes its eyes and opens its mouth as wide as it can, revealing both its top and bottom teeth. The mouth closes again quickly. The subject remains seated, bipedal or in a quadrupedal position.

3.10. Attacking: the subject charges, chases or tries to grab, strike or bite an individual and even ends up doing so. The purpose of this behaviour is not to feed on the other.

3.11. Fleeing: the subject, faced with another individual's behaviour, increases the distance between them and, after running a few metres or having occupied another stratum, faces the original direction again to scan and look for the individual. If the subject is a baby, it generally takes shelter with its mother and, from this safety position, faces the other individual again.

3.12. Scaring: when other animals, like birds, are eating in the exhibit, one or more subjects move quickly towards them, striking some item in the exhibit to make noise or vocalising, in order to get rid of them.

3.13. Hunting: the subject traps an individual from another species and ingests it.

3.14. Waiting for food*: the subject, in the presence of humans carrying a trophic item, approaches the regular area in which food is provided and concentrates on the individuals, following all of their movements and emitting vocalisations.

3.15. Lip smacking*: the subject, relaxed, looks at a person and opens and closes its lips quickly while showing its incisors, which remain together. This behaviour is normally done to ask for food.

3.16. Inspecting the item shown*: the subject visually explores some object (or some part of the body) shown by a person.

3.17. Asking for contact*: when the exhibit permits physical contact, the subject exposes some part of its body (for example, the belly region or back…) in front of people while watching them.

3.18. Affiliative interaction*: the subject, in response to people, starts to play

around (doing acrobatics, touching the glass…).

3.19. Mouth gaping*: the subject, looking at a person, repeatedly opens and closes its mouth without showing teeth.

3.20. Tongue flicking*: generally the male, in a quadrupedal position and facing the person (generally a woman), half opens his mouth, sticks its tongue out partially and moves it quickly in all directions.

3.21. Playing with stick*: the subject sticks a stick through the exhibit fence and, holding it, looks at people so that they take the other end of the stick. When people do it, the subject tries to take the person's hand while pulling the stick toward it. In this interaction, the subject seems excited and at times bites the stick while showing its teeth and looking at the person.

* Behaviours only observed in interactions with humans