EAZA Best Practice Guidelines

White-faced saki Monkey (*Pithecia pithecia*)

Larger New-World Monkey TAG

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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.

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Summary

This document contains the guidelines for the white-faced saki monkey (*Pithecia pithecia*) and is divided in two sections.

The first section, Biology and Conservation, provides a description of the current knowledge of thespecies in their natural habitat.

The second section is focusing on Zoo Management. This part provides information in eleven chapters about the management in captivity. Including, but not limited, to housing, feeding, social structure, breeding, population management and veterinary care.

Finally this document is for all holders of white-faced saki Monkeys. To ensure that white-faced saki monkeys in captivity will get the best possible care, we urge zoos to regularly consult the guidelines, share them with their keepers and contact TAG members in case of concerns or queries.

All the zoos, mentioned in this document were informed about their appearance in these guidelines.

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SECTION 1: Biology and Conservation

1.1 Taxonomy

Kingdom: Animalia
Phylum: Chordate
Class: Mammalia
Order: Primates
Suborder: Haplorhini
Infraorder: Simiiformes
Family: Pitheciidae
Genus: *Pithecia*
Species: *Pithecia pithecia*



Figure 1. White-faced saki monkey. On the left a female saki is shown and on the right a male saki (Photo credit: GaiaZoo).

Common names of the white-faced saki are showed in table 1. All members of genus *Pithecia* are showed in table 2.

Table 1. Common names of the white-faced saki.

Languages	Name(s)
Latin	*Pithecia pithecia*
English	White-faced saki, Guianan saki, golden-faced saki
Dutch	Witgezichtsaki
German	Weißkopfsaki, Blasskopfsaki
French	Saki à face blanche, Saki à face pâle
Spanish	Saki cariblanco

Table 2. Members of genus Pithecia.

Scientific name	English name
Pithecia aequatorialis	Equatorial saki
Pithecia albicans	White-footed saki
Pithecia cazuzai	Cazuza's saki
Pithecia chrysocephala	Golden-faced saki
Pithecia *hirsuta*	Hairy saki
Pithecia inusta	Burnished saki
Pithecia irrorata	Rio Tapajós saki
Pithecia isabela	Isabel's saki
Pithecia monachus	Monk saki
Pithecia milleri	Miller’s saki
Pithecia mittermeieri	Mittermeier's tapajós saki
Pithecia napensis	Napo saki
Pithecia pithecia	White-faced saki
Pithecia pissinattii	Pissinatti’s bald-faced saki
Pithecia rylandsi	Rylands' bald-faced saki,
Pithecia vanzolinii	Vanzolini's bald-faced saki

1.2 Morphology

The white-faced saki monkey (*Pithecia pithecia*) is a sexual dimorphic animal in their coloration and size (figure 1), which is rare in New World Monkeys. The adults weigh between 1.4 – 2.0 kg, with the male on average 500g heavier than the female. The average length of the male saki is 33-38 cm. Sakis have long, none-prehensile, bushy tails which are used for balance while jumping through the trees.

The females have a brownish-grey fur with white or pale brown stripes around the corners of the nose and mouth. The males have a blacker fur with a reddish-white face, forehead and throat. Their faces are also much whiter than females. All sakis appear feminine in characteristics for the first two months, after which the males begin to show male characteristics. The sexual dimorphism gradually becoming obvious over the next 3 to 4 years.

1.3 Physiology

Little information is known about the physiology of the *Pithecia* genus. The primate species that has closest relation to the sakis are titis (*Callicebus*). Relatively close relation between the two families indicates that physiological data such as heart rate, haematological values and body temperature would be considerably similar. Nevertheless, more research on the subject is needed to confirm this hypothesis.

1.4 Longevity

The lifespan of the sakis is overall longer in captivity than in wild. Wild sakis live on average 15 years while captive sakis usually live about 20-25 years. The oldest saki in captivity was one wild-caught saki 'Nanni' from Frankfurt, who was estimated to be more than 37 years at the time of death.

1.5 Zoogeography

1.5.1 Distribution

The species ranges from Brazil, remote parts of Venezuela, most of French Guiana, Guyana and Suriname (figure 2)(Marsh et al., 2015).

Group size is relatively small for this species. There are studies which found an average group size of 2-3 individuals (Oliveira et al., 1985; Vié et al., 2001), while other studies found larger group sizes withan average of 5-9 individuals (Lehman et al., 2001; Norconk et al., 2003).



Figure 2. The home range of the white-face saki monkey (Marsh et al., 2015).

1.5.2 Habitat

White-faced sakis exist in a variety of habitat types, including lowland to highland forests, relatively dry to seasonally flooded forests, primary to secondary forests and disturbed forests. They prefer areaswith an abundance of watering holes and fruit trees. Sakis occupy the understory (3-15m) and the lower to middle canopy levels (15-25m) and will only come to the ground to search for food. They areactive during the day and in the afternoon, they start to move slowly towards their sleeping site, whichis usually in large upper canopy trees with a wealth of foliage for cover. White-faced saki groups occupyrelatively exclusive home ranges with clearly defined boundaries. The size of this home range is relatively small for frugivorous primates, around 10 ha (Anzelc, 2009; Grubich, 2013). There have beensightings of much larger home ranges from observations of relocated animals. Their home ranges ranged from 68 to 152 ha (Vie et al., 2001).

1.5.3 Conservation Status

The IUCN Red list classifies the white-faced saki monkey as Least Concern, though the population trend is decreasing. The species is widely distributed and are present in a number of protected areas lacking any apparent major threats (Marsh et al., 2015) The exact number of sakis in the wild is currently unknown. There is extensive information available about a few localised populations in Venezuela, Guyana and Suriname, but not throughout the entire range of the species (Marsh et al., 2018).

The white-faced saki monkey is listed in CITES Appendix II. This appendix lists species that are not threatened with extinction now but may become threatened if trade is not regulated.

1.5.4 Threats

Habitat destruction through logging and wood harvesting is the main threat for the white-faced saki monkeys. Additionally, they are sometimes captured for the pet trade and are hunted for their meat or tails (Grubich, 2013). Their natural predators are tree dwelling snakes, birds of prey and small cats.

1.5.5 Conservation Actions

There are currently no direct conservation actions specially aimed at the white-faced saki monkey. Although this species occurs in protected national parks in Brazil, Guyana and Suriname (Marsh et al., 2018). Because all species in these national parks are protected so is the white-faced saki monkey.

1.6 Diet and feeding behaviour

The white-faced saki monkey is known as a frugivorous seed predator (Ledogar *et al.,* 2013). They prefer unripe fruits (Kinzey and Narconk, 1990). Young seeds are an excellent source of lipids, proteins and structural carbohydrates (Narconk and Conklin-Brittain, 2004; Narconk *et al.,* 2002). Young seeds are often elastic in texture and have low levels of toxic secondary compounds, which would build up as the seeds age and the fruit ripens (Narconk and Conklin-Brittain, 2004). They have been observed actively foraging for unripe non-succulent fruits (Ferrari *et al.,* 2013). An animal which is adapted to forage and ingest seeds and fruits, that are protected by a tough outer test or protective membrane are known as sclerocarpic foragers. This is uncommon amongst primates and may be an adaptive strategy used by the saki monkeys to gain early access to fruits and seeds, therefore, avoiding competition and minimising food shortages (Kinzey and Narconk, 1990). They have been observed ingesting insects as well, specifically Orthopterans (Grasshopper family) (Barnett *et al.,* 2012). The ingestion of leaves is known to be opportunistic, grabbing and ingesting leaves as they move through the forest (Narconk and Conklin-Brittain, 2004). Different studies have reported similar values as shown in saki's diet. These include the results shown in table 3 and table 4 below.

Table 3: This table includes data on three different studies done on the average amount of different feed categories chosen by the saki monkeys.

Food Item	Ledogar *et al.,* 2013 (%)	Norconk and Conklin-Brittain, 2004 (%)	Ferrari *et al*., 2013 (%)
Seeds	53.3 - 60.6	88	61
Fruit Pericarp	27.8 – 31		28
Flowers	2 - 2.2	1.8	7
Leaves	7.1 - 10.4	5.7	2
Insects	2.3 - 3.7	3	2

Table 4: A reproduction from Narconk (1996), detailing the changes in diet per season. Every season lasts 3 months. Percentages of the components are expressed as log values.

Feed Group	Early Dry (%)	Late Dry (%)	Early Wet (%)	Late Wet (%)
Fruits and Seeds	94.84	86.83	90.91	88.92
Leaves	4.38	6.05	5.37	4.37
Pith	0.00	0.49	0.21	0.12
Flowers	0.59	4.13	0.53	0.96
Fauna	0.19	2.50	2.99	5.64

Most commonly ingested fruit families are: Conneraceae, Lecythiadaceae, Loganiaceae, Fabaceae and Erythroxylaceae (Ferrari *et al.,* 2013).

The dental morphology of the pitheciin primates is adapted to the extraction and mastication of seeds (Norconk *et al.,* 2002). Specifically, the saki monkey's cranial, mandibular and dental morphologies make it possible for the species to predate on challenging unripe fruits and seeds. (Ledogar *et al.,* 2013). They use their large canines and procumbent incisors to extract the nutrient rich seeds from inside the hard-shelled fruits (Ferrari *et al.,* 2013; Ledogar *et al.,* 2013). Their post-canine teeth are then used to process said seeds. Their post-canine teeth have low and bulbous cusps which are inferredto be efficient at fracturing seeds and nuts (Lucas, 2004). A sharper cusp would have required a muchgreater force to break into these resistant plant parts. Therefore, their blunt cusps help to reduce the risk of tooth crown fractures, once again depicting how adapted they are to consuming hard shelled seeds and nuts (Berthaume *et al.,* 2010). Both the pre-molars and molars have an expanded flat surface

area for efficient trituration of the fibrous seed tissue (Kinzey, 1992). The dentine of their teeth is relatively thin, but crenulations help to reinforce the teeth to prevent breaks as well (Kinzey, 1992). Morphologically speaking, they are absolutely adapted to breaking open nuts and seeds that many other species simply cannot negotiate.

The digestive system of the white-faced saki monkey is relatively simple but has an enlarged hind gut area. This coupled with their long-recorded food transit time of 14 hours, suggests some fermentation capability (Norconk *et al.,* 2002). Their mean retention time of food is recorded by Narconk *et al. (*2002) to be 25.6 hours which also suggests some level of hemi-cellulose digestion. The same article determined that white-faced saki monkeys can digest up to 70% fibre fractions. Their typical diets contain on average, 38.4% nitrogen detergent fibre (NDF) and 22.4% acid detergent fibre (ADF) all on a dry matter basis (Narconk *et al.,* 2002).
Special adaptations within the saki's digestive tract permit the exploitation of plant parts which contain toxic secondary compounds, such as cyanides (Ferrari *et al.,* 2013). During periods of low unripe fruit availability, the sakis have been observed eating the topsoil off termite mounds (Setz *et al.,* 1999). These mounds contain kaolinite which has the capacity to bind tannins and other secondary plant metabolites (Setz *et al.,* 1999).

Sakis forage in the understory and lower-level strata of the forest canopy (Ferrari *et al.,* 2013), like other South-American species: capuchins, marmosets and titis. Sakis have relatively small home ranges and feeding occurs throughout the day, with an increase during the middle of the day (Vie *et al.,* 2001). Some individuals can forage for up to 50% of their active time (Vie *et al.,* 2001), remove fruit from the trees with their hands and process and ingest them on the same branch (Barnett *et al.,* 2012). While feeding behaviour has not yet been described in detail, they have been observed descending to the ground to capture grasshoppers. They immediately return up a tree to consume it (Barnett *et al.,* 2012).

Saki monkeys have a relatively stable diet. Because they have such a large range, they are usually able to find a fruiting tree (Cunningham and Janson, 2006). During the dry seasons of March and May, they decrease the amounts of seeds eaten and would feed more heavily on leaves, insects and flowers (Cunningham and Janson, 2006). Because the sakis are adapted to ingest fruits of varying maturity, there is no major change in seasonal food intake (Vie *et al.,* 2001). During the rainy seasons, the sakis would move further out and move faster with no observed feeding peak (Vie *et al.,* 2001).

Specific dietary requirements to create a white-faced saki diet have not yet been identified for this species. The recommendations most often used are the New World monkey recommendations from Jansen and Nijboer (2003) (Table 5). Note that these recommendations are not specific to saki monkeys and should only be used as loose guidelines. Narconk and Conklin-Brittain (2004) have analysed the nutritional content of the average diet consumed by a saki monkey (table 6) and these, in conjunction with Jansen and Nijboer (2003) should provide adequate guidelines. While these values are not to be treated as absolutes or minimum/maximum values, they are the nutrient values that the saki monkey have evolved to cope with. Practical uses can include ratios of fibre fractions, approximate protein amounts to aim for, etc.

Table 5: Nutrient recommendations for New World primates from Jansen and Nijboer (2003). Values written here areconcentrations of diet on a dry matter basis.

Nutrient	Recommendation
Crude Protein (g/kg)	278
Calcium (g/kg)	5.6
Phosphorous (g/kg)	4.4
Magnesium (g/kg)	1.7
Zinc (mg/kg)	11
Iron (mg/kg)	200
Vitamin A (IU A/ g)	14
Vitamin D (IU/g)	2
Vitamin E (Mg/kg)	56

Table 6: Average nutritional contents of a white-faced sSaki monkey diet, collected over a year's time. Narconk and Conklin-Britain(2004)

Nutrient	Amount (% dry matter)	Standard Deviation (% Dry Matter)
Lipids	16.05	+/- 8.60
Free simple sugars	3.40	+/-3.59
Soluble carbohydrates	20.54	+/-17.83
Crude Protein	6.45	+/-4.45
NDF	38.40	+/-10.53
ADF	22.38	+/-6.86
Hemi-cellulose	11.02	+/-4.48
Lignin	11.16	+/-6.03
Cellulose	7.96	+/-4.06
Condensed tannins	3.29	+/-2.92
Bioactive tannins*	3.74	+/-2.25

**This looks at the tannins in the food but detected using a different method than the Condensed Tannins row. Instead, the author used radial diffusion method to detect bioactive tannins*.

1.7 Reproduction

In captivity (zoo environments) sakis are mostly monogamous, but in the wild sakis are less monogamous when compared to captive groups. Monogamy is less common in larger groups with more than one adult breeding male and female (Anzelc, 2009; Norconk, 2006).

Males reach sexual maturity at the age of 32 months (Grubich, 2013). Captive females reach sexual maturity at the age of 26-32 months. Wild white-faced sakis gave birth for the first time between 4-6 years, while captive sakis give birth starting from 3 years old (Savage et al., 1992). Their ovarian cycle lasts about 17 days and they have a gestation period of 138 – 152 days. Their cycle is non-seasonal and can happen throughout the whole year. They are capable of giving birth once a year, with an interbirth interval ranging from 343 – 479 days (Savage et al., 1995)

1.7.1 Infant Development

Sakis mostly give birth to a single young, but there is a low rate of twinning. Paternal care for the infants is minimal, with the majority being done by the mothers with occasional help from older siblings.

For the first month after giving birth, the infant straddles the mother's thigh. Between one and four months the infant shifts to a more dorsal position. After four months the infants will spend more time off mum as they gain confidence and increased locomotor independence (Norconk, 2006). The onset of solitary play has been documented at the age of five months, when the mothers leave the infants alone to follow them (Homburg, 1997).

Mothers are the primary caregivers (Brush and Norconk, 1999), but as the infants mature the males show an increasing interest in them and have been observed to play and share food with older infants

(Buzzel and Brush, 2000).

1.8 Behaviour

The behaviour of the white-faced saki can be divided into four categories: social behaviour, feeding behaviour, moving behaviour and other (rest) behaviour. According to the research of Vie et al. (2001) those behaviours occur in different frequencies at different times during the day. Figure 3 shows an average activity pattern of a group of White-faced sakis. The feeding behaviour and moving behaviour increases as the day goes on. Activity increases throughout the day, then decreases rapidly towards the end. Their social behaviour has it peak between eleven and twelve. On average, wild sakis spend about 9 hours on the move, travelling distances of roughly one or two kilometers per day. These activity bouts are relatively short compared to related monkeys, who may be active 10 to 12 hours perday.

According to this research it can be said that the social and feeding behaviour increases during the day and will decrease at the end of the afternoon. Towards the end of the day, the rest behaviour increases as the other behaviours decrease.

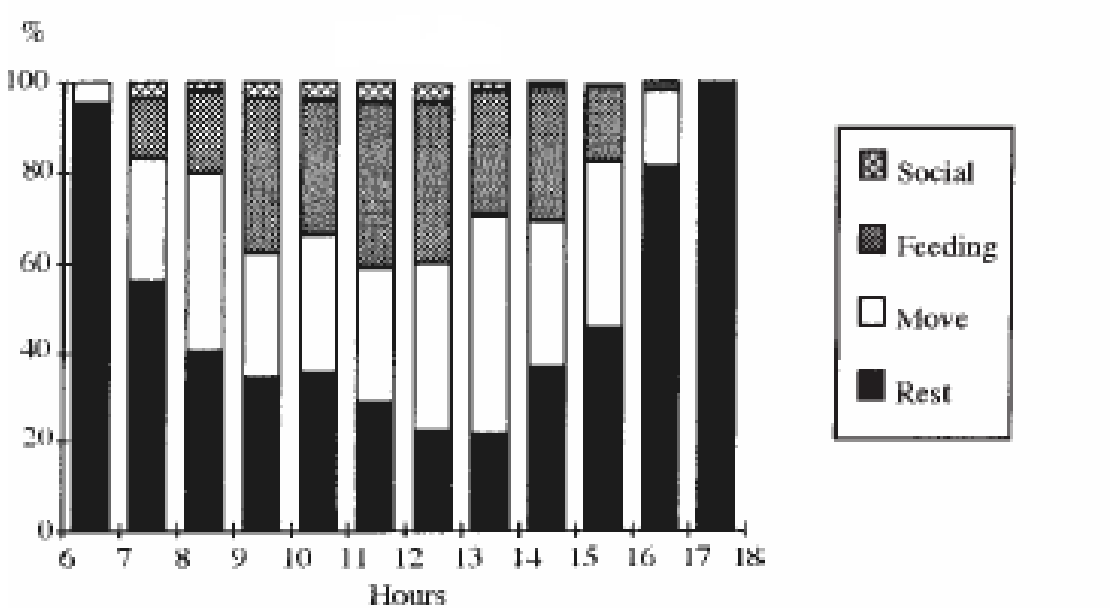


Figure 3. Abundance, use of space, and activity patterns of white-faced sakis (*Pithecia pithecia*) in French Guiana (Vie et al., 2001)

The white-faced saki moves through the forest both quadrupedally and by leaping (Fleagle, 1988). When the white-faced saki takes off from a tree branch, they do so from a vertical clinging position (Walker, 1993). When resting, white-faced sakis will hold onto branches closest to the trunk of the tree (Walker, 1992).

1.8.1 Sexual behaviour

Females do not show any obvious physical or behavioural changes at time of ovulation and they were not observed actively seeking copulation from males (Savage et al., 1993, 1995). Males might be able to distinguish cycling females from non-cycling females, as copulations are more frequent with cycling females (Thompson et al., 2011).

Scent-marking behaviour seems to be one of the most common sexual behaviours. The sent marking behaviour can be broken into a few specific behaviors, like throat-and-chest rubbing, groin with the hand and urinating on marked branches. Marking behaviour is strongly sex related, with the adult males making 88.4% of the markings (Eleonore et al., 1997). The frequency of scent-marking, by adult

males, increased during breeding periods. Scent-marking behaviour seems related to courtship, and possibly stimulates sexual behaviour.

1.8.2 Social structure

Sakis are social animals that live in small groups of two to four adults with their offspring. The White-faced saki has a multimale-multifemale social system. Fleagle and Meldrum (1988) have suggested that this species live in small groups that come together to form larger congregations. These groups ofWhite-faced sakis are described as closed social units (Soini, 1986). Both males and females groom their young (Kinzey, 1997).

1.8.3 Communication behaviour

When sakis notice a predator, they will first make an alarm call, which is echoed by the group members. After this the group will get together and they will try to scare the predator away. The biggest threat for the sakis are avian predators. A study found that 90% of saki alarm-calls are directed to avian threats (table 7) (Gleason and Norconk, 2002).

Table7. Frequency and percent alarm calls (Gleason and Norconk, 2002).

Predator class	Frequency	Percentage of total observations	Number of species of predator
Vulture	174	77.0	2
Raptor	11	4.9	2
Snake	6	2.7	1
Felid	2	0.9	1
Unknown	33	14.6	-
Total	226	100.0	6

SECTION 2: ZOO MANAGEMENT

2.1 Captive Population

The population of white-faced saki monkeys in EAZA zoos is managed through an EEP. At the start of the 21st century, only around 150 white-faced sakis were housed in just over 50 EEP institutions. Over the years this number increased to almost 350 animals in around 100 zoos in 2015. As space in zoos is limited, it was decided to implement strict breeding recommendations. This resulted in a decrease of annual births from 45 to about 25 animals. Since that moment, the EEP population remains stable at around 330 animals in approximately 115 institutions. Most of the animals are housed in Europe, but several animals are housed in other regions (e.g. Guyana and Singapore). The target population size for the species is set at around 300 animals. This is enough to provide the animals good husbandry care and to keep a sustainable population for the upcoming generations.

2.2 Accommodation

The recommendations below are based on comparative research and elaborate experience with white-faced sakis in 39 different EAZA institutions, who participated in May 2019 to a survey in orderto facilitate this document. As is the case with all captive animal husbandry, it must be kept in mind that the quality of the space is just as important as the quantity when considering the housing requirements of white-faced sakis. This means the enclosure must provide a safe environment suitedto their physical and psychological needs as well as taking into account the arboreal nature of the species. The standards for Accommodation and Care set by EAZA (EAZA, 2014) must always be met. Itis in no way suggested that the following recommendations are the only suitable options for white- faced saki husbandry, but are merely meant to provide a general overview of what has been found to be appropriate through experience. As every group of animals and situation is different, the applicability of these recommendations depends on various aspects such as the local climate and the presence of other species in the same exhibit. In the section below the recommendations for indoor and outdoor enclosures will be discussed separately.

2.3 Indoor enclosure

Since white-faced sakis originate from an equatorial climate, Indoor enclosures with regulated temperature, humidity and ventilation are a necessity in temperate climates. It is recommended to have at least two separate indoor areas with multiple connections to the outdoor area. At least one indoor compartment should be able to function as a separation area, preferably out of sight of visitors, to facilitate introductions or medical treatment.

2.3.1 Boundary

Solid walls are the most practical and commonly used type of barrier when it comes to indoor enclosures, as they provide an enclosed shelter where climate control can be easily regulated. They can be constructed of brick, concrete or wood.

Glass is used as a barrier primarily at public viewing areas and is generally used in conjunction with other materials to create some shelter. Benefits of glass are the ability for up close viewing, prevention of disease transmission and public feeding. Downsides of glass as a barrier include reflection problems and keeping the glass clean (Bairrão Ruivo & Stevenson, 2017).

To separate the keeper area from the indoor compartments, wire mesh fencing is most commonly used, providing a safe distance between the animals and the keeper, while simultaneously increasing the usable vertical surface area and creating opportunities for health examination and potential medical treatment.



Figure 4. View from the visitors side of an indoor enclosure for White-faced sakis combining solid walls, glass and wire mesh fencing as boundaries in Tierpark Berlin, Germany.

2.3.2 Outdoor access

Outdoor access, even for a limited time a day, is beneficial to the animals, providing them fresh air, sunshine and enrichment. To get to the outdoor exhibit, mesh tunnels are commonly used. These tunnels must be placed at a minimum height of about 1.5 meters, as sakis naturally only get closer to the ground when foraging for food and feel safest up high. If the outdoor enclosure is directly connected to the indoor accommodation, sliding doors will work just as fine. In both cases the entrance should measure about 30x30 cm in length and width. Keepers must be able to easily control the doors with a cable system or sliding doors. With a group larger than two individuals, or when the entrance to the outdoor is shared with other



Figure 5. A mesh tunnel used for sakis in Oasis park Fuerteventura.

species, it is recommended to have at least two connections to the outdoor exhibit. These connections must be spaced far enough to prevent dominant animals from controlling passage between enclosures. These tunnels may be furnished with a handling tunnel. These tunnels are useful if animals need medical attention or need to be moved to another zoo. Especially in colder and temperate climates it is recommended to give the sakis the opportunity to go back inside. To conserve heat and prevent drafts in the inside area flaps can be added to the animal access doors. Several institutions indicate that they use soft PVC material as the draft excluder. This is placed on an angled door frame and is easily lifted by the sakis as they move in and out.

2.3.3 Substrate

Any type of substrate should be easy to remove for cleaning purpose, to prevent health problems. The pie chart below (figure 6) shows the different types of substrate used and/or recommended for White-faced sakis by 39 different institutes. In general, any natural type of substrate such as bark, mulch, woodchips, bio-floor or soil is recommended. Substrates that are used by only one institute are filed under "other". These include miscanthus, flax, hay, bark and hemp. Although used in multiple cases, it was stated as a downside by respondents that sawdust and woodchips can be excessively dusty, so these substrates should be used with care, especially around animals with sensitive respiratory systems. As shown in the pie chart (figure 5), some collections (14% of the 39 questioned institutes) consciously choose to not use any substrate on concrete flooring since this makes the environment more sanitary. However, a natural substrate like bark or bio-floor provides the animals with foraging enrichment and will also decrease the possibility of injury due to falls. When choosing whether or not to use substrate, the nature of the animals in question must weigh in on the decision. While in their natural habitat, most White-faced sakis prefer to stay in the understory and lower to middle canopy of the rainforest, they have been recorded foraging for food on the ground (Barnett *et al.,* 2012). Some sakis will descend to the floor more than others. Factors increasing the risk of falling accident, such as infants or elderly animals in the group should also be taken into consideration when deciding whether or not to use a substrate in the enclosure. Faeces and scraps of food should be cleaned from the substrate on a daily base, and the entire substrate should be replaced periodically or when disease pathogens or parasites are found.

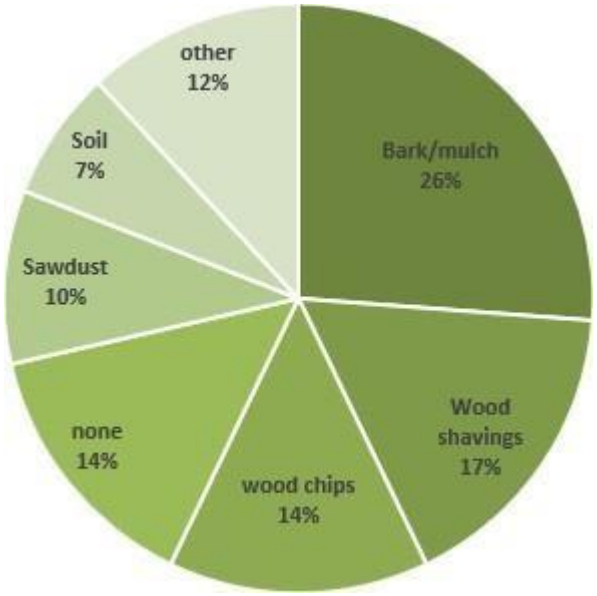


Figure 6. Percentage of collections using a specific substrate for White-faced sakis.

2.3.4 Furnishing and Maintenance

The indoor enclosure must provide the animals with some level of complexity. This can be achieved by wooden structures and other climbing facilities such as wooden poles and branches, hammocks, platforms and securely placed fire hose. Helsinki Zoo also mentioned using curvy tree trunks on the floor to encourage foraging on the ground. A mix of permanent and temporary fixtures is ideal, changing around the furniture allows the White-faced sakis to explore their environment and is great enrichment. Flexible materials such as branches, ropes, and ladders (with rungs spaced appropriately) will promote exploratory and locomotive behaviour, stimulate muscle tone and balance, as well as providing shelter, cover and (if applicable) visual barriers to escape the public view. Examples of furnishing for indoor exhibits can be seen in figure 4 (page 17) and in figure 7 (page 19). Some sakis like to stay in a wooden nest box. Therefore, it is recommended to have at least one wooden nest box installed in the enclosure, so they can retreat in their own space if required. Nest boxes should be at least 40 x 40 x 40 cm and could double as capture device when fitted with appropriate sliding doors. Complete cleaning of the nest boxes and other furnishings should not be done all at once, as White-faced sakis mark their territory with their scent (Eleonore et al., 1997). Instead cleaning of the furniture should be carried out in stages. When housing a family of more than two sakis, it is advised to install at least two feeding and watering sites within the enclosure to make sure dominant animals are not keeping their subordinate family members away from the food and water. The sites should be easily accessed for all animals, and at least 1.5 meters high since most sakis do not go down to the ground. Food should be presented in trays or bowls, preferably on a flat surface for easy cleaning.

Water can be given in either a bowl or in water bottles installed through wire mesh fencing. When designing an indoor enclosure, keep in mind not to place food and watering sites underneath branches, perches, orany other kind of instalment the sakis could sit and drop faeces or urine. Ideally the design should allowfor the keeper to remove the feeding and watering trays or bowls for cleaning and refilling without having to enter the exhibit.



Figure 7. Indoor white-faced saki exhibit furnished with a construction of branches and hammocks to facilitate climbing at Connecticut's Beardsley Zoo, Bridgeport USA. (Photo Credit: Connecticut's Beardsley Zoo)

2.3.5 Environment

Temperatures and humidity levels maintained for white-faced sakis in a controlled environment highly vary per facility. Most institutions keep their temperature between 20°C and 28°C by day and somewhere between 18°C and 25°C for the night without any apparent problems, although some state their temperature doesn't go any higher than 16°C. Given the equatorial climate of their natural habitat, it is recommended to keep the temperature of the indoor enclosure above 20°C by day, and not any lower than 18°C by night. Temperature is most often regulated through the use of a thermostat. Suitable heating systems include electronic heating, central heating, heat lamps, floor heating, radiators and decentral heating systems. Note that any hot pipes or other heating equipment should be placed out of reach of the animals. When the outside temperature drops below 16°C, a basking spot can be provided for the animals to warm up.

Humidity levels should be kept fairly high to maintain a good condition of the skin and coat. Most facilities keep their indoor humidity levels around 60%, although it is not uncommon for sakis to be kept in an indoor greenhouse ecosystem, in which case humidity can reach up to 90%. Humidity can be raised with the use of humidifiers, misters, or simply by lightly spraying the floor with water on a daily base.

As for ventilation, Indoor enclosures should have a full air circulation system with air inflow points positioned in the upper part of the enclosure building and air outflow points in the lowest parts to keep the levels of CO_2 below 0.1%.

2.3.6 Dimensions

Recommendations for enclosure size depend on several variables. If a family of white-faced sakis are able to go outside every day, they will not need as much indoor space as a family that is bound to their indoor enclosure year-round. The number of animals also weighs in in the equation. At the moment, it is nearly impossible to give exact recommendations applicable for every situation, so depending on the variables, some adaptation to these recommendations is possible.

Appendix I. provides an overview of enclosure measurements for white-faced sakis in 39 different institutes, pointing out additional factors like group composition, if the enclosure is shared with other species and what kind, and other variables and information worth pointing out.

The enclosure must be a minimum height of 2.5 meters, with at least 2 meters of climbable height so the sakis can perform their natural climbing behaviour.
When the animals have access to both an indoor and outdoor enclosures, the indoor exhibit should have a minimum floor size of 3m² per animal and must contain at least two separable areas to enable easier cleaning and to separate animals if needed.
If the animals only have an indoor enclosure, the minimum floor size per animal should be 10m² per animal.

2.4 Outdoor enclosure

2.4.1 Boundary

A number of different boundaries can be used to separate the white-faced sakis from the public and/or keep the animals in. Walls can be built to provide the animals with shade and protection from drought. They can either be constructed of sturdy wood, concrete or cement and can easily be disguised as a natural barrier by covering them in artificial rocks, which serves both the aesthetic and the complexity of the environment.

Glass is typically seen as a barrier at areas for public viewing and is generally used in conjunction with other materials. Benefits of glass are theability for up close viewing, prevention of disease transmission and public feeding. (Bairrão Ruivo & Stevenson, 2017). However, it is often more expensive to construct, can cause problems with reflection and must be cleaned daily for a clear view of the enclosure.
The use of wire mesh fencing or netting as a barrier is commonly used for white-faced sakis. It is relatively cheap to build and increases the climbable surface area

Table 8. Mesh size used in fencing for white-faced saki enclosures among 39 different EAZA institutes.

Mesh size used in fencing of white-faced saki enclosure	amount of times used
none	18
25x25 mm	6
20x20 mm	3
30x30 mm	2
50x50 mm	2
5x5 mm	1
40x60 (hexagonal) mm	1
80x80 mm	1
35x35 mm	1
30x40 mm	1
40x40 mm	1
15x15 mm	1
10x10 mm	1
Total:	**39**

of an exhibit. 21 out of 39 respondents stated they use some form of wire mesh fencing as a form of containment for their white-faced sakis. The mesh size used is variable, as can be seen in table 8.
The use of a mesh bigger than 50x50 mm is discouraged in breeding groups, as small infants could get stuck and/or attempt to climb through. A downside of wire mesh is that it disrupts the view for the public. If wire mesh is used in a public viewing area, a mesh size larger then 10x10 mm is preferred to reduce the obstruction of the view. Care must be taken in construction to bury the mesh approximately 1 meter below the substrate or to anchor the substrate to a solid foundation to prevent local predators from getting inside. The perimeter should be checked regularly for holes and weak spots.
Electric fencing is used sporadically, as it is not typically necessary to keep the white-faced saki in their habitat. When applied it must be used carefully, as too high a voltage could be dangerous or even fatal to the animals. The use of electric fencing is only recommended in case of very large enclosures or as a secondary barrier to keep out local predators.

As sakis are rarely swimming, a water moat can provide a natural barrier without any obvious fencing, giving the public an unobstructed view of the enclosure. This moat doesn't need to be very deep as the sakis normally will avoid the water regardless of its depth. 0,5 meter will most likely suffice. The moat should be at least 3 meters wide or more, depending on planting and climbable constructions upand around the island. The slope of the moat should not be too steep around the island regarding the danger of animals slipping and falling in the water. A slope of 30 degrees or less is suitable for the species. For safety reasons it is recommended to place a secondary barrier on the visitors' side of the moat, for example a wooden fence. This should prevent any unlucky accidents with visitors falling into the water.

2.4.2 Indoor access
White-faced sakis should always be given the opportunity to go inside during the day if they wish to do so, especially if the temperatures drop below 15°C or in rainy/windy weather conditions. If the temperatures reach below 5°C it is advised to keep the sakis inside all the time.

2.4.3 Substrate
Natural vegetation is highly recommended as it provides the animals with cover, shade, and a more interesting and complex environment. Abundance of plants also makes an enclosure more aesthetically pleasing for visitors. Vegetation does not necessarily have to be from the sakis' natural habitat since not all climates are suited to harbour tropical plants, but it should be checked for toxicity before being planted. In most cases a natural substrate of soil will be sufficient as a substrate in the outdoor enclosure. It should be ensured that the soil is rich enough to sustain the vegetation present in the exhibit.

2.4.4 Furnishing and maintenance
As is the case with the indoor furnishing, the outdoor enclosure should provide the white-faced sakis with some level of complexity. A vast amount of live plants, trees and/or shrubbery at different heights is great enrichments on its own as it provides dimension, climbable surface and attracts insects as well. Care must be taken to ensure that none of the vegetation is positioned in such a way that it may provide a potential escape route from the enclosure. A usable vertical height of at least 3 meters is desired, preferably higher. Additionally, the enclosure can be made more exciting for the animals as well as the visitors by adding climbable structures, preferably made from natural yet sturdy material such a thick branch, tree trunks, horizontal and vertical perches and platforms. Care must be taken that these permanent types of structures are firmly fixed in the ground. A mix of permanent and temporary fixtures is ideal. Changing around the furniture allows the white-faced sakis to explore theirenvironment and is great enrichment, although generally speaking the outdoor enclosure provides a more challenging environment then the indoor enclosure, so temporary fixtures don't need to be changed around as often as inside. Examples of temporary fixtures that can be

added into the enclosure are ladders (with rungs spaces appropriately), nets, hanging baskets, ropes, loose tree branches, puzzle feeders, various and different feeding stations, cargo nets, log piles, and hammocks. Obviously, all furnishing should be made from non-toxic materials and should be resistant to rain and other weatherly conditions. The diameter of perches and branches for climbing should be appropriate to the sakis anatomy, so that they are able to grab onto the material with their hands and feet. Appropriate shelter should be provided in case of bad weather. The furnishing should provide shade as well as areas with direct sunlight. Cleaning is less of an issue as natural substrates and natural climatic conditions will help maintain standards of hygiene. Minimizing access by vermin is also advisable in the outside enclosure by selecting materials appropriately.

Figure 8 provides an example of a species appropriate outdoor exhibit in Tierpark Berlin.The exhibit is enclosed with an artificial rock wall combined with a glass barrier constructed out of wood. There are trees, branches and logs varying in sizes and heights, as well as temporary fixtures like a ladder, providing an interesting environment.



Figure 8. A visitors' view of the white-faced saki exhibit (shared with red howlers) in Tierpark Berlin.(Photo credit: Tierpark Berlin)

2.4.5 Dimensions

Recommendations for enclosure size depend on several variables. Like the number of animals in the group and potential other species present in the enclosure. Appendix I. provides an overview of enclosure measurements for white-faced sakis in 39 different institutes, pointing out additional factors like group composition, if the enclosure is shared with other species and what kind, and othervariables and information worth pointing out. Given the information in this overview, the minimum requirement for an outdoor enclosure for white-faced sakis should measure at least 10 m^2 per animalwith a usable vertical height of 2,5 meters as a minimum.

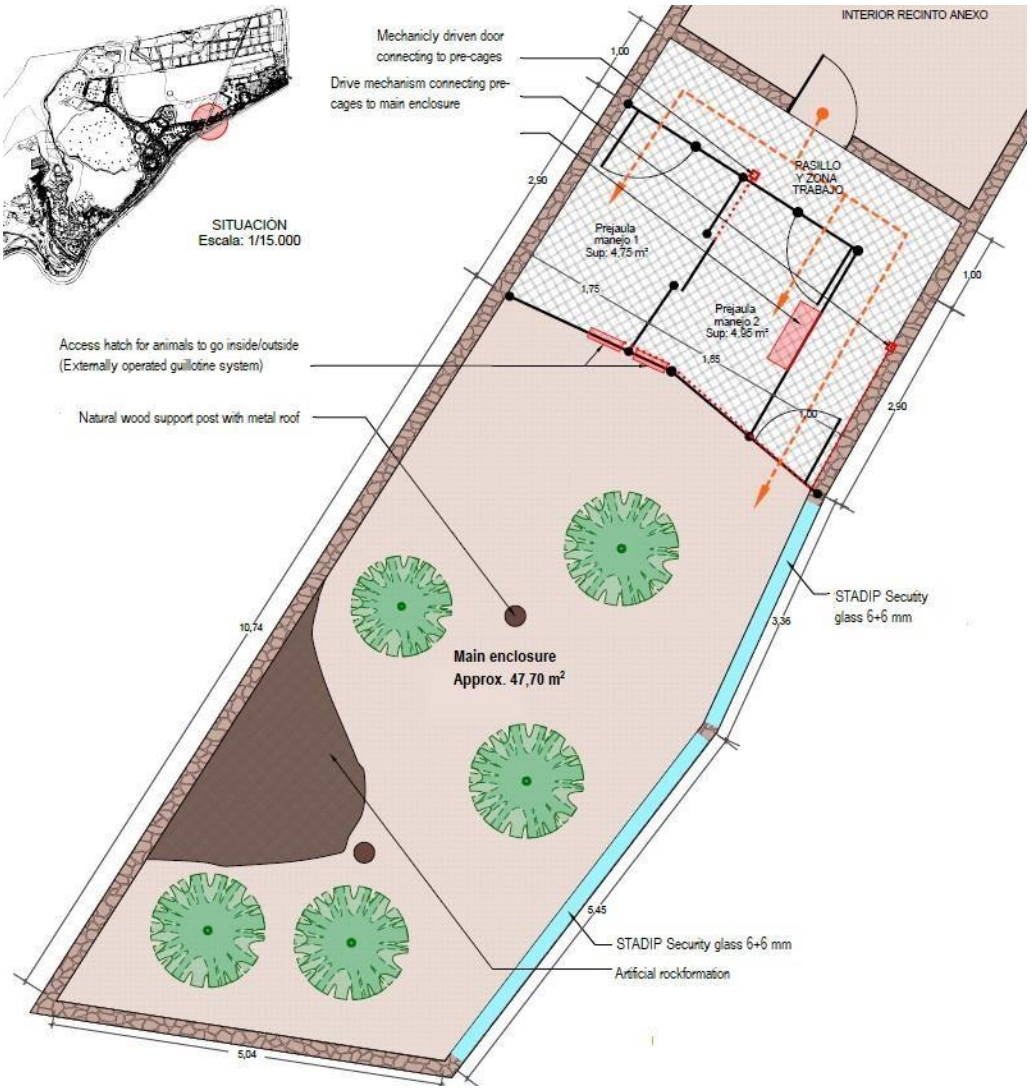
Figure 9 shows a construction map for a white-faced saki enclosure. The dimensionsin this map can be taken as an example for an exhibit for around 3 animals.

Figure 9.
The map shows a layout for a white-faced saki enclosure, suitable for 3 animals.

The average height of the indoor enclosure is 2.50 meters and measures 16.40 m² including the aisle

Approximate height of the main enclosure is 5.50 meters and surface area is 47,70 m²

Approximate volume of the main enclosure: 238.50 m³



2.4.6 Free range

Several zoos have successfully kept white-faced sakis in a free-ranging exhibit, i.e. where there is no barrier between the animals and the public and visitors are allowed to roam on designated paths in the enclosure. As sakis are typically docile in nature they are a well-suited species for free range exhibits. The free-range exhibit should be large enough with sufficient possibilities for the animals to withdraw from the public. White-faced sakis tend to keep a safe distance from visitors, but a strict no-feeding regulation must be maintained to keep the animals at a safe distance from the visitors. Hand-reared individuals are naturally drawn towards people and are therefore not recommended to keep in a free-ranging exhibit. Although most experiences with white-faced sakis in a free ranging exhibit are fairly positive, one zoo reported to have problems with juveniles becoming too bold. Therefore, it is advised to keep a keen eye on the young once they enter the adolescent stage.

2.5 Feeding

2.5.1 Basic Diet

Two separate surveys were undertaken within EAZA zoos inquiring about the different aspects of saki husbandry, particularly feeding. We received 36 replies on the first, and 39 replies on the second survey. Results from these surveys will be used to illustrate common practice but does not necessarily reflect what is recommended as best practice.
Assuming that evidence-based naturalistic diets are "ideal" diets in terms of appropriateness, some recommendations can be made about what general food groups should and shouldn't be included in the everyday diet of the saki monkey. Please refer to the table 3 through 6 for referenced evidence.

Diets *should* include the following:

Concentrate pellet

According to the surveys an adequate concentrate pellet is common in primate diets and ensures that the specimens receive their daily needs of vitamins and minerals. The energetic value of pellets is generally quite dense; therefore, care should be taken to deliver the right amount necessary to reach daily nutrient requirements and no more (generally 25% of necessary energy). Saki monkeys are larger than callitrichids and have very different dentition, for this reason small callitrichid pellets may not be suitable. Care has always been taken with new world primate pellets in that they should provide high amounts of protein and very high amounts of vitamin D. Oftedal et al. (2007) disproved the myth of high protein. When factoring in the digestive morphology of the saki monkey, pellets should have high fibre (30% or more NDF), they should be big enough to be held and fed dry and solid. Leafeater pellets of different brands have had success with saki monkeys.

Vegetables

Most vegetables can be included and varied within this diet. It is recommended to divide your available vegetables into three groups: leafy greens (lettuce, kale, cabbage etc.), watery vegetables (cucumber, broccoli, peppers, peas, beans, leeks etc.) and root vegetables (carrot, sweet potato, kohlrabi, turnip etc.) – a detailed list is available in Appendix II.
Vegetables should represent the bulk of the diet. Watery and root vegetables should dominate, with leafy vegetables being sparse. Daily types of vegetables should be restricted to 3-4 different types each time, but these can change throughout the week on a rota-like system, or whatever from that vegetable group is available. The large variety of vegetables fed to sakis should be given throughout the week and not on any given day. Approximately 60% of energy content should come from vegetables.

Seeds and Nuts

Saki monkeys are seed specialists so different kinds of raw, un-salted seeds and nuts should be given as a regular part of the diet. Due to the low level of physical activity in captivity, the amounts of seeds and nuts given must be strictly monitored and kept under the maximum. Raw seeds and nuts with a tough coating or shell are ideal and can be given daily such as almonds, walnuts, palm nuts and to a lesser extent: sunflower seeds and peanuts can be given. Seeds and nuts should only provide a maximum of 10% of an individual's daily energy needs.

Insects

A variety of insects should be given to sakis for instance crickets, locusts, mealworms and wax moth larvae. The feeding of live food should be enriching and not given in a bowl. Letting a few locusts loose on the branches of the enclosure or employing the use of an insect trickle feeder will only reap positive benefits for the saki monkeys.

Currently every zoo surveyed feeds invertebrate. 47% of them feed invertebrates daily, 14% feed invertebrates everyother day and 14% only three times a week. Every other day should be the bare minimum for saki monkeys. If your institution cannot afford to give live insects every other day, then please contact theauthors who can help you set up your own breeding colony.

Browse

Browse is a topic of debate for saki monkeys. 37% of zoos do not offer fresh browse and 34% only occasionally do, however 75% of all establishments report that saki monkeys showed no interest in the browse. Browse species offered include: hawthorn, apple, cherry, beech, hazel, sycamore, willow, bamboo, maple, oak, hornbeam, silver birch, acacia and bramble.
On average, 9% of saki monkey diets are leaves and 4% is flowers. Providing natural branches of the species listed above with young leaves, buds, seeds or flowers tends to increase its attractiveness to saki monkeys. Even if interest is low, keep offering browse and varying the tree species offered.

Supplements

Currently, 83% of institutions use supplements. Depending on the current diet, supplements can be given in order to round out the nutrient levels of a diet. Most popular are multi vitamin and mineral powder/drops and/or pure vitamin D. The most effective vector for supplements is in gum or inside a boiled root veg, dusted insects are also suitable. Sprinkling over vegetables or fruit is not recommended, because this way there is a high percentage of nutrient loss.

Diets can include the following:

Exudates

Around 30% of zoos include exudates as part of their saki monkey diets. Raw or refined gum Arabic is an excellent source of nutrients and necessitates specialist feeding behaviours to consume. Including this in the diet once in a while can only be beneficial but is by no means necessary. Try spreading it into cracks and holes in branches for maximum enrichment purposes. Nectar can also be given as longas it is sporadic, diluted, and presented in as naturalistic way as possible, for example by using a hummingbird feeder.
Marmoset or tamarin jellies/cakes are not necessary but can be given as their ingredients are quite similar to pellets.

Whole Grains

Only whole grains such as cooked brown rice, quinoa or bulgur wheat are appropriate. Occasional scatter feed of these items can keep the animals busy and active while providing nutrients and fibre. Any other cereals or refined grains are too high in soluble carbohydrates and can trigger an earlier feeling of hunger.

Diets should **not** include **large** amounts of the following:

Fruits

Sakis consume many different un-ripe fruits in nature; the nutritional composition of uncultivated South American fruit is very different than the cultivated fruits that are available at our disposal (Oftedal and Allen, 1997; Schwitzer and Kaumanns, 2003). The soluble carbohydrate contents are much higher than that of the wild fruits, especially in comparison with un-ripe fruit which form a largepart of the diet of wild sakis. The protein and fibre amounts are both significantly less in cultivated fruit. Sugar, protein and fibre concentrations of wild fruit are generally closer to the levels our vegetables offer. A reduction of fruit in the diet to a minority will benefit the physical and mental health

of the saki monkeys fed high-fruit diets (Oftedal and Allen, 1997; Schwitzer and Kaumanns, 2003; Plowman, 2013).

Dairy Products

There is no evidence to support giving any dairy products to adult saki monkeys. The main sugar in dairy products (Lactose) requires a specific enzyme called lactase to catalyse its digestion (Stevens and Hume, 2001). All primates have an abundance of this enzyme in their infant life stages, but as weaning occurs (less mother's milk intake and more solid food intake), the amount of lactase in the digestive system is heavily reduced. No adult mammal is known to ingest any dairy or milk products in the wild because milk is only produced for infants. Dairy products are not a healthy source of protein or calcium for captive primates and instead contribute to health problems and obesity.

Meat Products

Sakis have a digestive system adapted for feeding on plants parts, made evident by their capability for hindgut fermentation. They do not need to ingest any animal matter, except for insects. Their average diet contains at most 10% protein. The occasional hardboiled egg is fine.

To see total food items currently used in diets as detailed by our surveys, please view Appendix II and III**.**

2.5.2 How Much to Feed

The total amount of food and different proportions of food given will vary depending on the type of pellet available.

A suitable diet can be compiled by using the information of tables 3 to 6 (see above) and other information mentioned in these guidelines. The use of animal nutrition software, such a Zootrition, may be helpful for calculation the exact contents of the diet. Alternatively, the contents can also be calculated by hand or by using Windows Excel.

When neither of these are an option, a good guideline for small primates is that they need a daily intake of 4-5% of bodyweight as total dry matter (about 80-100g dry matter for and adult saki monkey). During a period of several weeks, the exact total amount of food can be adjusted to the appetite of theanimals. Table 9 shows what percentages each part of the diet should be.

Table 9. percentage distribution of the ingredients in the diet of the white-faced saki

Ingredients	Percentage of total diet
Concentrate feeds (pellets)	20
Seeds and nuts	5
Vegetables	60
Other food items (Browse, insects, exudates, whole grains, fruits)	15

2.5.3 Seasonality

The majority of zoos do not change their saki diets seasonally (69% of survey respondents). Their diet does in fact, vary seasonally in the wild and a replication of that can be enriching in captivity. So far, no evidence to support its necessity. Using the vegetable groups proposed above, it is easy to allow for seasonal changes of your vegetables. This helps to keep costs low, increase food diversity over theyear and gives your zoo the opportunity to buy its produce locally.

2.5.4 Medication

Medication such as tablets should be hidden in a highly palatable food item such as a little piece of boiled root vegetables or fruit (for this case, an exception to the no fruit-rule is alright). Some capsules

can be opened up, or tablets can be grounded and the resulting powder can be mixed in with a natural peanut butter, which can then be placed on any vegetable. Check with the veterinarian before employing this method.

2.5.5 Special Dietary Requirement

Pregnant Animals

The current trend with saki monkeys is not to increase the total amount of diet during gestation or lactation (83% of survey respondents). Pregnant females will require larger quantities of nutrients overall, but special attention must be paid to calcium and phosphorous. The calcium to phosphorous ratio should always be at the very minimum 1.2:1, but during pregnancy 2:1 is preferred. For this reason, a more concentrated or extra dose of vitamin and mineral supplement is suggested.
Gestate female primates have been shown to have a more efficient digestive process than non-gestate females (Kemnitz et al. 1984). They will metabolise more energy and assimilate more nutrients than they normally would, which renders giving extra food unnecessary.

Lactation

Lactation is the most energetically expensive state for mammals. Daily energy needs are estimated to increase by 23% (NRC, 2003). The majority of zoos did not increase total food quantity in the diet. One common tactic is to add in an extra portion of food for the offspring. Initially this may be eaten by the mother when her energy requirement is higher, but eventually it will be eaten by the juvenile.

2.5.6 Method of Feeding

All animal diets should be prepared in a clean environment that has not been in contact with any animal products as described in Kleiman et al. (2010) and which follows the agricultural laws of your country. All utensils used in food preparation should be clean and it is advisable to wear gloves.
According to the nutrition survey, zoos are divided on how many feeds should be given per day. 19% of zoos feed three times a day with 14% feeding two times a day. Ideally you would provide your primates with many small meals, which has been shown to keep them active for a longer part of the day. They can forage for up to 50% of their daytime in the wild. Three feeds per day should be the norm, with some zoos able to perform even more feeds. This will also help to control their appetite and reduce possible aggression during and around feeding time (Speechly and Buffenstein, 1999). The first meal of the day should be the pellets to encourage ingestion.
The majority of zoos feed their sakis at set times (75%) which is only a problem if abnormal anticipatory behaviours are observed. If so, then the switch should be made to random and/or increase the number of feeds per day.
According to the nutrition survey, 52% of zoos chop their diets (usually fruit and vegetables). This is commonplace with the idea being that the more pieces there are, the easier it will be for all members ofthe group 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 belief. Plowman *et al.* (2009) showed us that diets actually should NOT be chopped. A study was done at Paignton Zoo Environmental Park on food presentation with *Macaca nigra* where their daily diets were either cut in pieces or left whole and either scattered or placed in piles. 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. 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 contents of a fruit or vegetable begin declining immediately after being cut therefore, offering un-chopped food items will also ensure a higher nutritional fidelity.

The diet should be presented as naturally as possible. Hanging baskets across the enclosure (the location of which canthen be changed), scatter fed across multiple vertical levels and hidden food items in bags andin boxes of leaves or sand. Food presentation should always be enriching (it should always promote natural feeding behaviours) and the feeding in bowls should be discouraged. This will also look better for visitors, seeing active “foraging” monkeys instead of individuals sat down eating from their plate.

2.5.7 Water

Water should always be available in both indoor and outdoor enclosures. Bowls can be used as well as water bottles, as long as the white-faced sakis have an unhindered access to clean, potable drinking water. More than one sources of water are desired to allow all members of the troop to drink if they want to.

2.6 Social structure

2.6.1 Basic Social Structure

Most of the captive saki groups consists of a breeding male, a breeding female and their offspring. The offspring stays with its parents until it is kicked out of the group, which happens mostly after three years.

The maximum size of a bachelor group is two. Sometimes a group of three will manage, but this is mostly when the group consists of a father with his offspring. With larger bachelor group sizes, the animals will start fighting with each other regardless of the amount of space in their enclosure. Bachelor female groups can sometimes grow up to 4-5 animals, although, there is no expectation that these kind of female bachelor groups will be created in the nearby future as there is currently a surplus of males in the EEP population.

2.6.2 Changing Social Groups

For the programme management it is essential for animals to be transferred and introduced in new, existing groups. Introducing animals to each other is a gradual process which takes some time. All introduction should have increasing olfactory, visual, auditory and physical contact. There have been successful reports of adults of both sexes being re-introduced to existing groups, for example after surgery.

There is one known case where a mother with offspring was introduced to an unrelated male; no aggression to the offspring was observed and the introduction was successful.

2.6.3 Mixed Species Exhibits

Saki’s are very tolerant animals and therefore ideal to keep in multi-species exhibits. Many zoos currently house their sakis together with other animals. A list of all the species that zoos have a positive experience with can be found in Appendix IV. There is a difference of opinion with regards to the certain species and their suitability of certain species to be mixed with white-Faced sakis. A list of those species can be found in Appendix V.

If different species are together in an exhibit all species should have their own indoor enclosures. This allows separation of species and offers a safe escape area.



Figure 10. Golden headed lion tamarin young on the back of a white-faced saki female. Photographer Heidi Schneider, Zoo Wilhelma, Stuttgart

2.7 Breeding

2.7.1 Oestrus and mating

Captive Saki's don't have a breeding season, and births can occur throughout the year. Females do not show any obvious physical or behavioural changes at time of ovulation and they were not observed actively asking for copulations from males (Savage et al., 1993, 1995). Males might be able to distinguish cycling females from non-cycling females, as copulations are more frequent with cycling females (Thompson et al., 2011).

Scent-marking behaviour seems to be one of the more common sexual behaviours. Among scent-marking are behaviour patterns such as throat-and-chest rubbing, rubbing their groin and urinating on marked branches. Marking behaviour is strongly sex related, with the adult male making 88.4% of the markings (Eleonore et al., 1997). Male scent-marking frequency increased during breeding periods. Scent-marking behaviour seems related to courtship, and possibly stimulates sexual behaviour.

2.7.2 Pregnancy and birth

During May 2019, a questionnaire on zoo management and husbandry was conducted among saki holders within EAZA. Among the 39 responses, two institutions reported to have experience with caesareans on a female white-Faced Sakis. In both cases the procedure was done because the infant died in utero. The breeding female in Zoo Basel had four C-sections, before she was able to give birth and raise young independently. She however has raised 7 young since then without complications. Why this was difficult before and if a similar situation could occur with another individual of the species is unclear. Pregnancy in sakis is usually assessed by weight or belly size.

2.7.3 Maternal behaviour

Females sakis are the predominant caregivers. Infants stay attached to their mother's side from birth to one month. From age one to four months, the young shift to a dorsal position where they can achieve greater mobility. The mothers carry their infants for the first three months. Once the infant isaround the age of five months, the mother will stop carrying it. They feed, protect, and nurture younguntil they are ready to be on their own. In the wild infants observe at least one birthing event prior to

leaving their family group (Waters 1995). In captivity, sakis overall show good parenting behaviour. Nyiregyhaza Animal Park in Hungary reported that when their female saki died, the male took over the role of caregiver and started carrying the young on his back. Cross-fostering is also frequently seen and documented in sakis. Often the older offspring will carry and take care of their younger sibling, or a grandparent will tend to their grandchild. As long as the young gets sufficient opportunities to nurse this is completely fine.

2.7.4 Infanticide

Infanticide is very uncommon in the species, only one animal in the current zoological collection is known to kill her offspring. She has been together with her partner since 2013 and has fully reared only one young. She shows usually normal behaviour and no signs of stress. Therefore, infanticide is something that is not further discussed.

2.7.5 Development and care of young

There is a lack of specific data on the development care of young for the white-faced saki. Data on hand rearing of a silver-backed saki (*Pithecia monachus)* is recorded in Oklahoma City Zoo (Clevenger, 1981, p. 221). In this example the young needed to be hand reared because the mother was not able to take care of the young. Because of the similarities between these species this can be used as an example for the development and care of young white-faced sakis. The young weighted 121 g when entering the nursery and there were some signs of dehydration. The saki was housed in an Amstrong XP infant incubator and provided with a blanket to cling to for security. The incubator's bedding was changed as necessary and was disinfected daily. The temperature was set to 29℃ and a relative humidity of 65 – 70 % was maintained to help prevent respiratory problems. At the age of six weeks the saki was transferred to a glass fronted wooden box (93x55x55 cm) with a 2,5 cm^2 woven wire lid. The box was supplied with wooden dowels, tree branches and a variety of small toys. When the saki was climbing well, and extra 76cm of height was added.

2.7.6 EAZA policy on hand rearing

The policy from the EAZA on hand rearing a EEP species is: natural rearing is preferred over hand rearing. Whenever there is no other possibility than hand rearing and the parents of the young are of genetic importance for the EEP. The coordinator should be consulted before making any decision (EAZA, 2019).

2.8 Population Management

Most groups in the zoo population consists of one breeding male, one breeding female and their offspring. Sub-adults are placed in other collections after they have seen their parents give birth to and raise a young or if they have been kicked out of the group.
Culling is currently used as a management tool in three institutions. If you are interested in this option, always discuss with the programme coordinator what the options are.

2.8.1 Contraception

A big part of the European population has received contraception. The main reasons to apply contraception are to prevent breeding or inbreeding, but other reasons to apply contraception can be reduction of aggression, for sub-adults to stay longer in the group or for health reasons. Hormonal implantation is the most commonly used form of contraception. Castration or vasectomy is only applied if it is certain that the animal will not need to breed for the rest of its life, and is only allowed after consent of the EEP coordinator. The majority of the contraceptiveusers do not see any behavioural, physical or hierarchical problems or changes (Prins, 2015; Stenger, 2014). However, an increase in positive behaviours, negative behaviours, self-directed behaviours and sexual behaviours were reported for animals on hormone implants. One animal which was on a hormonal implant had a mild weight change. A castrated animal which never really developed full-male colours now has a female physical appearance (figure11). No issues with reversibility have been observed and there have been individuals who have successfully reproduced after their implant has expired (Prins 2015).



Figure 11. Male saki with a feminine appearance after castration. Photo credit: Gaia Zoo

The EAZA Reproductive Management Group (RMG) has produced a set of contraceptive guidelines which can be used when planning to contracept an animal.

2.9 Behavioural Enrichment and Training

Just as all New World monkeys, sakis are highly intelligent animals. They may be trained to perform certain behaviours that could be useful for both medical and management purposes through the use of positive reinforcement. For example, they can be taught to enter and exit an exhibit on command, to shift between enclosures, to enter a crate, shifting onto a scale to be weighed or to allow certain medical procedures such as the injection of insulin by stationing themselves at the bars or mesh of the fencing (Reinhardt 2005). However, take note not to use additional food as reinforcement, but only use food types and quantities that are part of the daily diet of the animal, as it is easy to overfeed.

2.10 Handling

Handling of the animal should be avoided if other methods are available. In cases where handling of the animal is necessary, for example with the placement of a microchip transponder as a mean of identification, safety measures should be taken(see 2.10.2).

2.10.1 Individual identification and sexing

Sexing is usually done by visual examination through wire mesh fencing. Training the animals to position themselves against the fence for examination, through the use of positive reinforcement, can be a useful tool in sex determination. As an individual identification method, a microchip transponder is usually placed subdermal in the shoulder.

2.10.2 Catching/Restraining

Capturing a White-faced saki can be done in multiple ways. Ideally enclosures are built with a crush tunnel system in which the animals can be captured if necessary. When such a system is not available nets are commonly used as a capturing method. The animal should first be separated from the others to keep family members from interfering. Wearing protective gloves as precaution is recommended when performing this method.

When saki has to be captured for transport, it is recommended to start training the animal to go into a training cage by itself a few weeks in advance. This can easily be achieved through the use of positive reinforcement.

Physical restraint should only be applied if no other methods are available. It should only be carried out by experienced handlers, as it causes a lot of stress for the animal and could potentially be

dangerous for an inexperienced handler (Fowler & Miller 2015). When handling the white-faced sakiit is recommended to wear thick leather gloves and long-sleeved clothing to avoid scratching or biting.

2.10.3 Transportation

Generally speaking, sakis are best transported in plastic or wooden crates or carriers designed for dogs and cats. The crate can also be built specially for monkeys, but a regular crate or carrier for house pets will do just fine, given that it is sturdy, well ventilated, in good condition and substantial enough to safely contain the animal and prevent people from accessing it during transport (Fowler & Miller 2015). Sakis should generally be transported individually. Exception is when they have a suckling youngster or newly weaned juvenile.

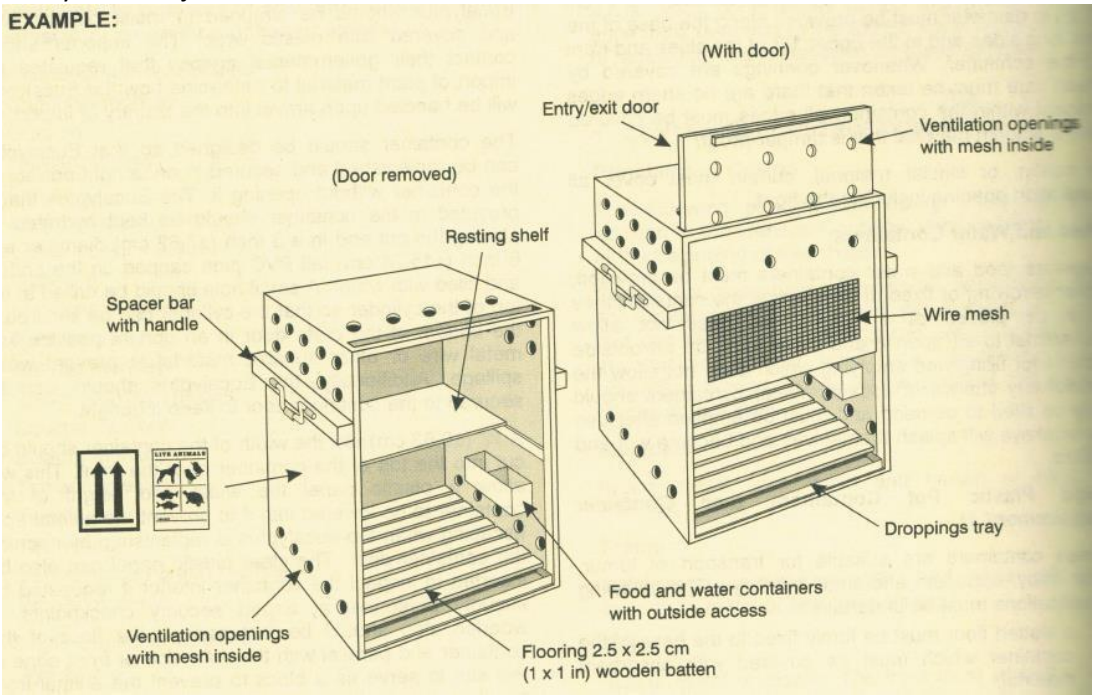


Figure 12. Example of a crate conforming to container requirements 31, set by IATA for multiple primate species, including the white-faced saki.(picture: IATA.org)

When travelling by plane, compliance with shipping regulations of the international Air Transport Association (IATA), local and national regulatory agencies, and those of the airline are required. The crate must meet all requirements of design by IATA (see Figure 12 above for an example crate fit for transport of the species). Food and water should be provided in transit when the shipment is delayed. Therefore, the crate construction should prevent the spilling of food, water or waste. Any necessary pre-shipment medical testing should be completed, and the health certificate, the medical record, and copies of test results should be included with the shipment (Fowler & Miller 2015). Pregnant females and females with suckling young are not allowed to be transported by plane. Young animals must not be separated from one another while traveling as this increases stress. They must be in portioned off containers or in separate containers loaded adjacent to each other in the aircraft (International Air Transport Association, 2014).

2.11 Veterinary Care

2.11.1 Sedation and anaesthesia

When possible, anaesthesia should be avoided since the procedure is risky for the animal. For any given situation, the cost and benefits of sedation or no sedation should be weighed against each other.Since the correct dose of anaesthetic is vital, it is important that the animals are weighed periodically so the correct dosage can be provided (Hosey, Melfi and Pankhurst, 2013).

2.11.2 Preventative medicine

Preventive medicine is very important in the care for white-faced sakis. A preventive medical program should typically include a routine check for parasites through faecal examination (at least annually, preferably several times a year), and prophylactic parasite treatment protocols based on the parasite history of the colony or zoo collection and faecal parasite results. In many cases, prophylactic parasite treatments will be administered for both protozoal and helminth parasites. If animals have negative faecal results it is recommended to rather do routine checks, instead of treating animals without having a positive test.

Other preventive medical procedures should be based on the medical history of the individual animal and/or the medical history of the group. The decision to perform any examination or procedure should be based on a risk-benefit analysis. Calculating in the risks involved with anaesthesia and handling of the animal, the social impact on the individual animal or the group, and the expected benefit from the procedure. If performed annual examinations can cover: physical examination, dental evaluation, hematologic and biochemical screening from blood sample, viral serology specific to the species, vaccinations, tuberculin testing, radiography and ultrasonography (Fowler & Miller 2015).

2.11.3 Health examination before and during animal transportation

Health certification and serological testing must be arranged several weeks before transport. Only animals which appear to be in good health, judging by appearance and behaviour, should be transported. If there is any chance of pregnancy in a female saki scheduled for air transport, this must be checked. Pregnant monkeys of any kind are not accepted in air travel and should be transported long distances otherwise. It is better to wait with transferring pregnant animals if there is no need to do so immediately. If an animal appears to have become ill or has been injured during the transport, veterinary treatment must be arranged as soon as possible (International Air Transport Association, 2014).

2.11.4 Infectious diseases

White-faced sakis are susceptible to a range of diseases caused by pathogens, including parasites, bacteria and viruses. This section highlights infectious diseases commonly found in the species, ordered by causative pathogen. Signs indicating presence of the disease are provided, as well as how a diagnosis is established. Notable cases of treatment are also mentioned for future reference.

2.11.4.1 Viral diseases

The most common serious viral disease in white-faced sakis as well as other New World and Old World monkeys is infection with the human herpesvirus 1 **HHV1.** HHV1 infection is transmitted through direct contact with a human host with active lesions. Signs include: conjunctivitis, nasal discharge, ulcerative dermatitis, lingual ulcers, and necrotic plaques. Analysis of conjunctival swabs can confirm if the infection is indeed caused by HHV1 (Fowler & Miller 2015).

In most cases the disease is rapidly fatal in white-faced sakis. However, one case was reported in which an ocular infection with HHV1 in a 20-year-old male saki was successfully managed for over 2 years by using acyclovir (5 mg/kg PO twice daily) during flare-ups before the disease progressed and the animal was euthanized. This is the first reported case of successful management of HHV1 infection in a platyrrhine primate and the first case of HHV1 in a white-faced saki that was not rapidly fatal (Bauer et al., 2018).

2.11.4.2 Bacterial diseases

Table 10 shows a comprehensive list of bacterial diseases commonly found in white-faced sakis specifically or New World Monkeys in general, which are zoonotic and thus should be handled with protective precautions. Non-zoonotic bacterial diseases are portrayed in table 11.

Table 10. Selected list of zoonotic bacterial diseases in white-faced saki's and New World monkeys alike (Fowler & Miller 2015).

Disease	Epizoology	Signs	Diagnosis
Mycobacteriosis	Saprophytic opportunistic organisms acquired by contact with contaminated water or soil via respiratory, oral or skin contact.	Diarrhoea weight loss, lymphadenopathy, splenomegaly, segmental to diffuse thickening of intestinal mucosa mainly terminal ileum and proximal colon; draining fistula or ulcerated cutaneous lesion.	Intradermal tuberculin skin test with Mammalian Old Tuberculin read at 24, 48 and 72 hours; radiographs; antibody-based testing (see text); faecal and gastric samples for acid-fast stain, culture and PCR, acid-fast stain; necropsy, histopathology; biopsies ay aid in diagnosis and culture is definitive, but only if positive.
Yersinia	Food contamination by rodents and birds carry faecal-oral transmission	Diarrhoea, anorexia, dehydration, suppurative enteric and hepatic lesions, abortions, stillbirths.	Culture and histopathology, impression smear from necrotic foci
Shigellosis	Faecal-oral transmission; initial infection from humans. Colony infection is probably due to asymptomatic carriers and rodent reservoirs. Stress may be a factor in causing overt disease.	Bloody, mucoid, dysentery, weakness, dehydration; facial oedema.	Rectal culture (may require several cultures); necropsy, histopathology; tissue PCR
Salmonellosis	Faecal-oral transmission; Aerosol transmission is rare. Insects and rodents may be source of infection.	Can be asymptomatic carries, watery to bloody mucoid diarrhoea and dehydration.	Culture, gross and histopathology

Escherichia coli	Faecal-oral transmission	Diarrheal, pneumonia, enteritis, meningitis, hepatomegaly, splenomegaly	Culture; necropsy, histopathology, identification of specific serotypes of *E. coli* (reference laboratory to type and isolate), HEp-2 adherence assay, detection of *E. coli* toxin genes by PCR.
Campylobacteriosis	Faecal-oral. Recovered animals shed bacteria for up to 21 days after diarrhoea resolves.	Asymptomatic carriers, watery to mucohemorrhagic diarrhoea, colitis, electrolyte imbalances, weight loss. C. fetus caused fetal death	Culture; histopathology, serology; fluorescent antibody or avidin-biotin antibody staining of intestinal biopsies.

Table 11. List of selected non-zoonotic bacterial diseases in white-faced sakis or New World monkeys alike (Fowler & Miller 2015).

Disease	Epizootiology	Signs	Diagnosis
Gram-positive cocci	Respiratory, aerosol transmission; carriers harbour bacteria in nasal passages, throat. Animals may be predisposed to infection by stress, viral infections, immunosuppression.	Asymptomatic carriers; Pneumonia, septicaemia, bacterial meningitis, purulent conjunctivitis, panophthalmitis, peritonitis and arthritis.	Culture, CSF tap, clinical signs, histopathology
Tetanus	Soil contamination of wounds, post-partum infection, frostbite	Progressive over 1-10 days; lethargic, excessive thirst, unable to prehend food, difficulty swallowing, progressive stiff gait and adduction of forelimbs, biped walking or hopping, piloerection, tenesmus, extensor rigidity exacerbated by noise, seizures, opisthotonos.	History and signs; bioassay for tetanospasmin. PCR test for human diagnosis, tetanus IgG (Antitoxin) enzyme-linked immunosorbent assay (ELISA)
Helicobacteriosis	Transmission occurs in young in social groups, likely oral to oral from dam to offspring. Some enterohepatic helicobacters are identified with no definitive link of causality.	Usually asymptomatic. Gastric: gastritis, occasional vomiting, gastric ulcers. Enteric: chronic wasting, diarrhea.	Gastric helicobacters: gastric endoscopy and gastric biopsy, culture, rapid urease test, *H. pylori*plasma IgG. Enteric helicobacters:culture, colonoscopy, colonic biopsies with PCR.

2.11.4.3 Fungal diseases

Table 12 below shows two fungal diseases commonly found in white-faced sakis or other related New World monkeys, including signs that could indicate infection as well as how the disease is diagnosed.

Table 12. Selected parasitic diseases in New World monkeys (Fowler & Miller 2015).

Disease	Epizootiology	Signs	Diagnosis
Pneumocystis	Pneumocystis species infecting different hosts are genetically distinct taxa. Life cycle includes a trophic and cyst (generative) phase.	Clinical disease is secondary to immunodeficiency, stress, neoplasia etc.	History (pulmonary disease with immunodeficiency); necropsy; histopathology; bronchoalveolar lavage (BAL)
Coccidioidomycosis	Transmission through inhalation of arthrospores. Exposure usually in non-human primates housed outdoors exposed to dust storms or dust from recent construction with disturbance of virgin desert.	Disseminated disease: lesions in lung, vertebrae, liver, kidneys, spleen, esophagus, and lymph nodes. Nasal discharge, cough, dyspnea, pneumonia, weight loss, lameness, altered gait, paralysis, ascites, failure to thrive.	Culture; Identification of organism in cytology or histopathology; clinical signs, history, serology (completement fixation or tube preciptin test) or skin testing with cocci dioidin, radiography.

2.11.4.4 Parasites

Table 13 below shows a list of diseases found in white-faced sakis or other related New World monkeys caused by the infection with a parasite. Information on whether or not the disease is zoonoticis included, as well as where in the body the parasite is usually found, signs indicating infection and how the disease is usually diagnosed.

Table 13. List of diseases commonly found in white-faced sakis or New World monkeys alike caused by parasites (Fowler & Miller 2015).

Disease	Zoonotic	Location in host	Clinical signs	Diagnosis
Giardia Enteric flagellates	Yes	duodenum, jejunum, upper ileum	Asymptomatic carriers, usually self-limiting, vomiting and diarrhoea	Trophozoites/cyst in faeces, DFA; faecal EIA
Ameba **Amebiasis**	Yes	Ameba and cysts in cecum, colon. Invasive trophozoites cause abscesses in lung, liver and brain.	Asymptomatic to severe disease (weight loss, lethargy, haemorrhagic, diarrhoea, rectal prolapse), pulmonary, neurological signs, virulence depends on host, strains, nutritional status, gastrointestinal, microflora, and environmental factors.	Fresh faecal examination for O and PI histopathology, faecal trophozoites may be non-pathogenic
Toxoplasmosis	Yes	Found in any organ but especially the liver, lymph nodes and brain.	Retinal lesions; respiratory distress and central nervous system signs.	Histopathology (IHC), Sabin-Feldman dye test, serology: CF, IFA, HA

Malaria	Yes	Asexual phase: schizogonic phase in erythrocyte (erthrocytic; blood phase) or in liver (exoerythrocytic; liver phase)	May be fatal even in adults because of destruction erythrocytes.	Identification of organisms in red blood cells, PCRF, fluorescent antibody, serology.
Pinworms **Oxyuriasis**	Yes	Adult worms reside in colon. Deposit eggs in perianal and perineal area; hatch into larvae.	Perianal pruritus, restlessness, self-mutilation, increased aggressiveness.	Faecal O and P; Examine sample of anal area with cellophane tape and perianal or perineal swabs; adult worms coming out of anus.
Filarioidea **Filariasis**	No	Adult worms in subcutaneous tissues, thoracic and peritoneal cavity; subserosal connective tissue of abdominal and thoracic cavities. Microfilariae in blood biting and blood sucking insects transfer microfilariae to primate host with blood meal.	Asymptomatic. In heavy infestations *with D. graciliformes, D. gracile, D. robini, D. caudispina* or *D. freitas* may cause pleiritis or peritonitis; anemic, eosinophilia, hyperproteinemia, decreased A/G ratio. Lesions: haemorrhage, thickening of connecting tissues, adhesions in sites where worms are located.	Microfilariae in blood, adult worms found in peritoneal cavity.

2.11.5 Non-infectious diseases

Wounds inflicted through conflict are generally not that common in white-faced sakis, but can still occur in unstable groups. Wounds should be disinfected as soon as possible to prevent inflammation.

2.11.6 Necropsy

Necropsies should be conducted on all monkeys that die in quarantine or in the colony or zoo collection. This should include gross necropsy, histologic evaluation of the tissue, and appropriate ancillary testing (cultural, molecular diagnostics, etc.). Thorough necropsy will not only determine the cause of death but also serves as a way to evaluate the group, species and colony or zoo collection for the presence of infectious, parasitic, nutritional, toxic, or metabolic diseases that are relevant to the care of the remaining group of sakis.

2.12 Recommended research

As stated in paragraph 1.3, little research is done about the physiology of the white-faced saki. To aid future medical treatment and examination, research comparing information such as heart rate, respiratory rate and body temperature from several healthy adult individuals is recommended. This research is best executed in captivity and would shine a light upon the physiology of the captive white-faced saki population.

A report published in Comparative Medicine in 2018 stated that an ocular infection in a white-faced saki monkey was successfully managed for over two years (Bauer et al., 2018). This is the first reported case of successful management of HHV1 infection in a platyrrhine primate and the first case of HHV1 in a white-faced saki that was not rapidly fatal. Extended research on the management of HHV1 infection is recommended, as it would not only be interesting for the species but for non-human primates in general if successful management of the viral infection could be reproduced.

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APPENDIX

Appendix I: An overview of white-faced saki enclosure size in different zoos compared to group composition and other relevant factors

Group composition	Shared with	Enclosure size	Other notes	Zoo
1.1	Breeding group emperor tamarins and gold agouti	**Indoor:** 4x6x3m 3 separate compartments, 4x3m + 3x1m + 1x4m **Outdoor:** 6x10x4.5m, roofed with wire mesh 3x3 cm	A part of the accommodation is in public view, excluding the separation area	Blackpool
2:0	-	**Indoor:** 2.5x3.5x3m One compartment but can easily be adjusted if needed **Outdoor:** 10x122x5m, partially roofed and designed to create a raised conservatory that traps heat and stops wind, 50 mm chain-link fence	In public view	Not stated
1.2	Motmot, gold agouti, channel-billed toucan	**Indoor:** 40 m^2, 4 m high, 1 behind the scenes management stall of 10 m2 **Outdoor:** No outdoor exhibit	A part of the accommodation is in public view, excluding the separation area	Parc Zoologique de Lille
5.3	2 golden lion tamarins and 1.1	**Indoor:** 3 separate rooms +/- 3x4x5m which are all accessible through sliders	Indoor accommodation is out of public view	GAIA Zoo

	White-faced marmoset	**Outdoor:** Open outdoor exhibit with trees, 15x8m, 15 m useable height		
2.0 (father+son)	Golden lion tamarins	**Indoor:** 7.20m x 3.00m x 2.50m high **Outdoor:** Open top Island about 10x4m, about 8-10 m useable height, water barrier	Indoor accommodation is out of public view	Not stated
2.1 (father+offspring)	-	**Indoor:** 4m^2, split in 2 compartments **Outdoor:** Island: 10-15m^2 , about 6m useable height open top exhibit. Small wooden fence, water barrier	Indoor accommodation is out of public view	Not stated
2.0	White-lipped tamarins, 2m1 common marmosets, armadillos and iguanas	**Indoor:** 3.6 m x 2.90 m 2 compartments of 1.75x2.9m//1.85x2.9m **Outdoor:** 4707 m^2, 5.5m useable height, roofed with fence, glass fencing	Indoor accommodation is out of public view	La Lajita
1.2	3.0 Goeldi's monkey, 1.1 lowland paca, 1.1 sun bittern, 0.1 black-tailed trogon. No problem except with nutrition	**Indoor:** The aviary is in a greenhouse. Approximate width 10m x depth 6m x height 6m **Outdoor:** No outdoor exhibit	Entirely in public view	Montpellier
2.0	Emperor tamarins	**Indoor:** 2x3.5x2.5m **Outdoor:** 5x7x10m, mesh and timber roof	A part of the indoor accommodation is in public view, excluding the separation area	Not stated

2.3	Common marmosot, golden-headed lion tamarin, red footed tortoise	**Indoor:** 6 x 9m 2 separate compartments of 6 x 9 m and 2 x 1.5 m **Outdoor**: 5x5x4m , roofed with 2.5x5 cm netting	Tension before with 2 more male offspring (they are gone now and male is castrated, everything is fine). A part is in public view, excluding the separation area	Faruvik
2.0	Cotton top tamarin, Azara agouti and red howlers	**Indoor:** 15x4x3m 1 compartment of 1.5x5m **Outdoor**: 40x15x10m, open top	Aggression between the males 3-4 times a year	Not stated
2.1 (couple and young of the female)	Azara's night monkey. Titi monkey, golden lion tamarin, pygmy marmoset	**Indoor:** 2000m^2 **Only indoor**	Entire accommodation in public view	Not stated
2.0	Cottontop tamarins	**Indoor:** 4x3m 2 different compartments (one for saki's, one fortamarins) of 2x2m **Outdoor**: 100m^2, useable height 4m, roofed with an iron net of about 5mm	A part of the indoor accommodation is in public view, including the separation area	Not stated
1.1	-	**Indoor:** 15m^2, two compartments **Outdoor**: 45 m2, useable height 5m, roofed with fence with 2.5 x 2.5 cm mesh	A part is in public view, including the separation area	Not stated
1.2	-	**Indoor:** 8 m^2	Indoor accommodation is out of public view	Not stated

		3 compartments of about 2m^2 each **Outdoor:** 47m^2, height 6m, roofed with 4x6 cm hexagonal mesh		
2.0 (but separated)	One with 2.0 red- handed tamarins,one with 2.0 golden-headed lion tamarins	**Indoor:** two separate compartments, both 3x1.5x2.5m **Outdoor:** 6x5.5x7.5m 6m useable vertical height, roofed, wooden frame with 8mm metal mesh	Arrived at the zoo as bachelor pair, however displayed aggressive/over dominance behaviour which led to separation.	Not stated
1.1	Goeldi monkeys, golden headed lion tamarins	**Indoor:** 20 m^2 (2 separate compartments of 3.5m^2 and 10m^2) **Outdoor:** 80 m^2 and 4000 m^3 with a useable height of 5m and anetted roof with 3.5cm mesh size	A part is in public view, excluding the separation area	Reserve Zoologique Calvac
1.2 (castrated M + 2 sisters)	3.0 Red howler and 2.0 mara	**Indoor:** 14m^2 2 separate compartments (7m^2 for 1.1 and 7m^2 for 0.1) **Outdoor:** 600 m^2 with a useable height of 5-6m, open-top and water moat barrier	aggression between the sisters after the arrival of the male. A part of the indoor accommodation is in public view, excluding the separation area.	Not stated
2.0	Red howler, capuchins, agouti, paca, tamandua	**Indoor:** 40 ^{2}, 4.5m height 2 separate compartments (2 x 20m^2) **Outdoor:** 1100 m^2 with a useable height of 4-7m, open top exhibit with 3 x 4cm mesh wire fencing, secured with electric wire.	No problem introducing young male to older male A part is in public view, including the separation area	Tierpark Berlin

1.1	Goeldi's marmoset	**Indoor:** 6x3x3m No compartments **Outdoor:** No outdoor exhibit, height over 3m	Entirely in public view	Not stated
2.0 (father+son)	Giant anteater	**Indoor:** 3 indoor areas: 20.5 m^2, 20.5m^2 and 11m^2 **Outdoor:** 22 m^2 with a useable height of 3 m, open top exhibit with 2 cm mesh size for the fence and windows	A part of the indoor accommodation is in public view, including the separation area.	Nyíregházi Állatpark/SóstóZoo
1.2	Golden headed lion tamarins, pygmy marmosets and sloths	One big indoor hall with 600m^2 with a large pool for manatees and fishes. Two islands that the animals can use. It is a high room, approx. 10m, a lot of rope and plants for climbing. It's all one big room. There are cages for the different monkeys in case of conflict, illness or introduction.	Entirely in public view	Odense ZOO, Denmark
1.1	Green iguana, scarlet ibis, chaina torquata and other small bird species	**Indoor:** Small wood house of approx. 1 m x 0.8 x 0.8 m	All in public view Spend most of their tie outside because of warm climate	Selwo Marina
3.3, breeding pair with offspring	Titi monkeys recently, did not work well (titi's were stressed) so not currently	**Indoor:** 16.9 m^2 + 12.6m^2 +24.2m^2. Height: 2.7m 3 big compartments: 10.4m^2, 11.3m^2, 20.4m^2. One medium-sized compartment:4.4m^2 and seven small compartements >1,5 m^2	Separation area out of public view	Zoo Basel
1 group of 2.1 couple w/ son **1 group 2.1 pair w/ son** **1 male surpus**	Golden headed lion tamarin, emperor tamarin, alaotra gentle lemur, pied	**Indoor:** Approx. 4-8 m^2, divided in 2 compartments or more	In the second group the oldest son was expelled and is surplus.	Apenheul

	tamarin, goeldi's monkey		Indoor accommodation is out of public view.	
2.1 (bachelor M als non-breeding pair)	Pygmy marmosts, golden lion tamarin	**Indoor:** 6m^2, Height: 4m No compartments.	Indoor accommodation is in public view	Beauval
1.1.1	Pair of titis, a pair of pied tamarins and a sloth. There were problems at first with the male pied Tamarins.	90m^2 greenhouse plus a 10 m^2 night accommodation	A part is in public view, excluding the separation area	Paris Zoo
2.0	-	**Indoor:** 15m^{2}One compartment	The entire indoor accommodation is in public view.	Exmoor Zoo
2.2 breeding pair and offspring	-	**Indoor:** 2 compartments each 3.2x3.2x2.5 m	A part of the indoor accommodation is in public view, excluding the separation area	Edinburgh Zoo
1.1	Two-toed sloth, red-handed tamarin, iguana	**Indoor:** 8m^2, 2 compartments of 4m^2	Out of public view	Loro Parque
1.1	Golden headed lion tamarin	**Indoor:** 11m^2 with 2.8 height, 2 compartments (one of 3m^2 and one of 8m^2)	A part of the accommodation is in public view, excluding the separation area	Thoiry ZooSafari
1.3, neutered male, female and 2 adult duaghters	-	**Indoor:** 6x4m 2 compartments of 4x2 and 2x1.5m	A part of the indoor accommodation is in public view, excluding the separation area.	Fota Wildlife Park
1.3 (couple and offspring)	0.2 Golden headed lion tamarin, blue-crowned parakeet	**Indoor:** 1.2x6x2.8m 2 compartments, 1m2x2.8x2.8 and 1.2x2.8x2.8	Out of public view	Zoo de Lyon

2.0 (brothers)	Red howlers and spider monkeys	**Indoor:** Night lodge divided into 2 compartments of 2x2x2.5m	Out of public view	Zoo de Guadeloupe
3.4	0.1 Hofmann's sloth	**Indoor:** 48m² Indoor back area ca 16m^2 (2 cages of 4m^2 connected with tunnel) and a training area 8m^2	A part of the indoor accommodation is in public view, excluding the separation area	Helsinki Zoo
1.3, mother with offspring	None at the moment	**Indoor:** 13m^2, no compartments	Entire indoor accommodation is in public view. Occasionally aggression in the group. Male and one daughter (both neutered) are catalysts.	Zoo Dortmund
0.2	Sloth, agouti, howler monkey	**Indoor:** 25.6m^2, no compartments	Entire accommodation is in public view	Frankfurt
1.1 (mother and son)	2 golden lion tamarins and 2 common marmosets	**Indoor:** 6m2 3 compartments of 1.5m^2/1.5m^2/3m^2	The indoor accommodation is out of public view	Parc Zoologique de Champrépus
1.1	Cottontop tamarins	**Indoor:** 3x3m, 1 compartment	The entire indoor accommodation is in public view	Zoo du Bassin d'Arcahon
1.2	Golden lion headed tamarins, sloths and yellow-footed tortoise	**Indoor:** 38m^2 on show exhibit. 2 off-show exhibits of 12 and 8m^2	The large exhibit is visible for the public	Wilhelma Zoo Stuttgart

Appendix II: Food items used in saki diets by different zoos (study 1)

Food item name	Number of collections currently using item	Food item name	Number of collections currently using item
Apple	24	Arabic gum	5
Banana	19	Baby cereal	4
Grapes	18	Cat biscuit	2
Mango	5	Cereals	5
Melon	10	Dog biscuit	1
Orange	12	Hummingbird mix	1
Other fruits	19	Marex	7
Papaya	6	Marmoset jelly	3
Pear	19	Primate pellet	11
Tomato	15	Tamarin cake	7
Fruit	3	Trio munch	8
Avocado	3	Boiled egg	19
Beetroot	4	Boiled rice	7
Boiled potato	7	Cheese	7
Broccoli	8	Cooked meat	13
Carrot	20	Edible flowers	1
Celery	13	Honey	2
Chicory	4	Jam	1
Courgette	6	Live food	27
Cucumber	16	Nuts	16
Fennel	6	Peanuts	6
Other Veg	18	Puree mix	2
Parsnip	5	Raisins	7
Pepper	7	Seed mix	8
Swede/ turnip	4	Sunflower seeds	12
Vegetables	4	Yoghurt	2

Appendix III: Food items used in saki diets by different zoos (study 2)

Food item name (Vegetables)	Number of collections currently using item
Carrot	39
Cucumber	34
Celery	33
Broccoli	32
Zucchini	30
Peppers	30
Fennel	29
Sweet potato	25
Beetroot	22
Boiled potato	20
Leek	18
Parsnip	18
Chicory	18
Peas	16
Turnip	14
Beans	13
Kohlrabi	12
Cauliflower	7
Corn	5
Eggplant	5
Bok Choi	2
Kale	2
Radish	2
Cabbage	2
Brussel sprout	1
Mushrooms	1
other	5

Insects	Number of collections currently using item
Mealworms	32
Crickets	18
Grasshoppers	15
Morio worms	7
Wax moth larvae	3
Earthworms	1
Blaptica dubia cockroaches	1
Unknown	1

Food item name (Fruits)	Number of collections currently using item
Apple	35
Pear	25
Tomato	23
Melon	22
Banana	20
Grapes	20
Orange	17
Mango	15
Papaya	15
Watermelon	4
Berries	4
Pineapple	3
Kiwi	3
Other	7

Nuts and seeds	Number of collections currently using item
Sunflower seeds	28
Walnuts	27
Seed mix	21
Peanuts	18
Hazelnuts	16
Almonds	15
Pumpkin seeds	12
Macadamia nuts	1
Pecans	1
Cashew	1
Brazil nuts	1
Other	3

Supplements	Number of collections currently using item
Mealworms	32
Crickets	18
Grasshoppers	15
Morioworms	7
Wax moth larvae	3
Earthworms	1
Blaptica dubia cockroaxches	1
Unknown	1

Appendix IV: Possible species for mixed species enclosures with white-faced saki

Primates		
Species	**Latin name**	**Experienced Zoos**
Black howler monkey	*Alouatta caraya*	Frankfurt
Cotton-top tamarin	*Saguinus oedipus*	Besancon, Faunia, Karlsruhe, Natur'Zoo de Mervent, Opole, Skansen Akvariet
Emperor tamarin	*Saguinus imperator*	Asson, AviFauna, Dudley Zoo
Golden headed lion tamarin	*Leontopithecus chrysomelas*	Amazon World, Calviac, Chessington, Copenhagen, Drayton Manor, Furuvik, Karlsruhe, Zoo Plzen, Wilhelma Zoo
Grey-bellied night monkey	*Aotus lemurinus*	Den Lille Dyre Hague
Pygmy marmoset	*Callithrix pygmaea*	Beauval, Copenhagen, Den Lille Dyre Hague, Helsinki, Peaugres, Zoo Plzen, Montpellier, Wroclow
Red-faced spider monkey	*Ateles paniscus*	GaiaZoo
Red handed tamarins	*Saguinus midas*	Besancon, Chessington, Drayton Manor, Loro Parque
Silvery marmoset	*Callithrix argentata*	Drusillas, Leipzig
Venezuelan red howler monkey	*Alouatta seniculus*	Planete Sauvage, Tierpark Berlin
Yellow-breasted capuchin monkey	*Sapajus xanthosternos*	Tierpark Berlin

Other mammals		
Species	**Latin Name**	**Experienced Zoos**
Azari aguti	*Dasyprocta azarae*	AquaZoo, Berlin, Gettorf
Big hairy armadillo	*Chaetophractus villosus*	Frankfurt
Gaint anteater	*Myrmecophaga tridactyla*	Sosto
Giant otter	*Pteronura brasiliensis*	AquaZoo, Leipzig
Golden aguti	*Dasyprocta leporina*	Asson, Furuk Yalçin Zoo, Zurich
Greater guinea pig	*Cavia magna*	Frankfurt, Karlsruhe
Linnaeus's two-toed sloth	*Choloepus didactus*	Amazon World, Bassin d'Arcachon, Frankfurt, Karlsruhe, Krefelder Zoo, Loro Parque, Wilelme Zoo Stuttgart
Long-tailed tamandua	*Tamandua tetradactyla longicaudata*	Tierpark Berlin
Lowland paca	*Cuniculus paca*	Tierpark Berlin
Paca	*Cuniculus*	Bassin d'Arcachon, Montpellier
Palla's long-tongued bat	*Glossophaga soricina*	Nuernberg

Red acouchi	*Myoprocta acouchy*	Gettorf

Birds		
Species	**Latin Name**	**Experienced Zoos**
Amazonian motmot	*Momotues momoota momota*	Zurich
Channel-billed toucan	*Ramphastos vitellinus*	Zurich
Croaking ground dove	*Columbina cruziana*	Nuernberg
Elegant crested tinamou	*Eudromia elegans*	AviFauna
Golden pheasant	*Chrysolophus pictus*	Selwo Marina
Nocturnal curassow	*Nothocrax urumutum*	AviFauna
Northern cardinal	*Cardinalis cardinalis*	Zoo de la Fleche
Paradise tanager	*Tangara chilensis*	Nuernberg
Red-legged seriema	*Cariama cristata*	AviFauna
Ringed teal	*Callonetta leucophrys*	La Fleche
Scarlet ibis	*Eudocimus ruber*	Selwo Marina
Sunbittern	*Eurypyga helias*	Montpellier
Trumpeter birds	*Psophiidae*	GaiaZoo
Turquoise tanager	*Tangara mexicana*	Nuernberg
Violaceous euphonia	*Euphonia violecea*	Nuernberg
Ibis		Faunia
Macaw		Faunia
Toucan		Faunia, Skansen Akvarit
Different birds		Den Lille Dyre Hague, Karlsruhe, Krefelder Zoo, Zoo Zlin-Lesna

Reptiles		
Species	**Latin Name**	**Experienced Zoos**
Green iguana	*Iguana iguana*	Krefelder Zoo, Loro Parque, Selwo Marina
Martinique's anole	*Anolis roquet*	Nuernberg
Red-footed tortoise	*Chelonoidis carbonarius*	Furuvik
Yellow-headed gecko	*Gonatodes albogularis*	Nuernberg
Yellow-spotted river turtle	*Podocnemis unifilis*	Nuernberg

Lizards	Den Lille Dyre Hague, Krefelder Zoo

Amphibians		
Species	**Latin Name**	**Experienced Zoos**
Anthony's poison arrow frog	*Epipedobates anthonyi*	Nuernberg
Golden poison frog	*Phyllobates terribilis*	Nuernberg
Red-eyed tree frog	*Agalychnis callidryas*	Nuernberg

Insects		
Species	**Latin Name**	**Experienced Zoos**
Butterflies		Nuernberg
Leaf cutting ants		Nuernberg

Appendix V: Species that were mixed with white-faced saki monkeys and for which experiences are various

Primates			
Latin name	**Species**	**Zoos with positive experience**	**Zoos with negative experience**
Common marmoset	*Callithrix jacchus*	Calviac, Chemprepus, Faunia, Wroclow	Halle
Geoffrey's marmoset	*Callithrix geoffroyi*	Calviac, Chessington, Faunia, GaiaZoo,	AviFauna
Goeldi's marmoset	*Callimico goeldii*	Beauval, Calviac, La Fleche, Montpellier, Opole	Bassin d'Arcachon, Den Lille Dyre Hague, Marlow Bird Park
Golden lion tamarin	*Leontopithecus rosalia*	Beauval, Copenhagen, Frankfurt, GaiaZoo, Helsinki, Skansen Akvarit	Champrepus, Drusillas, Peaugres
Red-bellied titi monkey	*Plecturocebus cupreus*	AviFauna	Skansen Akvarit
Squirrel monkey	*Saimiri sciureus*	Vienna Zoo	Dudley Zoo
White-lipped tamarin	*Saguinus labiatus*	Oasis Park	Amazon World