EAZA

Best Practice Guidelines

for the slow loris (*Nycticebus*) species

1st Edition

2022

Editors and contributors:

Katarzyna Byczyk
Ogród Zoologiczny w Poznaniu

Nic Dunn
Wellington Zoo Trust

František Příbrský
Ostrava Zoological and Botanical Garden, The Kukang Rescue Program

Cecilia Tang
Mandai Wildlife Group

Contributors:

Dr Frances M. Baines, M.A., Vet. M.B., M.R.C.V.S.,

Lynsey Bugg
Bristol Zoo Gardens

Paige Bwye
Bristol Zoo Gardens

Dr Francis Cabana
Pet cubes

Lucie Čižmářová
Olomouc Zoo, The Kukang Rescue Program

Nils Dijkgraaf
DierenPark Amersfoort

Dr Guillaume Douay
Mandai Wildlife Group

Sergey Hlyupin
Moscow Zoological Park

Kateřina Holubová
Ostrava Zoological and Botanical Garden, The Kukang Rescue Program

Dr Barbara Jantschke
Zoologischer Garten Augsburg GmbH

Prof K.A.I. Nekaris
Oxford Brookes University

Marcel Stawinoga
Plumploris e.V., c/o Zoo Dortmund

Jan Vašák
Jihlava Zoological Garden

Ariana V. Weldon
Noctural Primate Research Group, Oxford Brookes University

Publication date:
2022

Editors' logos:

Cover page design:
Cecilia Tang

EAZA Prosimian Taxon Advisory Group:

Chair
Achim Johann, NaturZoo Rheine

Vice-Chair
Delphine Roullet, Cotswold Wildlife Park

Program Coordinators:

Pygmy Slow Loris | Katarzyna Byczyk, Ogród Zoologiczny w Poznaniu

Bengal Slow Loris | Nic Dunn, Monkey World - Ape Rescue Centre

Sunda Slow Loris | Cecilia Tang, Mandai Wildlife Group

Disclaimer

Copyright 2022 by EAZA Executive Office, Amsterdam. All rights reserved. No part of this publication may be reproduced in hard copy, machine-readable or other forms without advance written permission from the European Association of Zoos and Aquaria (EAZA). Members of the European Association of Zoos and Aquaria (EAZA) may copy this information for their own use as needed. The information contained in these EAZA Best Practice Guidelines has been obtained from numerous sources believed to be reliable. EAZA and the EAZA Prosimian TAG make a diligent effort to provide a complete and accurate representation of the data in its reports, publications, and services. However, EAZA does not guarantee the accuracy, adequacy, or completeness of any information. EAZA disclaims all liability for errors or omissions that may exist and shall not be liable for any incidental, consequential, or other damages (whether resulting from negligence or otherwise) including, without limitation, exemplary damages or lost profits arising out of or in connection with the use of this publication. Because the technical information provided in the EAZA Best Practice Guidelines can easily be misread or misinterpreted unless properly analyzed, EAZA strongly recommends that users of this information consult with the editors in all matters related to data, analysis and interpretation.

Preamble for the EAZA Best Practice Guidelines

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 “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. All forms/templates are available to download on the EAZA Member Area. 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 (Byczyk, K., Dunn, N., Příbrský, F., Tang, C. (Eds): EAZA Best Practice Guidelines for the slow loris (*Nycticebus*) species – First edition. European Association of Zoos and Aquaria, Amsterdam, The Netherlands). DOI: 10.61024/BPG2023slowlorisEN

Introduction

This is the first edition of the EAZA Best Practice Guidelines for *Nycticebus* species. The document was created due to the involvement of people working in zoos and institutions where slow lorises are kept, and people involved in the protection of species in nature. The document was created to convey the experience gathered over the years in zoos and institutions as well as rehabilitation centers, in order to provide species of the genus *Nycticebus* with the best possible conditions to live in captivity.
Previous guidelines for the care of captive loris are extensive and have been available on the website www.loris-conservation.org for a number of years. These guidelines will draw on much of the experiences from the years of experiences from those contributors.
Section 1.
It reflects our current knowledge of the genus of *Nycticebus* occurring in the wild.
Section 2.
This part was written based on the experience and surveys sent to the participants of the EEP *Nycticebus pygmaeus*. It captures our knowledge of animal husbandry in zoos and rehabilitation centers.
We do recognise that the majority of the guidance in these chapters are for animals housed in European climates and conditions in the hope of improving their management and welfare, however we hope that many of the methods are easily adapted to those holding animals in more natural settings and climates. As a result, we have a chapter written by those with experience in the rescuing, rehabilitation and management of these species in the range of countries.
During the writing of this document, the statute of the *Nycticebus* genus has changed. The species *Nycticebus pygmaeus* has been split into its own genus *Xanthonycticebus*. There occur significant differences between the *Nycticebus pygmaeus* and the other eight *Nycticebus* species. This genus is different from *Nycticebus* due to giving birth to twins, by displaying seasonal body mass and whole-body coat colour changes, and a multi-male, multi-female social system.
Section 3.
Includes the literature cited in this document.

We hope that the complex needs of all slow loris will be fully explored in the following guidelines and that further editions and update will be made to reflect the evolving nature of the best practice with these enigmatic animals. It is a living document that will be updated as we increase our knowledge of the species.

Acknowledgements
We would like to thank all those who contributed to the creation of this document. We especially thank the contributors for your work and for writing individual chapters and people and institutions for sharing photos. Thank you to everyone who took part in completing the survey, which was sent to the members of the EEP Pygmy Slow Loris in 2019 and was a source of information for us for individual chapters.

Content:

Section 1: Biology & captive history

Authors:
Section 1.1 (Taxonomy): Anna Nekaris, Ariana V. Weldon
Section 1.2 (Morphology): Anna Nekaris, Ariana V. Weldon
Section 1.3 (Physiology): Katarzyna Byczyk
Section 1.4 (Longevity): Katarzyna Byczyk
Section 1.5 (Conservation status, zoogeography, ecology, species): Katarzyna Byczyk, Nic Dunn, Cecilia Tang
Section 1.6 (Diet and feeding behaviour): Francis Cabana
Section 1.7 (Reproduction): Katarzyna Byczyk
Section 1.8 (Behaviour): Anna Nekaris, Ariana V. Weldon

1.1 Taxonomy

Order	Primates
Family	Lorisinae
Genera	*Loris* (slender loris)
	Nycticebus (slow loris)

The family Lorisinae comprises two genera (*Nycticebus* and *Loris*), with nine currently recognized species in the genera *Nycticebus: N. pygmaeus, N. bengalensis, N. coucang, N. javanicus, N. menagensis, N. kayan, N. bancanus, N. borneanus* and *N. hilleri.* Two subspecies are recognized within *N. menagensis* • *N. menagensis menagensis* and *N. menagensis insularis*. Ongoing genetic work suggests at least two genera within the lorises, and there is also evidence for more species, particularly within the *Nycticebus bengalensis* and *Nycticebus pygmaeus*[1].

Table 1. Scientific names and English common names for *Nycticebus spp.*(and *Xanthonycticebus pygmaeus*), their distribution and IUCN Red List Status as of 2021 (Nekaris & Burrows, 2020).

[1] The taxonomy was changed in 2022 while writing the EAZA of BPG

Order	Primates
Family	Lorisidae, Subfamily Lorisinae
Genera	*Loris* (slender loris)
	Nycticebus (slow loris)
	Xanthonycticebus (pygmy loris)

The family Lorisinae comprises three genera (*Nycticebus, Xanthonycticebus* and *Loris*), with eight currently recognized species in the genera *Nycticebus: N. bengalensis, N. coucang, N. javanicus, N. menagensis, N. kayan, N. bancanus, N. borneanus and N. hilleri.* Two subspecies are recognized within *N. menagensis* •– *N. menagensis menagensis* and *N. menagensis insularis*. There is also evidence for more species, particularly within the *Nycticebus bengalensis.* The second genus is currently monospecific comprising the pygmy lorises *Xanthonycticebus pygmaeus,* with soon to be published genetic work advocating at least two species in Northern and Southern Vietnam. The slender lorises within the genus *Loris* comprise two species (*L. tardigradus* and *L. lydekkerianus),* with the number of species and area of contention.

Species	Common Name	Distribution	IUCN Red List
Nycticebus bengalensis	Bengal slow loris	Northeast India, Bangladesh, Bhutan, Myanmar, Thailand, Cambodia, Vietnam, Laos, China	EN (A2acd+3cd+4acd)
N. pygmaeus (*X.pygmaeus*)	Pygmy slow loris (Pygmy loris)	Cambodia, Vietnam, Laos, China	EN (A2cd+4cd)
N. coucang	Greater slow loris, Sunda slow loris	Malaysia, Thailand, Singapore, Southern Sumatra	EN (A2acde+4acde)
N. hilleri	Sumatran or Hiller's slow loris	Northern Sumatra, Indonesia	EN (A2cd+3cd)
N. javanicus	Javan slow loris	Java, Indonesia	CR (A2cd+4cd)
N. menagensis	Philippine slow loris	The Philippines, Brunei Darussalam, Malaysia (Sabah, Sarawak)	VU (A2cd+3cd)
N. kayan	Kayan slow loris	Indonesian Borneo North and West; Malaysia (Sarawak)	VU (A2cde+3cde)
N. borneanus	Bornean slow loris	Indonesian Borneo South	VU (A2cd+3cd)
N. bancanus	Sody's or Bangka slow loris	Bangka, Indonesia	CR (A2cd)

1.2 Morphology

Both morphological and molecular genetic data support the division of the Lorisidae, which includes the African galagos and pottos and Asian lorises, into three subfamilies: Galaginae, Perodicticinae and Lorisinae. This family comprises the Asian slender and slow lorises, which exhibit one of the greatest ranges of body sizes amongst the primates (male mass range 135-2,100 g; female mass 100-2,000 g). Slender lorises comprise two species in Sri Lanka and India (*Loris lydekkerianus* and *L. tardigradus*) and are not considered in this overview.
Morphologically, slow lorises possess an array of characteristics that adapt them for a slow-moving arboreal lifestyle in continuous canopy, undergrowth or tree fall zones. They cannot leap but can racewalk and are capable a wide array of hanging and clinging postures. A reduced second digit on their opposable hands and feet, a 180° abducted thumb, and a grooming claw on their hind limbs, alongside limb arteries that end in vascular bundles called *retia mirabilia*,

allow them to maintain a powerful grasp for extended periods of time. In terms of relative lengths of digits, by listing them in order of decreasing length, or the digital formula, lorises ally with lemurs at 4:3:5:2:1. The second digit, replete with toilet claw on the foot, is extraordinarily reduced in comparison. Possession of fewer caudal vertebra and a greater number of thoracic vertebrae (16 rather than 12) gives lorises a sinuous appearance, allowing their backs to sway like a snake.

Another key suite of characteristics of slow lorises are their extreme adaptations to exudativory, or gum and exudate feeding. The features above allow them to cling to trunks for extended periods. Although the dental formula varies based on species, in general it is: i 2/2, c 1/1, pm 3/3, m 3/3), and all species possess a stout tooth comb that permits active gouging in trunks, branches, and even bamboo and the tough skin of fruits such as jack fruit to lick the resin within. A long narrow tongue, lack of whiskers, short duodenum, large caecum and expanded volar pads also point towards a specialisation in exudates. They also are characterised by a long dorsal stripe that in at least three taxa (*N. pygmaeus, N. bengalensis, N. javanicus*) changes seasonally, and may be related to camouflage or background matching for resource acquisition (Starr and Nekaris, 2013).

Nycticebus spp. are robust animals with short and dense fur ranging from greyish white to reddish brown. They are characterised by well-marked facemasks that help to distinguish the species. These facemasks also can have important advertising functions during dispersal to indicate fierceness and level of venomousness (Nekaris et al., 2019). The facemask also has been suggested to be a form of Batesian mimicry with cobras (Nekaris et al., 2013). Indeed, slow lorises are the only venomous and toxic primates. On its own, saliva can be cytotoxic; over-licking can cause necrosis, as can biting another slow loris. Slow loris toxin becomes venomous when saliva is mixed with secretions from the brachial gland (an adapted apocrine sweat gland) (BGE) (Alterman 1995; Krane et al., 2003). This solution can kill insects, ectoparasites, other slow lorises and also humans (Nekaris et al., 2020). Slow loris venom is administered through the modified toothcomb. Practical experiments display effective capillary action of the mandibular toothcomb as an adaptation to enable effective transfer of venom to the occlusal tooth surface allowing venom administration (Alterman, 1995; Rode-Margono & Nekaris, 2015). Venomous bites are a main cause of death of captive slow lorises, and many caretakers of slow lorises show allergic reactions to being bitten, handling them, or even being in the same room with them (Gardiner et al., 2018).

In the past, more than 20 slow loris species were recognised, and indeed incredible variation in appearance and body size persists today. Taking into account that this slow-moving species has inhabited Asia for a longer period than more speciose gibbons, macaques and langurs and faces greater biogeographic boundaries due to their locomotion, it is almost certain that several more species will be identified in the future. Until now, difficulty in obtaining and exporting or analysing genetic samples from Asia has precluded more advanced taxonomic work. Considering, however, that nocturnal primates are cryptic and rely less on vision, the extremely different appearance of geographically separated groups has been used to elevate slow lorises to new species (e.g. Munds et al., 2013).

***N. pygmaeus* (*Xanthonycticebus pygmaeus*)**

Body weight: 360-580 g

Distinct from other slow loris taxa based on their relatively small size (360-580 g); naked large black ears; fully black nose; the fur on the crown patch of the head is orangish to light brown and is diffuse to ears with eye patches rather than sharply forked. In Vietnam and China, the species exhibits regular coat colour change. Having diverged from other slow lorises 12-15 Mya and the only species regularly sympatric with another slow loris species, the only seasonal breeder and the only species that gives birth to twins, the pygmy lorises were confirmed as a distinct genus (Nekaris and Nijman, 2022). Furthermore, research in Vietnam suggests the high potential for two species in the north and the south.

N. bengalensis

Body weight: 850-2,100 g

The largest of the slow loris species, considerable variation in body size and coat colour (white to crimson red; absence of head forks to possession of light head forks) characterises *Nycticebus bengalensis* and can cause considerable confusion in wildlife trade. Generally, the neck is a creamy/white colour with stripe, ears are red/ginger in colour and encased by white/cream fur, eye forks light or not present and dark fur rim around eyes. Earlier researchers described several taxa within this species, and genetic studies in Thailand provide strong evidence for the re-elevation of *N. tenasserimensis* for the more heavily forked forms that occur near the Isthmus of Kra.

N. coucang

Body weight: 635-850 g

Physical appearance is characterized as brownish with brown crown and a dark dorsal stripe enclosed by darker line, a frosted nuchal region, a head fork that meets the circumocular patch to form points, a brown body colour that covers a less percentage of the body, with a lighter ventral region, a dorsal stripe continuing to the caudal region, and white or grey pre-auricular hair (Nekaris and Jaffe, 2007). Compared to other *Nycticebus spp.*, muzzle length is short, particularly in Sumatran forms. Like other primates in the Riau Peninsula, there is a broken distribution of this species, which does not occur North of Lake Toba in Sumatra. Earlier taxonomies, however, separated the Malaysian and Thai forms. They are unique in their facial markings and slightly larger in size and may prove to be distinct species.

N. hilleri

Body weight: 650-790 g

Physical appearance is characterized as smooth coat tending to reddish-brown or brightly rufescent chestnut washed in grey, including the dorsal stripe and facial markings with the exception of a dark black ring around the eyes. The crown is diffused with rounded forks above the eyes and less distinctly divided, the dorsal stripe does not extend to the caudal region, the red body colour extends to the belly, with a redder ventral region, and reddish pre-auricular hair (Nekaris and Jaffe, 2007; Lydekker, 1904). This species is restricted to Sumatra north of Lake Toba. It is larger than the southern Sumatran forms and distinguished especially by its redder colour and dark face mask. Rampant reintroduction of the two species across Sumatra may confound taxonomic uncertainty.

N. javanicus

Body weight: 850-1,050 g

Like its closest relative *N. bengalensis*, neck is a cream/white colour with stripe and these two species are sometimes mistaken for each other in trade and in museum specimens. Ears are tufted and encased by dark fur. A key feature of this species is the white/cream diamond shape formed by the interocular stripe between the eyes and eye patch extending down the cheek.

The distinct black and white long-haired appearance of subadults and juveniles were earlier mistaken as a distinct species *N. ornatus* (Nekaris and Jaffe, 2007). The species can fade in colour with age, and also exhibits a seasonal change in dorsal stripe (Nekaris et al., 2019).

N. menagensis

Body weight: 265-800 g

Adults of this species are the smallest known of the slow lorises, although great variation across its range means that some populations have adults larger than the minimum adult body size. Distinguished by pale golden to red fur, virtual lack of markings on its head, and consistent absence of a second upper incisor (Groves, 1971, 1998; Ravosa, 1998; Chen et al., 2006; Nekaris and Jaffe, 2007). Very pale with a light contrasting facemask and round or diffuse-edged upper circumocular patch. Lower circumocular patch is variable and sometimes extends below the zygomatic arch, it has a narrow interocular stripe, crown patch is mostly diffused, the ears are usually barely visible and naked, and the preauricular hair band is variable but mainly wide (Munds et al., 2013). The forms on Borneo tend to be darker and more marked than the almost completely pale forms from the Philippines and Natuna Island; these latter two previously were described as different species. Two subspecies are recognised: *N. m. insularis* from Tioman and *N. m. natunensis* from Natuna.

N. borneanus

Body weight: 560-680 g

Dark contrasting facemasks and predominantly round but sometimes a diffuse-edged upper circumocular patch. The lower circumocular patch never extends below the zygomatic arch, variable width interocular stripe, the crown patch is often round but sometimes a band (never diffuse), the ears are hairy, and the preauricular hair band is wide. In addition, the pelage is extremely long and fluffy, as would typically characterise a subadult. Until recently, this species had not been reported in the wild, but has been recently confirmed at the Tuanan, Borneo study site.

N. kayan

Body weight: 500-700 g

Characterized by typically having a dark, highly contrasting facemask. Its dark circumocular patch is either round or point edged along its upper margin, and the lower circumocular patch commonly extends below zygomatic arch, often as far as the base of the lower jaw. The interocular stripe is almost always narrow and is either rectangular or bulb shaped. The crown patch is variable but mainly diffuse along edges. The ears are hairy, and the light preauricular hair band is variable but primarily of moderate width (Munds et al., 2013). This species is likely sympatric with *N. menagensis,* but no studies or surveys have occurred to date.

N. bancanus

Body weight: unknown

Characterized by a deep chestnut coloured facemask and a diffuse-edged upper circumocular patch. The lower part of the circumocular patch never extends below the zygomatic arch, it has a wide interocular stripe, the crown patch is also diffused, the ears are hairy, and the preauricular hair band is narrow. The species is also characterized by a distinct crimson red dorsal pelage (Munds et al., 2013).

1.3 Physiology

1.3.1 Torpor and hibernation

Torpor and hibernation are characterized by a reduced metabolic rate, reduced activity and reduced body temperature (Bieber et al., 2014; Hoelzl et al., 2015; Ruf & Geiser, 2015; Streicher et. al., 2017). Torpor typically lasts less than 24 hours, while a prolonged state of energy-saving mode that lasts more than 24 hours is termed hibernation. During the colder winter nights, food resources (e.g. invertebrates) can become limited, and *Nycticebus pygmaeus* have been documented to then enter a state of torpor, tapping on their fat reserves (Ratajszczak, 1998).

Studies conducted at the Endangered Primate Rescue Center (EPRC) showed that *Nycticebus pygmaeus* undergo hibernation during winter; torpor was not observed outside the winter season, and hibernation was limited to the coldest months. Lorises usually fall into torpor late at night or in the early morning and return to euthermia in the early afternoon (Streicher, 2004; Ruf et al., 2015). Temperatures can drop below 5°C in the winter nights in northern Vietnam, and monitored individuals exposed to such climatic conditions have been documented to be in torpor that lasts up to 63 hours (Ruf et al., 2015). Granted, food was made available for these specimens throughout the year, the trigger for their hibernation is thus unlikely to be related to food availability (Streicher et al., 2017; Ruf et al., 2015).

Nycticebus pygmaeus are also able to significantly reduce their body temperature within euthermic levels on cooler days, but not below 30°C. Variable body temperature probably allows *Nycticebus pygmaeus* to stay alert and react to predators and save energy (Glanville and Seebavher, 2010; Streicher et al., 2017). According to the researchers, hibernation in *Nycticebus pygmaeus* is probably caused by an internal biological clock. The decrease in ambient temperature and limited access to food conducive to submission to hibernate. Like most hibernating animals, *Nycticebus pygmaeus* can gain weight by 50% before the winter period (Streicher, 2005; Streicher et al., 2017). Similar states of reduced physiological activity have also been documented in the *Nycticebus javanicus* and the slender loris - *Loris tardigradus tardigradus* (Nekaris, pers.com.; Streicher et al., 2017).

1.3.2 Body temperature

Clinical and pathological data from San Diego Zoo during the period of 1982 to 1995 suggests that the rectal temperatures of anesthetized specimens ranged between 31°C and 36.6°C for pygmy slow loris, 33°C and 36.6°C for other slow loris species (H. Fitch-Snyder, 2001).

1.3.3 Heart rate and respiratory rate

The heart rate and respiratory rate are difficult to determine because the values quickly change due to the capture stress in animal. By comparison, the heart rate in small primates is 165-240 heart beats per minute and breathing is 20-50 breaths per minute (H. Fitch-Snyder, 2001).

1.4 Longevity

While the average life span for *Nycticebus coucang* is 20 years in the wild, under human care, they can live up to 24 years (Daschbach, 1983). *Nycticebus pygmaeus* has been documented to live up to 20 years in captivity (Ratajszczak, 1998). *Nycticebus bengalensis* can live up to 15 years in the wild (Streicher at al., 2008). According to studbook data, the longest-lived *Nycticebus pygmaeus* (Studbook # OOO182) was 22.4 years old.

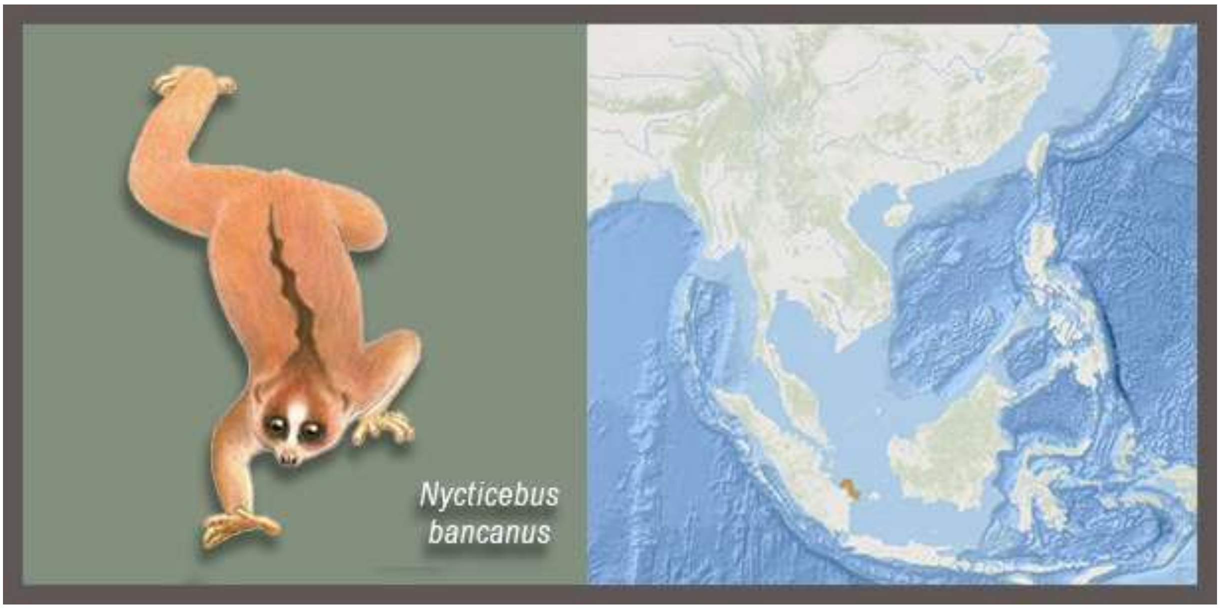
1.5 Conservation status, zoogeography, ecology, species

Species are listed below alphabetically by scientific name.
The graphics (except Nycticebus hilleri) were prepared on the basis of illustrations in the article "An updated taxonomy and conservation status review of Asian primates" Ch. Roos, J. Supriatna, R. Boonratana, J. Fellowes, Stephen D. Nash et al.; June 2014, while the range of occurrence of a given species on the basis of the map from the IUCN Red List of Threatened Species; 2015.

Nycticebus hilleri was drawn by P. Markiewiecz (Poznan Zoo) from the article "Unexpected diversity of slow lorises (Nycticebus spp.) within the Javan pet trade: implications for slow loris taxonomy" K.A.I. Nekaris, S. Jaffe Oxford Brookes University; Contributions to Zoology, 76 (3) 187-196 (2007).

1.5.1 *Nycticebus bancanus* (Lyon, 1906)
Common name: Bangka slow loris

IUCN Red List: Critically endangered (CR)
CITES: Appendix 1
Regional Collection Plan: Species not listed under EAZA *Ex-situ* Programme at the moment



Taxonomy:
This species was previously considered *Nycticebus menagensis* but was described as a new species by Munds et al. (2013). Evaluating this species in 1937, Sody wrote that the darkness of the ventral side was reason enough to accept Lyon's race bancanus. The species was last seen in nature in 1937, so it may already be extinct.

Habitat & Distribution:
Nycticebus bancanus is only known from the island of Bangka in Indonesia.
The species is nocturnal and arboreal as other *Nycticebus spp.*

Morphology:
It is a medium-sized species with scarlet-red hair and hairy ears. *Nycticebus bancanus* has a light mask on the face and a diffuse-edged upper circumocular patch. The lower part of the

circu-mocular patch never protrudes below the zygomatic arch, has a wide interocular stripe, and the crown patch is also diffused. *Nycticebus bancanus* never possess four upper incisors.

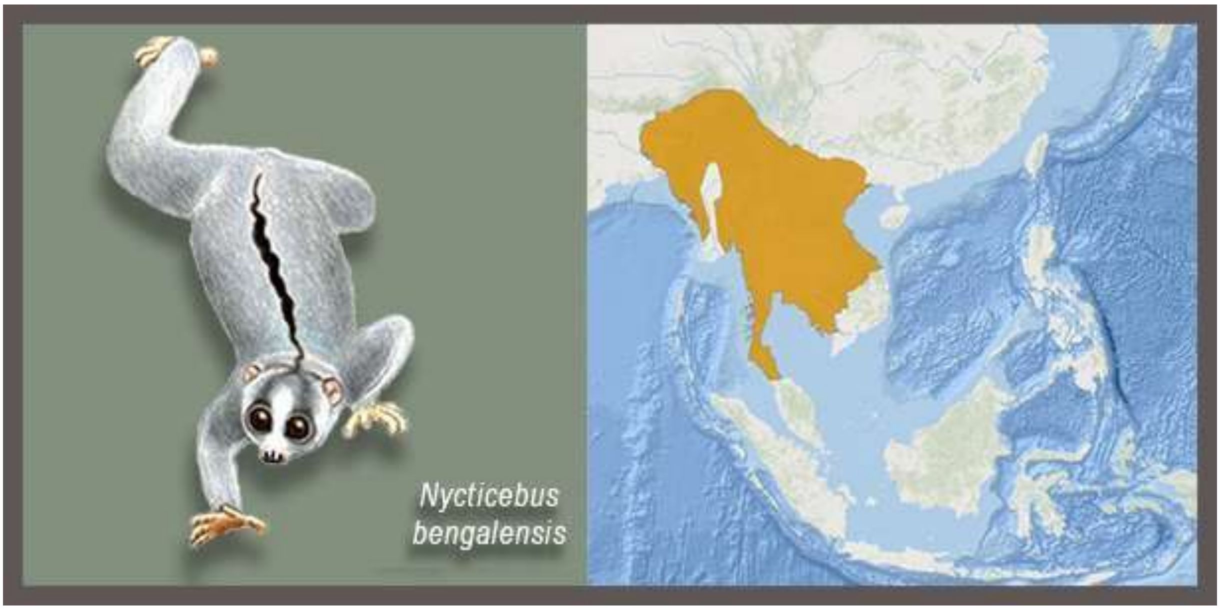
Reproduction:
No information available at the moment.

Diet:
Similar diets to other *Nycticebus* species, they like gums, nectar, sap, insects, fruits.

Behaviour:
No information available at the moment.

1.5.2 *Nycticebus bengalensis* (Lacépède, 1800)
Common name: Bengal slow loris

IUCN Red List: Endangered (EN)
CITES: Appendix 1
Regional Collection Plan: EEP - LTMP completed in 2021



Taxonomy:
This taxon was formerly considered a subspecies of *Nycticebus coucang*, with which there is a small hybridization zone in peninsular Thailand. Based on genetic evidence, it was elevated to species level by Roos (2003).
Habitat & Distribution:
This species occurs in Bangladesh, Cambodia west of the Mekong River, China (southern and western Yunnan and possibly in southwestern Guangxi), north-eastern India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura), Lao PDR, Myanmar (including the Mergui Archipelago), Thailand north of the Isthmus of Kra, and Vietnam.
Tropical evergreen rainforest, semi-evergreen forest, and mixed deciduous forest.

In India, the encounter rates vary from 0.1 to 0.77 individuals/km (Radhakrishna et al., 2006). Surveys have been carried out in Assam, India since 2005, with densities fluctuating over time. In 2005, densities of *Nycticebus bengalensis* ranged between 0.03-0.05 individuals/km (Das, 2005), in 2009 densities were found at 0.18 individuals/km (Das et al., 2009). In 2014, densities of *Nycticebus bengalensis* had declined to a range of 0.06-0.20 individuals/km (Das et al., 2015). Known localities of the species are as follows: Arunachal Pradesh (Changlang, Tale Valley WS, Kamlang WS, Kamlang RF, Mehao WS, Pakkei WS, Itanagar WS, Pakke Tiger Reserve, Deban, Namdapha Tiger Reserve); Assam (Amsang WS, Barnadi WS, Basistha RF, Bherjan Borajan Podumani WS, Borlander RF, Borail RF, Borajan WS, Burachapori WS, Chakrasila WS, Chirrang RF, Dehing Patkai WS, Dhansiri RF, Dibru Saikhuwa NP, Garampani WS, Gibbon WS, Goalpara, Innerline RF, Jeypore RF, Kaziranga NP, Langting Mupa RF, Laokhowa WS, Manas NP, Nameri NP, Nambor-Doigurung WS, Sonai Rupai WS, Ranni RF, Pobitora WS); Meghalaya (Nokrek NP, Balpakram NP, Baghmara RF, Nongkhyllem WS, Narpuh RF, Angratoli RF, Darugiri RF, Sibbari-Jacksongram Community Forest, Dambuk Adingre Community Forest, Siju Dobakol caves, Siju Forest Complex, Matcha Nokpante Community Forest); Mizoram (Nengpui WS, Dampa WS); Tripura (Trishna WS; Sepahijala WS) (Das J, Chetry, D pers comm; Molur et al., 2003; Das et al., 2009, 2015; Radhakrishna et al., 2006, 2010; Swapna et al., 2008).

The few records available for Myanmar come from a survey by Fauna and Flora International in Kachin State, where no night walks were ever conducted over two years. In 2011, a juvenile *Nycticebus bengalensis* was encountered downhill from Saw Law (N 26.15396, E 98. 27053; elevation 1,541 m asl) on the way back to Chibwe (N 25.88614, E 98.12851; elevation 257 m asl). Hunters in this area also reported seeing them during shifting cultivation. A captive *Nycticebus bengalensis* was recorded in Phimaw Internally Displaced Person's camp in February-March 2013 that was reported to come from the local area. According to local people, slow lorises are rarely seen in this area and are not easy to find.

In Bangladesh, no specific nation-wide population survey on this species has been carried out, but a 2015 survey team encountered 34 *Nycticebus bengalensis* (18-night survey) in Satchari National Park of Sylhet division. A one-night survey in Lawachara National Park revealed three individuals (S.C. Rahman, pers. comm.). The species was also recorded in Rema-Kalenga Wildlife Sanctuary (Feeroz et al., 2011) and Rajkandi Reserve Forest of Sylhet area (M. Foysal, T. Khan, pers. comm.). Feeroz (2013) reported *Nycticebus bengalensis* as being rare in Teknaf Wildlife Sanctuary of Chittagong region. All of these forests are semi-evergreen. A photography record is available from Kaptai National Park, Rangamati Hill District under Chittagong division (S.R. Rahul, pers. comm.). Beside these records, since 2010, several *Nycticebus bengalensis* were taken from human habitation in Jamalpur, Sherpur and Mymensingh district. These districts have some deciduous forests and are connected with Meghalaya state of India.

In Bhutan Choudhury (2008) reports that *Nycticebus bengalensis* habitat is mostly tropical evergreen and semi-evergreen forests in the foothills up to 300 m. The species has been indirectly recorded in the possession of woodcutters in four dzongkhags including Pema Gatshel, Samdrup Jongkar, Sarpang and Zemgang. From this, Choudhury inferred that they should occur in Royal Manas National Park, Khaling Wildlife Sanctuary and Phibsoo Wildlife

Sanctuary. Wangchuk et al. (2004) wrote that lorises also occur in Chukha and Samchi districts, but did not say on what evidence. The existing records indicate that the Sankosh River is the western limit for the species in Bhutan as well as Assam.

In Lao PDR, some researchers report the population to occur potentially in large forest tracts (R. Timmins pers. comm.). Duckworth (1994) and Ratajszczak (1998), however, both reported the species as being very rare in Lao PDR, with the former reporting abundance indices of about 0.30-0.65 individuals/km at sites including: Central Laos (Phou Xang He, NakaiNam Theun, Xe Piang, Muang Hom, Nam Kading, Nam Ao, Bang Navang) and South Laos (Xe Namoy). In 2000, published data from 1994-1995 recorded *Nycticebus bengalensis* frequency as “common” in some forests (Phou Khaokhoay NBCA, Nam Kading NBCA, and Bolavens Northeast PPA), whereas they were encountered “occasional” in others (Nakai Plateau) (Evans, et al., 2000, Streicher, 2014). A single record comes from Southern Laos in Xe Kaman lowlands in Dong Ampham NBCA, Attapu Province (Davidson et al., 1997).

In Vietnam, the populations are severely reduced and have disappeared from many forests (Fitch-Snyder and Thanh, 2002; V. Thanh pers. comm.). Surveys carried out in northern Vietnam at Na Hang Nature Reserve in 2013 recorded a density of 0.09 individuals/km (Blair, unpublished data). Recent surveys of *Nycticebus bengalensis* in Central Vietnam at Bach Ma National Park returned no animals in 30.4 km of surveys (Blair, unpublished data). A large population with a phenotype of the Cambodian forms occurs on Phu Quoc island in the Gulf of Thailand (Huaong and Blair, pers. comm.). Surveys in 2014 in Phu Quoc Island recorded a density of 0.38 individuals/km (Blair, unpublished data).

In Cambodia the species is very rare and has only been seen west of the Mekong River in Samkos Wildlife Sanctuary and Phnom Kulen National Park at 22.5-25.0 animals per km^2 (Starr et al., 2010). Observations of recently hunted animals were made in Preah Vihear Protection Forest, Kulen Promtep Wildlife Sanctuary and Phnom Tbeng (Coudrat et al., 2011). Starr et al. (2010) failed to detect this species in Bokor National Park and Cardamoms Protected Forest; they also did not detect it east of the Mekong (Phnom Prich Wildlife Sanctuary and Mondulkiri PF); Coudrat et al. also could not find this species east of the Mekong at the following sites: Mondulkiri (Lumphat Wildlife Sanctuary, Phnom Pritch Wildlife Sanctuary) or Ratanakiri (Vonsei District, Virachey National Park, Seima Protection Forest, Snoul Wildlife Sanctuary). Other surveyors in Cambodia have noted the presence of the species in a number of community forests (Eam Sam Un, pers. comm., 2014).

In Thailand, *Nycticebus bengalensis* is thought to be widespread (W. Brockelman pers. comm.) but has never been surveyed specifically. It is known from Khao Yai National Park. Pliosungnoen et al. (2010) found that the species is absent from many forests, and occurs at very low densities when present. In plantation forest in Khao Ang Runai Wildlife Sanctuary, they recorded *Nycticebus bengalensis* at a density of 0.64 individuals/km (Pliosungnoen et al., 2010).

In China, surveys have been carried out since 2013. *Nycticebus bengalensis* habitat is mostly a primary evergreen broad-leaf forest up to 2,200 m. The population occurs in counties of western and southwestern Yunnan (Yingjiang, Longchuan, Ruili, Tengchong, Mangshi, Zhenkang, Cangyuan, Gengma, Yongde, Shuangjiang, Ximeng, Lancang, Menglian, Menghai, Mengla), even in secondary forests and agricultural plantations (Ni, pers. comm.). Survey in Cangyuan recorded a density of 0.33 individuals/km (Ni, unpublished data). In southern and southeastern Yunnan, *Nycticebus bengalensis* is mostly distributed in scattered nature reserves as follows: Yuanjiang, Amushan, Guanyinshan, Huanglianshan, Fenshuiling, Daweishan, Laojunshan, Gulinqing, Laoshan. The populations are severely reduced and have possibly disappeared from southwest of Guangxi Province (Ni, pers. comm.). Suitable habitat, also containing gibbons, can be found in many nature reserves, where the species is likely present but still to be confirmed, including Nanguanhe, Ailaoshan, Xishuangbanna, Nabanhe, Wenshan in Yuannan; and Bangliang in Guangxi.

Morphology:
Considerable variation exists in body size (850-2,100 g), genetics and coat colour (white to crimson red; absence of head forks to possession of light head forks) in this taxon, which may lead to at least three new taxa being described.

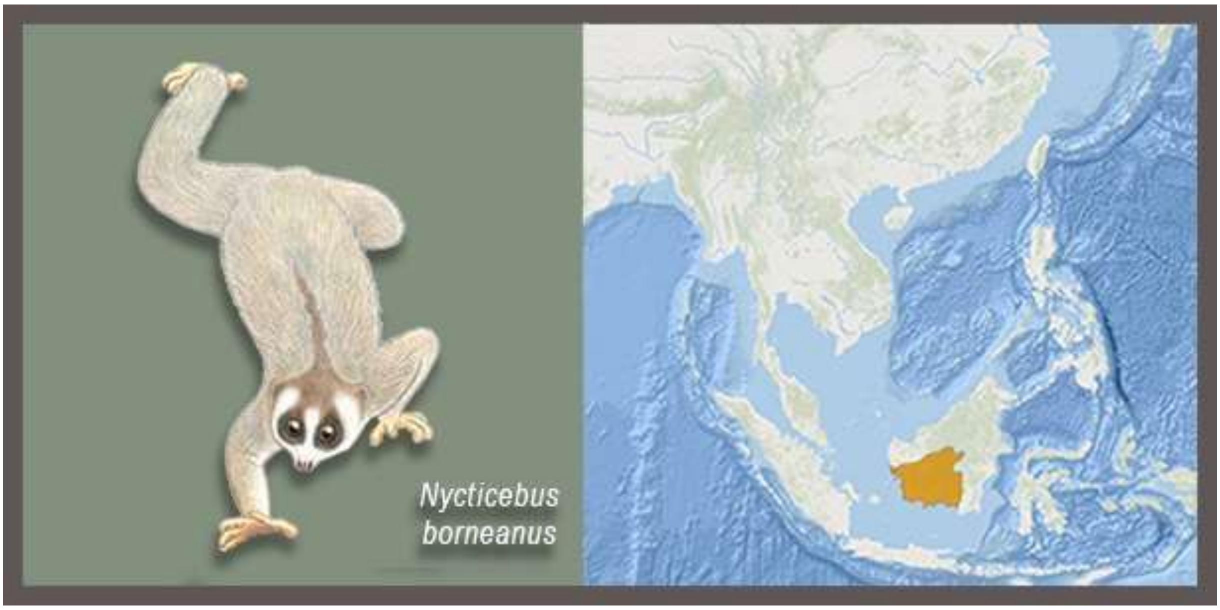
Reproduction:
Females give birth to one offspring per litter once every two years in semi-wild conditions (Rowe, 1996). In captivity, this rate maybe slightly higher (U. Streicher, pers. comm.).
This animal’s life span is about 15 years, and generation time is 7-8 years.

Diet:
The diet of the *Nycticebus bengalensis* consists of nectar, plant bark, fruits and small invertebrates; the majority of their wild diet comprises plant exudates, and this is a key staple year round (Swapna et al., 2009; Pliosungnoen et al., 2010; Das et al., 2014).

Behaviour:
This is an arboreal, nocturnal species. Studies show that behaviour varies from season to season depending on types of habitats and lunar phases etc.
Most studies conclude that a lot of time is spent extracting exudates and hunting insects.

1.5.3 *Nycticebus borneanus* (Lyon, 1906)
Common name: Bornean slow loris

IUCN Red List: Vulnerable (VU)
CITES: Appendix 1
Regional Collection Plan: N/A



Taxonomy:

This taxon was previously included in *Nycticebus menagensis* but was described as a separate species by Munds et al. (2013). The species description was based on facemask variation between sampled photographs and museum specimens previously classed as *N. menagensis*.

Habitat & Distribution:

Nycticebus borneanus is found in central south Borneo (West, South, and Central Kalimantan, but excluding the extreme southwest), south of the Kapuas River, extending as far east as the Barito River. This species may occur sympatrically with *N. kayan* or with *N. menagensis* (Munds et al., 2013).

Like other slow lorises (*Nycticebus spp*.), this species is nocturnal and arboreal. It has been observed in dipterocarp forest at Bukit Batikap Protected Forest, Central Kalimantan (Van Berkel, 2011). Slow lorises in Borneo are found in a range of habitats from heavily degraded to pristine rainforest, plantations, and lowland and montane forests (Nekaris et al. 2008, Thorn et al., 2009).

Morphology:

Nycticebus borneanus has a dark contrasting facemask and predominantly round but sometimes a diffuse-edged upper circumocular patch. The lower circumocular patch never extends below the zygomatic arch, variable width interocular stripe, the crown patch is often round but sometimes a band (never diffuse), the ears are hairy, and the preauricular hair band is wide. In addition, the pelage is extremely long and fluffy, almost resembling a subadult; museum specimens of this type were confirmed though to be adult (Munds et al., 2013).

Reproduction:

No specified information at this time.

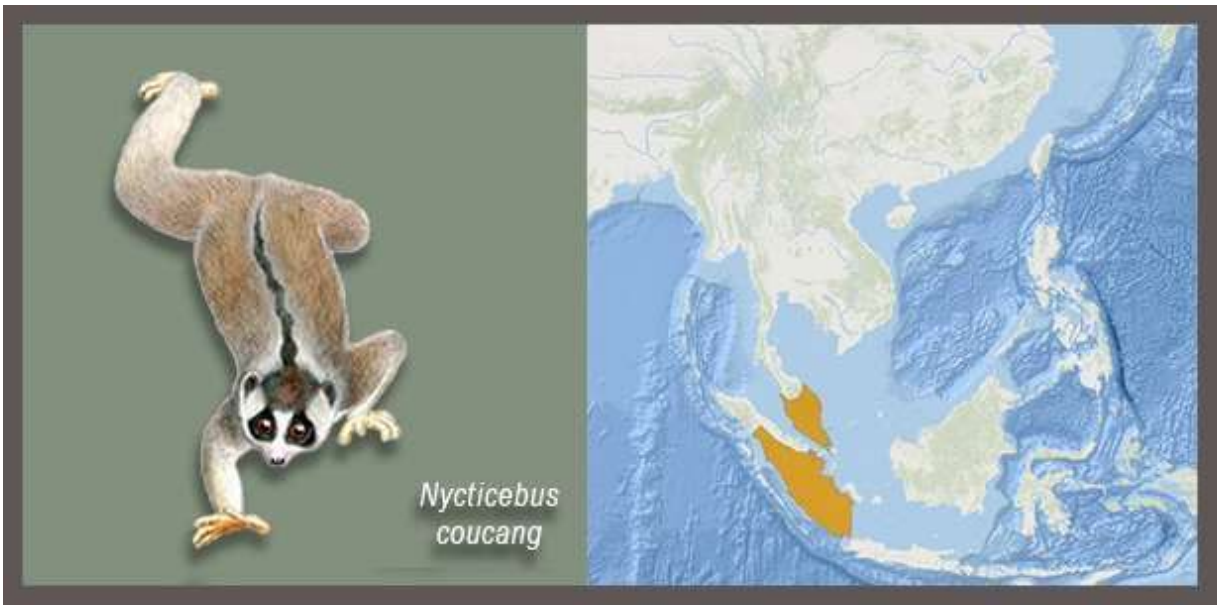
Diet:

Believed to be similar to other *Nycticebus* species, predominantly exudates and insects.

Behaviour:
Research required.

1.5.4 *Nycticebus coucang* (Boddaert, 1785)
Common name: Sunda slow loris, Greater slow loris

IUCN Red List: Endangered (EN)
CITES: Appendix I
Regional Collection Plan: EEP New Style



Taxonomy:
Nycticebus coucang (Boddaert, 1785) was previously considered a subspecies, along with *N. bengalensis, N. javanicus* and *N. menagensis*. A small hybridization zone is found between this species and *N. bengalensis* in southern peninsular Thailand (Nekaris et al., 2008). Subspecies classification of specimens from Natuna islands were proposed *N. c. natunae* (Indrawan and Rangkuti, 2001).

Habitat & Distribution:
This species occurs in Indonesia (southern Sumatra south of the Batang Toru River, Batam and Galang in the Riau Archipelago, and Pulau Tebingtinggi and Bunguran in the North Natuna Islands), Malaysia (on the Peninsula and the island of Pulau Tioman), southern peninsular Thailand (suggested from the Isthmus of Kra southward, but forms as far as Tai Rom Yen National Park according to *Nycticebus bengalensis*), and Singapore (Groves, 2001; KAI. Nekaris, pers. comm.; M. Shekelle, pers. comm.)

Generally, this species occurs in low densities in its habitat – primary and secondary lowland forest, gardens, and plantations (Nekaris et al., 2008).

The species is found in the southern region of Sumatra south of the Batang Toru river. During a camera-trapping season from Oct 2010 to Oct 2012, one *Nycticebus coucang* was recorded in the Bukit Batu Area of Giam Siak Kecil-Bukit Batu Biosphere Reserve, Riau, Indonesia (Fujita et al., 2012). A population has been recorded in the forest around Batutegi Dam (Collins and Nekaris, 2008). The species has also been recorded either from museum specimens or casual reports from researchers or local people in Bukit Barisan Seletan National Park, Kerinci Sebelat National Park, Berbak National Park, Way Kambas National Park, and Bukit Tigapuluh National Park (Thorn et al., 2010).

Reported encounter rates vary throughout Peninsular Malaysia. Several short-term studies indicated that it usually occurs at low densities: Pasoh Forestry Research Centre, Peninsular Malaysia (0.01-0.02 animals/km); Petalang Jaya, Malaysia (0.40 animals/km); Genting Sempah, Malaysia (3 captures after 30,000 trap nights) (Barret, 1981; Rudd and Stevens, 1992; Nekaris et al., 2008). It was described as uncommon in Panang Island, where one was shot after 11 nights (Liat et al., 1971). At sites where long-term studies occurred, greater slow lorises occur at relatively higher densities (Sungai Tekam Forestry Concession, Malaysia, 0.3-0.8 animals/km in logged primary forest, 0.5-1.2 animals/km in unlogged primary forest; Manjung District, Perak, Malaysia, 1.6-4.0 animals/km in unlogged primary forest and 0.4-1.0 animals/km in logged swamp forest and secondary savanna). Wiens (2002) conducted a study on a population in parts of Segari Melintang, Tanjung Hantu, and Batu Undan Forest Reserve, West Malaysia. The species has also been photographed or videoed in Hutan Lipur Rekreasi Tupah, Taman Negara National Park, Fraser’s Hill.

In Singapore the distribution of *Nycticebus coucang* is unknown due to the presence of translocated individuals of unknown origins and low sighting frequency (Lim et al. 2008). During a population survey in 2013 by Fam et al. (2014) including seven areas (Nee Soon Swamp Forest, Thomson Ridge, Rifle Range area, Kampong Trail, Bukit Timah Nature Reserve, Bukit Batok Nature Park, and the forest near Mera-lodge Condominium), individuals were only observed in Nee Soon Swamp Forest (0.12 animals/km). The encounter rate lowered to 0.017 animals/km when all seven sites were combined. The *Nycticebus coucang* is also known to exist on a military training island called Pulau Tekong (0.5-0.7 animals/km) (Lim et al., 2008) that is considered one of Singapore’s most protected forested areas. Their distribution in Thailand is still in need of further examination. There is a proposed hybrid zone between *Nycticebus bengalensis* and *Nycticebus coucang* in the southern peninsular of Thailand. It is not definitive which species occurs on the island of Phuket (Pliosungnoen et al., 2010), but it is generally believed that the wild slow lorises on this island are *Nycticebus coucang* (Meijaard, 2003).

Morphology:
This species weighs between 600 g to 850 g on average and often possesses a short muzzle. In terms of coat pattern, it has a greyish nape with dorsal stripe extending to rear and a reddish or brownish crown that tends to diffuse near its ears, but meets its eye patch at a point.

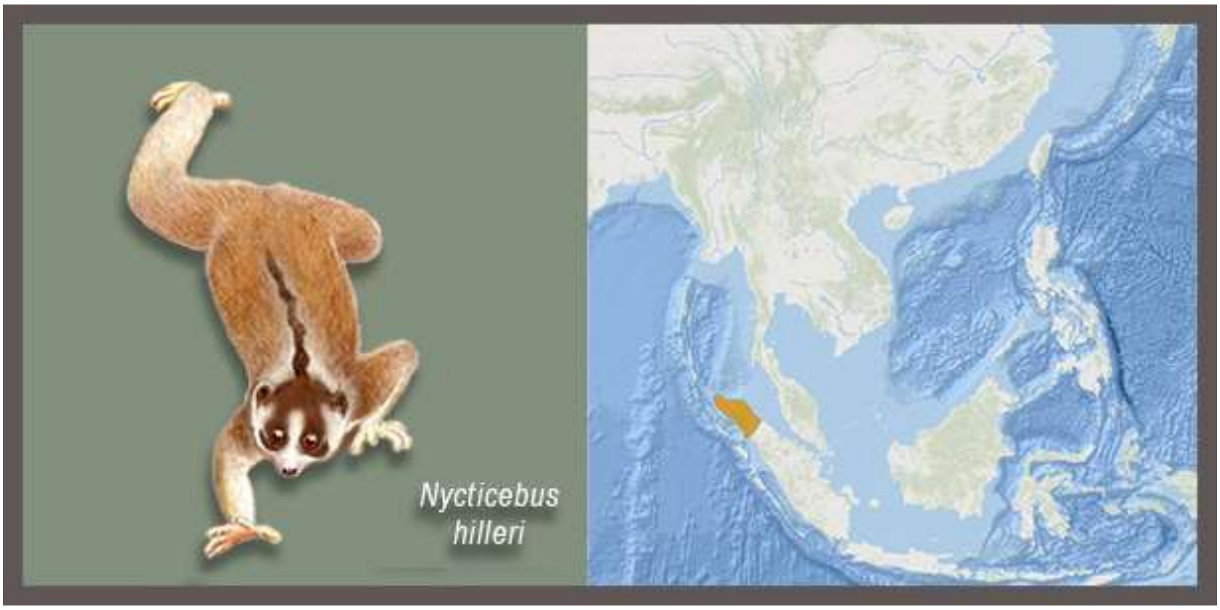
Reproduction:
Sexual maturity is estimated to be between 18 and 24 months of age for females, and 17 months for males. The oestrus cycle lasts 36 days on average while the gestation period is about 192 days, and lactation lasts approximately 6 months (Izard, 1988).
Diet:

The main food types ingested by this species in the wild include floral nectar, nectar-producing parts, phloem sap, fruits, gums, and insects (Wiens, 2002).

Behaviour:
Predominantly nocturnal, this species is often active after sunset and remains active for the majority of its time budget in the wild (Wiens, 2002). Wild *Nycticebus coucang* are also mainly solitary, spending up to 93% of their active time alone for both sexes (Wiens, 2002). They prefer trees as sleeping sites, and the height above ground of sleeping lorises ranged from 1.8 m to 35 m (Wiens, 2002).

1.5.5 *Nycticebus hilleri* (Stone & Rehn, 1902)
Common name: Sumatran slow loris

IUCN Red List: Endangered (EN)
CITES: Appendix 1
Regional Collection Plan: N/A



Taxonomy:
Described as a distinct subspecies in 1902, this taxon was later grouped with *Nycticebus coucang.* Lydekker (1904) described this much redder and larger form as having a brightly rufescent chestnut colour slightly washed with grey, with a dorsal stripe and crown-patch being a deeper rufous, faintly bordered with brown. When working with lorises confiscated in trade originating from Sumatra, Nekaris and Jaffe (2007) were struck by two forms in a sample of 25 individuals. Nine individuals possessed the characteristics described by Stone and Rehn (1902), and were so statistically distinct, that Nekaris and Jaffe suggested that they be elevated to a species, *N. hilleri*. They reported the following average morphometric parameters for *N. hilleri* that were larger than those of *N. coucang*: weight 689 g; head length 61 mm; muzzle length 21 mm; head breadth 39 mm; head + body length 278 mm; hand span 51 mm; foot span 68 mm; ear length 18 mm (Nekaris and Jaffe, 2007).
Habitat & Distribution:

This species occurs on the Indonesian island of Sumatra north of the Batang Toru River. It may occur on small surrounding islands, but this remains unknown.

This species occurs in areas that are characterised as lowland forest, sub-montane forest, and montane forest in the Ulu Masen (Kasia et al., 2011). The species has been mentioned in several studies taking place in the Gunung Leuser ecosystem. In the Katembe area in Gunung Leuser, they have been observed in primary rainforest and selectively logged forest (Rijksen, 1978; van Schaik and Mirmanto, 1985). They also occur in forests around Bukit Lawang.

Morphology:
Body weight: 650-790 g
Physical appearance is characterized as smooth coat tending to reddish-brown or brightly rufescent chestnut washed in grey, including the dorsal stripe and facial markings with the exception of a dark black ring around the eyes. The crown is diffused with rounded forks above the eyes and less distinctly divided, the dorsal stripe does not extend to the caudal region, the red body colour extends to the belly, with a redder ventral region, and reddish pre-auricular hair (Nekaris and Jaffe, 2007; Lydekker, 1904).

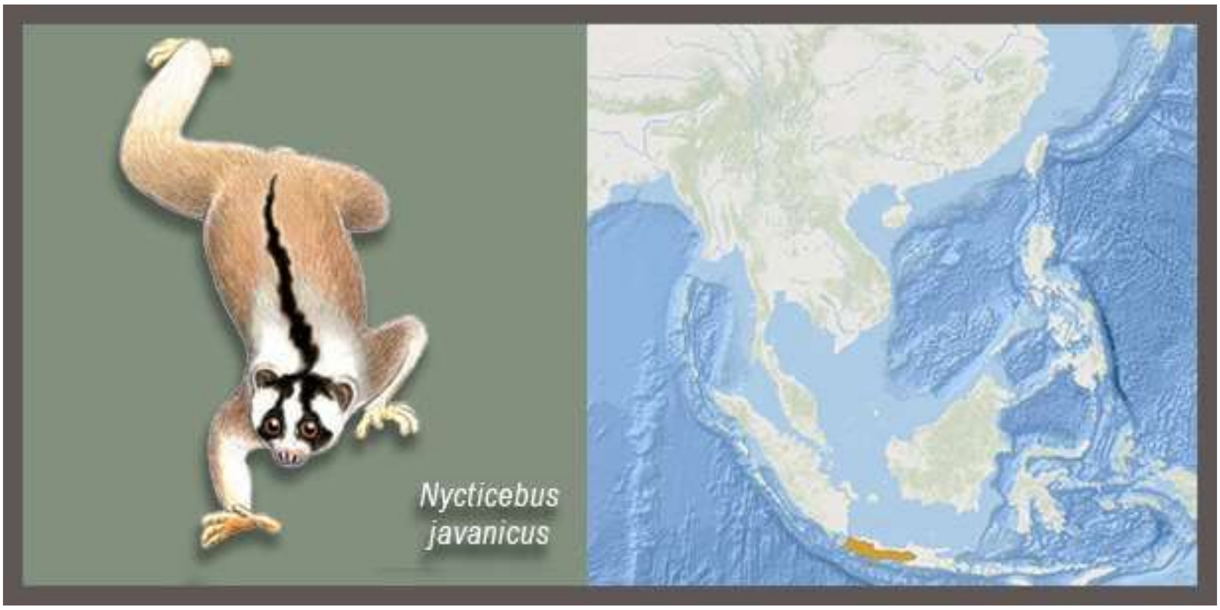
Reproduction:
No specified information at this time.

Diet:
During a field study in Aceh, *Nycticebus hilleri* were observed catching insects and consuming bland fruits (Nekaris and Nijman, 2007). The diet of slow lorises generally consists of insects, nectars, and gums supplemented with occasional fruit and small vertebrates; exudates have emerged as a key resource and are most likely a key resource in the *Nycticebus hilleri*'s diet as well, a prediction supported by their stout dentition and other morphological adaptations to this dietary specialisation (Das et al., 2014; Nekaris et al., 2010; Wiens et al., 2006).

Behaviour:
Research required.

1.5.6 *Nycticebus javanicus* (É. Geoffroy, 1812)
Common name: Javan slow loris

IUCN Red List: Critically Endangered (CR)
CITES: Appendix I
Regional Collection Plan: Species not listed under EAZA *Ex-situ* Programme at the moment



Taxonomy:
Closely related to *N. coucang* and *N. bengalensis*, it was first recognized as a distinct species by Jatna Supriatna and Edy Hendras Wahyono in 2000, and confirmed by Chen et al. through DNA sequencing and molecular analysis works in 2006 as well as by Groves and Ibnu Maryanto in 2008 through cranial morphology and pelage characteristics analysis (Chen et al., 2006; Groves and Maryanto, 2008).

Habitat & Distribution:
This species occurs in western and central Java, Indonesia. It inhabits both primary and disturbed secondary forest, as well as bamboo and mangrove forests. It is also sighted in plantations, suggestive of tolerance to human disturbance (Nekaris and Munds, 2010, Nekaris et al., 2013). It is typically found in altitude ranging from 479 to 1600 m, at an estimated density of 15.6 individuals per km^2 (Nekaris et al., 2013; Withaningsih et al., 2018).

Morphology:
Species generally weighs between 850 g and 1050 g and has cream-coloured or whitish nape with striped pattern. Its ears are often tufted and encased by dark fur. Eye fork is also present in most specimens, with eye patch extending down the cheek, and a cream-coloured diamond between the eyes. It also lacks the second incisor in its dentition (Ankel-Simons, 2007).

Reproduction:
No specific information available at the moment but likely similar to that of *Nycticebus coucang*.

Diet:
Gum and insects form the major diet component for this species but their diet can also include flower parts, fruits and nectar (Cabana et al., 2016; Fauzi et al., 2002). Plant species found to be frequented by this species for feed use include *Calliandra callothyrsus* and *Acacia decurrens* (Fauzi et al., 2002). Seasonal differences in feeding ecology between both sexes

were also recorded; females appear to ingest more protein, gum, fruits and flowers while males ingest more fibre (Cabana et al., 2016).

Behaviour:
This species is highly arboreal and can spend up to 18% of its daily activity budget foraging and 11% of the time traveling (Nekaris et al., 2013; Fauzi et al., 2002).

1.5.7 *Nycticebus kayan* (Munds, Nekaris & Ford, 2013)
Common name: Kayan River slow loris

IUCN Red List: Vulnerable (VU)
CITES: Appendix I
Regional Collection Plan: Species not listed under EAZA *Ex-situ* Programme at the moment

Taxonomy:
Prior to 2013, this species was classified as *Nycticebus menagensis*. Facemask pattern analysis in a study by Munds et al. revealed significant differences and elevated *Nycticebus kayan* to species status, distinct from *N. menagensis*, *N. borneanus*, and *N. bancanus* (Munds et al., 2013).

Habitat & Distribution:
This species occurs in central and northern Borneo (Sarawak, Sabah, and East Kalimantan). Its southern range extends to the Mahakam River in East Kalimantan and the Rajang River in Sarawak. Although it is sympatric with *N. menagensis*, it is rarely found along the coasts (Munds et al., 2013).

Morphology:
The species usually weighs between 600 g and 850 g and has a fluffy coat and a nape that is greyish-colored or frosted. Its facemask is often dark and contrasting; lower circumocular patch extends below zygomatic arch and can reach base of the lower jaw while interocular stripe is

almost always narrow and is either rectangular or bulb shaped. It also has diffused crown patch, hairy ears and its average head and body length of is about 273 mm (Munds et al., 2013). Like other Bornean slow loris species, it lacks the second incisor in its dentition (Ankel-Simons, 2007).

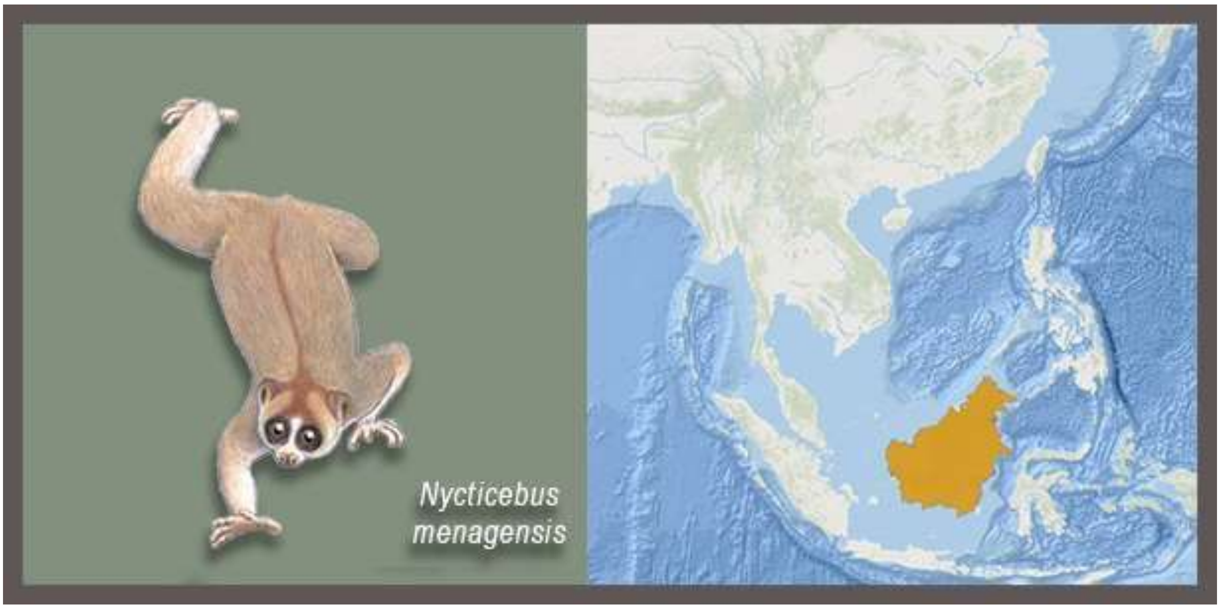
Reproduction:
No specific information available at the moment.

Diet:
No specific diet study done on this species in the wild but likely to be similar to other *Nycticebus* species - gums, floral nectar, phloem sap, fruits and insects.

Behaviour:
No specific information available at the moment.

1.5.8 *Nycticebus menagensis* (Trouessart, 1893)
Common name: Philippine slow loris

IUCN Red List: Vulnerable (VU)
CITES: Appendix 1
Regional Collection Plan: Species not listed under EAZA *Ex-situ* Programme at the moment



Taxonomy:
In the past, *Nycticebus menagensis* was considered a subspecies of *Nycticebus coucang*. *Nycticebus menagensis* was elevated to the species level by Roos (2003) and Chen et al. (2006).

Habitat & Distribution:
The species is found in Brunei, Indonesia (Kalimantan Borneo, Belitung, and Banka), Malaysia (Sabah and Sarawak Borneo), and the Philippines (Tawi Tawi, Bongao, Sangasanga, and

perhaps some other small islands in the Sulu Archipelago) (Fooden, 1991; Timm and Birney, 1992).
The species inhabits primary and secondary lowland forests, gardens, and plantations (Payne et al., 1985; Timm and Birney, 1992), at elevations between 35-100 m.

Morphology:
The species usually weighs below 500 g. They have a white muzzle and small black rings around their eyes. Ears are barely visible and concealed in fur. On the head, they have a yellow to light brown crown. All head markings are very faint and similar to the rest of the fur.
This species does not have a second upper incisor (Groves, 1971; Ravosa, 1998; Chen et al., 2006; Nekaris and Jaffe, 2007).

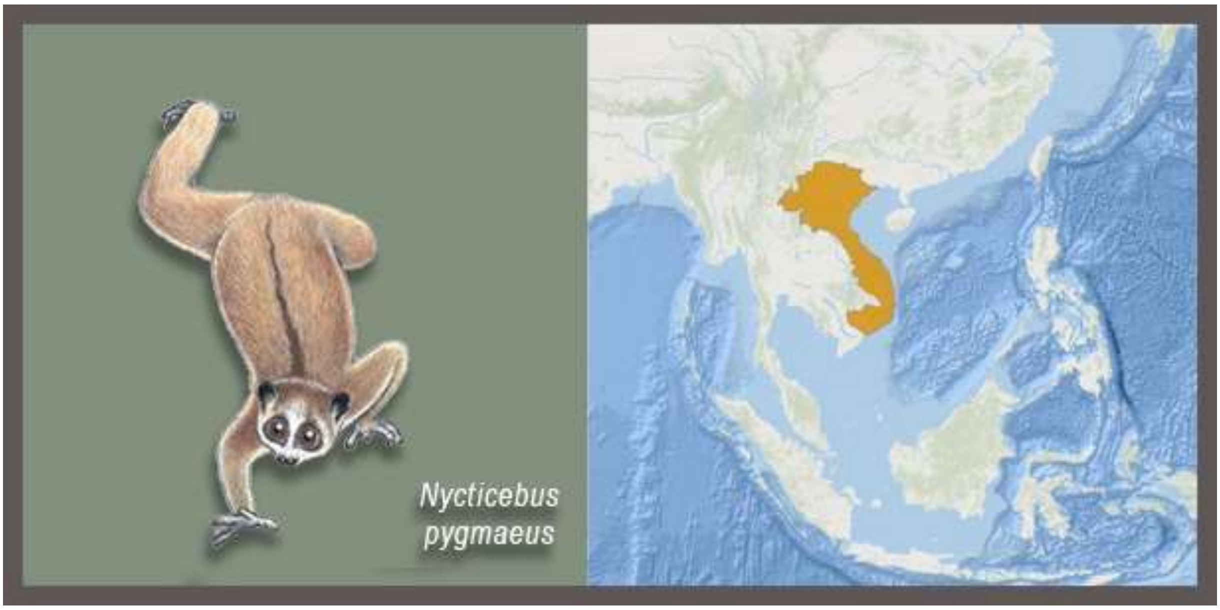
Reproduction:
No specific information available at the momemnt.

Diet:
It is believed that this species is the most insectivorous of all lorises species (Ravosa, 1998).

Behaviour:
This loris is nocturnal and almost entirely arboreal. The observation made in Sabangau National Park on four animals showed that half of the animals fed together with two or more animals on the same tree (*Callophylum hosei* and *Szygium cf. nigricans*).

1.5.9 *Nycticebus pygmaeus* (Bonhote, 1907)
Common name: Pygmy slow loris, Lesser slow loris, Pygmy loris
It was originally classified within genus *Nycticebus* until it was transferred to the genus *Xanthonycticebus* in 2022.
Xanthonycticebus pygmaeus (Nekaris and Nijman, 2022)
Common name: Pygmy loris
Genus: *Xanthonycticebus*

IUCN Red List: Endangered (EN)
CITES: Appendix 1
Regional Collection Plan: EEP



Taxonomy:
Nycticebus intermedius (Dao Van Tien, 1960) is considered a synonym. There is no evidence of hybridization between *N. bengalensis* and *N. pygmaeus* in areas where the range of the occurrence of both species overlaps.

Habitat & Distribution:
This species is found in the east of the Mekong River in eastern Cambodia, southernmost China (southeastern Yunnan), Lao PDR, and Vietnam (Streicher, 2004).
The species lives in many different habitats like primary evergreen and semi-evergreen forest, forest on limestone, secondary and highly degraded habitats and bamboo thickets (Ratajszczak, 1998; Streicher, 2004). Occurs up to a height of 1,500 m (MacKinnon and MacKinnon, 1987).

In Vietnam, researchers have concluded that wild populations are in major decline (Fitch-Snyder and Vu, 2002; Streicher, 2004). In 2002 in Phong Nha-Ke Bang National Park, 90 survey nights returned only seven sightings of this species; in Ben En National Park, only eight animals were encountered over ten night walks by four teams, each covering several kilometres per night. 2013-14 surveys in North Vietnam recorded 0.19 individuals/km and 0.4 individuals/km respectively (Blair, personal communication). In South Vietnam, 0.48 individuals/km were recorded in 2013 and 0.41-0.44 individuals/km in 2014 (Blair, personal communication). Surveys carried out in Central Vietnam in 2015 found low densities of *Nycticebus pygmaeus*, with no animals observed in 20 km at Bach Ma National Park, and 0.19 individuals/km at Son Tra Nature Reserve (Blair, unpublished data). The species has also been observed in Cat Tien National Park and Vinh Cuu Biosphere Reserve, which are both part of the Dong Nai Biosphere Reserve (Kenyon et al., 2014).

In Lao PDR, Duckworth (1994) recorded only four individuals during a survey in Phou Xang He Protected Area (about 0.05-0.10 individuals/km). He further recorded the species in Nam Kading (0.06-0.13 individuals/km) and Xe Namnoy (0.10-0.22 individuals/km). It is possible that this species was under-recorded, however, as villagers claimed that this species was common throughout the area but their accounts may also be historical (Duckworth, 1994;

Evans, 2000). The species presence was also confirmed at Nakai-Nam Theun National Protected Area in Central Laos (Coudrat, pers. comm.). The species is reported to be widespread in forested areas in Lao PDR, where exploitation of lorises is lower than in neighbouring Vietnam.

In Cambodia in 2009, the species was encountered in Seima Protection Forest (0.40-0.41 individuals/km) and in Phnom Prich Wildlife Sanctuary (0.10-0.13 individuals/km) but were absent from Mondulkiri Protected Forest in 34 km of surveys (Starr et al., 2010). Three individuals were recorded for sale for traditional medicine at Stung Treng Market in North East Cambodia (Rogers, pers. comm.).

In China, the species has been reported as extremely rare in Southeast Yunnan Province, with very few animals ever seen. Ma and Wang (1988) reports that their distribution is over Ma Guan, Ma Lipo, and He Kou County near the Sino-Vietnamese border. The species has been reported in Daweishan Nature Reserve of Pingbian (Xu et al., 2010). Only one individual was recorded in an area of more than 10 km^2 based on a camera trapping survey in Daweishan (Yu et al., 2013). 2015 surveys have also recorded the species in Xilongshan of Jinping, Huanglianshan of Lvchun, Gulinqing of Maguan, Laojunshan and Laoshan of Malipo (Ni, pers. comm.).

Morphology:

The species usually weighs below 500 g. The nose is fully black, ears are black and naked. The fur is fine, wavy and brownish orange in colour. The fur often develops a silvery frost during winter months (Tan, 1994; Larson, 2001). Individuals have a unique pattern of lighter and darker colored markings on their face, which commonly include circles around the eyes and dorsal stripes starting at their crown and continuing down their back (Harrison, 1955).

Reproduction:

The *Nycticebus pygmaeus* reproduction is seasonal. The oestrus occurs between July and October. After a pregnancy of six months, offspring are born from January to March. Usually, twins are born but in captivity, quadruplets have been recorded. When the female forages for food, she leaves the offspring alone. This behaviour is known as parking and is used from the first day of the offspring’s life. The fur of young differs from the fur of adults. The dense underfur is overgrown by long hair, giving young a fluffy appearance, similar to some fruits or flowers of the rainforest. Offspring are dependent on their mothers for about 6 months (Ratajszczak, 2004). Maturity is reached at 18 months in males and 16 months in females (Larson, 2001).

Diet:

Currently, lorises have been classified as exudativores which means that gum and other exudates, such as nectar, are the main components of their diet. Their behaviour of specialising in eliciting exudate flow is known as gouging (Tan and Drake, 2001; Streicher, 2009; Nekaris and Munds, 2010; Nekaris and Bearder, 2011; Starr et al., 2011; Starr and Nekaris, 2013; Streicher et al., 2013).

The diet of wild lorises is a composite of 33% insects, 63% exudates, and 4% other items (Nekaris and Bearder, 2011). Starr and Nekaris (2013) found it to be approximately 51% gum, 30% arthropods, 5% fungi, 6% bamboo, and 1% gecko during winter. Seasonality causes a change of diet and arthropod consumption decreases to 10% and plant parts (fruit, flowers and bamboo parts) increase to approximately 52% (Starr and Nekaris, 2013).

Behaviour:
The *Nycticebus pygmaeus* mostly have been observed as single individuals in the wild (Streicher, 2004). Lorises are arboreal and active at night. During the day, they sleep in tree forks or in clumps of branches. Lorises walk slowly and deliberately through trees. They can move quickly when necessary, such as when catching prey. Lorises communicate through olfaction and use urine to mark their territories. Vocal communication is also very important (Larson, 2001).

1.6 Diet and feeding behaviour

1.6.1 Food preference
The vast majority of slow lorises were originally erroneously described as frugivores, ingesting diets high in fruits and simple carbohydrates (Charles-Dominique, 1977). Recent field studies have demonstrated again and again that slow lorises are indeed not frugivores but rather exudativores, feeding on mostly arthropods and tree gum as well as smaller and seasonal amounts of flowers, part of bamboo culms and fruit (Starr and Nekaris, 2013). The *Nycticebus bengalensis* is by far the most exudativorous of all the slow lorises with the vast majority of its time ingesting gum, plant parts, nectar and insects with only 4.45% of their time eating fruits (Pliosunggnoen et al., 2010; Swapna et al., 2010; Das et al., 2014). The middle size *Nycticebus javanicus* also prefers exudates, insects and nectar (Rode-Margono et al., 2014; Cabana et al., 2017a) which is similar to the *Nycticebus coucang* diet (Wiens et al., 2006). The smallest *Nycticebus pygmaeus* has also rarely been observed ingesting fruit but has a larger proportion of insects in its diet than larger slow lorises (Starr and Nekaris, 2013). This is why slow lorises are now more appropriately classified as exudativorous, or obligate gum feeders (table 2; Cabana et al., 2017c).

Table 2. Average proportion of time spent feeding on exudates in the wild, within different slow loris species.

Scientific name	Proportion of time spent feeding on gum (%)	Reference
Nycticebus bengalensis	76.5-85.3	Das et al., 2014
Nycticebus coucang	43	Wiens et al., 2006
Nycticebus javanicus	59	Rode-Margono et al., 2014; Cabana et al., 2017a
Nycticebus pygmaeus	51	Starr and Nekaris, 2013

The foraging strategy of slow lorises more closely resembles generalist folivores, which are able to consume a variety of food items depending on availability, however, they rely of sources of fibre they can digest. Although slow lorises have been observed to ingest fruit under captive care when offered, this food is not ideal for them in the long term. Their digestive physiology is rather adapted to digesting food items high in fibre. They possess a cecum with an enlarged hind gut, both associated with the fermentation of the soluble polysaccharides found within their exudates (tree gums) (Coimbra-Filha and Mittermeier, 1977). The time it takes for them to digest their food is also relatively long considering their size (Table 3). They will take longer to digest higher fibre diets, which is also similar to folivores. The fermentation of fibre has a significant effect on the health of slow lorises. Their gut microbe communities were only able to thrive under higher fibre diets, which, under experimental conditions, has contained gum (Cabana et al., 2019). Key groups of beneficial bacteria would only increase in population when fibre was a part of the slow loris's diet. Less beneficial or downright harmful bacteria associated with gut and metabolic disorders were correlated with diets higher in simple carbohydrates (Cabana et al., 2019).

Photo credit: Bristol Zoo Gardens
Figure 1.

Table 3. Mean transit and mean retention times for gut passage rates of *Nycticebus* species either when fed a wild type diet (higher in fibre) or a typical captive diet (lower in fibre). Data from Cabana et al. (2017b).

Species	***N. javanicus***	***N. coucang***	***N. menagensis***	***N. pygmaeus***	***N. bengalensis***
Transit time captive	25.6	25.0	24.2	29.0	25.3
Transit time wild	25.9	24.4	24.5		
Retention time captive	33.4	29.7	32.88	39.75	24.32
Retention time wild	38.5	39.0	34.13		

The methods of studies which have seriously documented the diets of slow lorises in the wild focus on time spent feeding. This means the proportion of time spent feeding on a particular item or a category of food items. This is not directly proportional to intake, as some foods take longer time to process than others. A large feeding time for nectar, for example, translates to a very small intake amount. Nectar and flowers are probably the most overrepresented, gum and insect feeding are similar in time spent feeding and consumption and fruits and leaves are probably underrepresented in these kinds of data. Even with this in mind, exudates and insects form the most significant part of slow loris diets with nectar and various plant parts varying depending on location and season (Cabana et al., 2017a).

1.6.2 Feeding

Slow lorises display an array of morphological and physiological adaptations that land them on a spectrum between insectivore to exudativore. Slow lorises are well-known for their gouging and hanging behaviours. They bite through the bark of trees to cause an injury and return the next day after the gum has been produced and hardened (Smith, 2010). Their dentition is very specialised for this method of feeding. The first premolars anchor the teeth into the tree, allowing the upper mandible to scrape the cambium away, leading to the production of gum. Their extremities are also adapted for negotiating thick or thin trunks and branches, rarely horizontally. Their blood vessels allow them to contract their muscles (holding on to a branch or trunk) for long periods of time (Nekaris, 2014). It is therefore imperative that slow loris are given daily opportunities to perform these natural feeding behaviours and gum is presented in such a way to create it.

1.7 Reproduction

Nycticebus species generally reach sexual maturity when they are between 1.5 to 2 years of age (Izard et al., 1988; Nekaris, 2014). For females, their oestrus cycle typically lasts between 30 and 54 days (Jurke et al., 1997; Larson, 2001). When in oestrus, females tend to vocalize more, and their vagina also appear enlarged and more reddish (Larson, 2001).

During mating season, the female slow loris tends to scent mark the area by urinating while it makes characteristic whistle calls to alert males slow lorises in the vicinity. She will pause every now and then, to visually observe the response by the male lorises. If he urinates in her footsteps, whistles and sniffs the genitals while approaching her, she will adopt a copulative position (Zimmermann, 1989; Larson, 2001).

While most species of slow lorises give birth to young all year round, the *Nycticebus pygmaeus* is a seasonal breeder, with breeding occurring in July to early September, and the young are often born in early February to mid-March (Feng et al., 1994; Larson, 2001).
The average gestation period of slow lorises is about 6 months; dams give birth to well-developed, fully furred infants with eyes opened at parturition (Rasmussen et al., 1988; Jurke et al., 1998; Nekaris, 2014). *Nycticebus pygmaeus* usually gives birth to twins, but there have also been accounts of quadruplets. *Nycticebus coucang* often gives birth to a single young. While *Nycticebus bengalensis* also mostly gives birth to singleton, twins do occur as well. All *Nycticebus* young have fluffy long fur during the first few months, which fades as the animal matures (Larson, 2001).

The dam often carries the young on her stomach, and will “park” the offspring in the branches periodically, when she forages for food or explores. This behavior is known as baby parking. The young are weaned after 6 months but they will stay with the dam until they reach sexual maturity, if she allows it (Larson, 2001). The interbirth interval for *Nycticebus* can range from 17 to 22 months depending on the species (Rasmussen et al., 1988).

In the wild, *Nycticebus javanicus* do not get diffuse until they reach 16-18 months of age, and even then, they do return to their parents (Nekaris, 2014).

1.8 Behaviour

1.8.1 Activity

All slow lorises are nocturnal in their activity patterns, with no diurnal or cathemeral species. Animals may occasionally become active in daylight to change position for thermoregulatory purposes, to eat during periods of intense food scarcity, and to avoid predators (Bearder et al., 2006; Reinhardt et al., 2018). Intriguingly, if an animal is disturbed in the day, it will make up that time with sleep the next night (Reinhardt et al., 2018). Moonlight can affect activity; for example, *N. pygmaeus* and *N. javanicus* decrease their activity during the lighter moon phases (Starr et al., 2012; Nekaris et al., 2020). Slow lorises also increase activity and reduce their height in the canopy during periods of higher humidity when insect prey become more active. Slow lorises can remain active even during heavy rain. During colder periods, at least two species (*N. pygmaeus* and *N. javanicus*) enter regular torpor.

Several researchers have now conducted detailed studies on wild populations. The most detailed are those using radio collars: Wiens (2002) for *N. coucang* in peninsular Malaysia for 18 months; Starr and Nekaris (2013) for *N. pygmaeus* in Eastern Cambodia for 11 months; Nekaris et al. (2020) for *N. javanicus* in Java, Indonesia for ten years continuously. Additional studies, all of *N. bengalensis,* have been conducted in India (Swapna et al., 2010; Das et al., 2014), Bangladesh (Al-Razi et al., 2020) and Cambodia (Rogers and Nekaris, 2011), all without radio collars; the Indian study by Das et al. (2014) was the longest of these at nearly two years. Unpublished data exist for *N. menagensis* in Sabah. Although various studies have looked at reintroduced animals, these should not be taken as typical behaviour of the species (Moore et al., 2014). Table 4 compares the activity budgets. What is clear is that all species that have been studied intensively with radio collars spend half to up to two thirds of their time feeding, traveling and exploring. This is important as captive studies and early studies of lorises suggested they had small home ranges (see below for the opposite) or only moved a few metres per night. Resting can appear higher in non-radio tracking studies since it is easier to follow and keep track of the animals when they are not moving. Resting or vigilance can also be higher in studies where animals or not habituated or where non-red lights are used for observation. Indeed, animals habituated with white lights have been shown to resist habituation and also show more vigilance and fear of researchers (Nekaris and Burrows, 2020). Resting should be distinguished from torpor where possible.

Table 4. Activity budgets (%) for *Nycticebus spp*. Note for *N. bengalensis,* data were not obtained using radio tracking.

Lorisinae	Rest, sleep	Travel	Forage, feed	Groom	Alert	Social
N. bengalensis	48	36	6	4	7	0.4-0.7
N. pygmaeus	21	45	22	3	6	3
N. coucang	5.4	70.6	21			3
N. javanicus	15	16	46	7	13	4

No data are published for *N. menagensis, N. borneanus, N. kayan, N. bancanus, N. hilleri*

1.8.2 Locomotion

A ten-year study of *Nycticebus javanicus* has been able to establish a complete suite of positional behaviours of slow lorises. Because of the breadth of substrates available in the wild, many postures seen in the wild are often lacking in captivity. In addition to sitting, standing, climbing (up and down with head forward or behind) and classical bridging, wild slow lorises show an incredible array of suspensory postures, including horizontal and vertical suspension (Appendix 1. Javan Slow loris ethogram). These postures are developed through a long period of infant dependence, with adult postures being achieved around two years (Poindexter and Nekaris, 2017). Despite this lengthy time, limb proportions reach adult size early on. This seems to be related to a suite of morphological characteristics exhibited by slow lorises that help them specialise in extracting and consuming exudates. Play may be an important part of obtaining adult postures, including the unique postures used by slow lorises to inject venom (Barrett et al., 2021).
Slow lorises are found in numerous habitat types from primary rainforests to secondary forests with continuous edge canopy, mangrove forests (where they even can swim). With the exception of the Bornean species, all taxa have also been found in highly human-dominated landscapes, and even on Borneo, slow lorises have been anecdotally reported in plantations. Although the species are adaptable, it seems a slow loris that was raised in an agricultural landscape cannot thrive in a rainforest, with death rates from reintroductions almost 100% in these cases (Moore et al., 2014). All species studied make use of the lower and upper canopy, moving in an arcing motion; since they are unable to leap, they may need to move all the way down one trunk and up again to move through the habitat. They prefer branches that they can securely cling to for typical movement, and can hold on even in heavy winds. They also are regularly found on trunks, where they gouge for exudates. In general, they prefer dense habitat and almost always hold securely to three or even several branches. They also can cross distances of up to a few 100 m on the ground or move across a long branch but are far less comfortable doing so and may be vigilant at this time. A distinction seems to be the slow lorises of Borneo, which, in competition with the lower dwelling tarsiers, tend to maintain the higher levels of the canopy as much as possible (Nekaris, 2014).

As indicated by their highly active activity budgets, slow lorises move over relatively large home ranges and relatively long distances for their body sizes. *N. bengalensis* without radio tracking have been recorded to move between 40 m and 600 m in one hour. *Nycticebus bengalensis* also can move on the ground through grass to reach sparse trees, and equally travel through the tallest trees at heights of 25 m. Again, without radio tracking, a minimum home range size of about 1 ha was estimated for the species (Al-Razi, et al., 2020). Based on the home ranges of other taxa, this would clearly increase once radio tracking is employed. In Myanmar, *Nycticebus bengalensis* have been observed to swim across entire rivers. *N. pygmaeus* in Cambodia made use of long bamboo connectors to move across the arboreal pathway. Home ranges of adult males were 22 ha, and for adult females 12 ha. *Nycticebus pygmaeus* can move more than 600 m/hour and more than 5 km in a night on a straight plane, not counting vertical distances. *N. coucang* was studied in various habitats, ranging from scrub forest to rainforests adjacent to beaches. They too regularly move to the ground when needed. Home ranges for adult females was around 10 ha and for males up to 22 ha. In addition to habitat use as described above, *N. javanicus* living in an anthropogenic landscape regularly makes use of “loris bridges”, bamboo frames used for crops, and human bridges over rivers. Their home ranges in an anthropogenic landscape are 9.3 ha for males and 4.5 ha for females. Little is known about the locomotion behaviour of wild *N. borneanus, N. kayan, N. bancanus, N. menagensis* and *N. hilleri,* though reintroduction studies of the latter two may yield some basic data.

1.8.3 Social behaviour

All slow lorises are considered semi-gregarious, sleeping in pairs or in groups of up to six animals (more when they give birth to twins), and showing complex patterns of home range overlap (Nekaris, 2014). Most *Nycticebus spp.* appear to exhibit a uni male/uni female social organization, with the most common groupings being an adult male and female pair and their dependent offspring (Nekaris, 2014), but mating is promiscuous. Social behaviours include allogrooming, foraging together and contact during the night, play between all age classes, intensive paternal care and interactive vocalizations A whistle or irritated “chitter” may be used during conflict. Other vocalizations include an affiliative (friendly) “krik” call, and a louder call resembling a crow’s caw specific to *N. coucang*. On making contact with other individuals, *N. coucang and N. javanicus* emit a single high-pitched rising tone, and females use a high whistle when in oestrus.

N. coucang spend 3-10% of their time in social proximity during the night, whereas the *Nycticebus javanicus* spend as much as 65% of their time in spatial proximity and up to 18% of their time in body contact. *Nycticebus pygmaeus* spend 3% of their time together; spatial proximity was not recorded. Even with radio tracking, slow lorises are incredibly concealed in their sleeping sites of dense tangles. This may be why, in their very high sleeping trees, researchers recorded *N. pygmaeus* sleeping alone 96% of the time. For *N. coucang* and *N. javanicus,* both of which were studied in more open habitats, two to six animals regularly sleep in contact. They use sleeping sites repeatedly but swap them regularly. They do not sleep in nests or holes, and sleeping sites always comprise branch tangles, bamboo thickets, or dense lianas. Sleeping sites are cooler than ambient temperatures and rarely do sleeping lorises expose themselves to direct sunlight.

Although scent marking with urine is a dominant form of communication in captivity, it is very difficult to observe in the wild. Furthermore, we now know that most calls of wild slow lorises are in pure ultrasound but can occur 100s of times per night. In studies of *N. pygmaeus, N. coucang* and *N. javanicus*, animals are highly territorial and defend territories aggressively. Normally, males fight with males, and females with females. Females are the least tolerant, however, and the most territorial and can maintain a single home range for as much as ten years. Despite the large home ranges of males, their core areas overlap 100% with their pair mates, and the larger excursions outside the home range are due to the male’s promiscuous habits, visiting neighbouring females in oestrus. Fights are common in all three species leading to numerous healed scars and wounds generated from the slow lorises' venomous bites, whose principal purpose is for intraspecific competition (Nekaris et al., 2020). A whistle or irritated "chitter" may be used during conflict. Little is known about the social behaviour of wild *N. bengalensis, N. menagensis, N. borneanus, N. kayan, N. bancanus* and *N. hilleri.*

1.8.4 Sexual behaviour and infant development and care

All slow lorises have similar mating behaviours and copulatory patterns in captivity, but what we know most from the wild comes from *Nycticebus javanicu*s. A notable sign of oestrus in lorises is their high-pitched whistle. In the wild, males can be attracted from more than 2 km away to visit an oestrous female. In the days leading up to full oestrus, the mate also becomes extra attentive, sleeping with the female more often and following her and feeding with her throughout the night. Despite their uni-male uni-female social organisation, a fight ensues between males for the female, who usually rests and looks on at the contenders. Although she may mate with her "mate", she may also choose an outsider. Until now we have not been able to conduct genetic studies to know who the actual fathers are. When mating finally does occur, copulation normally lasts 30-45 minutes (there may be multiple intromissions during this time), with the male suspended almost entirely on the female's body, hanging from a strong branch. When copulating, the male mounts her from behind and dorsally clasps her sides with his arms. Mating usually lasts less than a minute before the male departs and licks his own genitals. He leaves a copulatory plug in the female that can last multiple days, based on captures of females during this period.

Nycticebus bengalensis and *Nycticebus coucang* gestation and lactation in captivity both last approximately six months, and the same is found in wild *Nycticebus javanicus* (Jurke et al., 1998; Izard, Weisenseel & Ange, 1988; Nekaris & Munds, 2010). *Nycticebus javanicus* and *Nycticebus pygmaeus* infants are parked in deep vegetation; although they are occasionally carried on the ventrum of the mother, they are scarcely seen until they are about three months old. *Nycticebus javanicus* learn feeding techniques from their parents (considering the male a social parent), and if siblings are present in the group, they spend considerable time with them, sometimes the entire night. Insects are one of the first foods they learn to consume. They also can eat gum early on, related also to the early eruption of their tooth comb. The other key component of their diet – nectar – with complex manual dexterity needed to wield flowers and core strength needed to navigate in terminal branches – is the last food item mastered (Maynard et al., 2021). Co-feeding with other family members may facilitate learning of complex food acquisition strategies. *Nycticebus javanicus* can disperse from their natal range as early as 18 months, but more commonly do so between 2.5-3 years (Campera et al., 2020). Females can have one offspring every year, and thus a social group may have parents and four offspring at a single time. These relations are amicable until the offspring start to disperse. At this point, the same sexed parent may become less tolerant if the offspring begins the dispersal process and returns again to the natal home range. Even after dispersal, settling with a mate can take up to two years. Thus, although in principle a wild *Nycticebus javanicus* could become pregnant at 18 months, it is more common for them to do so at 3-4 years of age. It is possible for female slow lorises to have periods of overlap in pregnancy and lactation within a 12- or 18-month period. Females reduce their home range size during the period of lactation but do not reduce their feeding or another activity. In the wild, there is no evidence for birth seasonality for all taxa with the exception of *Nycticebus pygmaeus*, and their birth data is based more on rescue centre data than in the wild. *Nycticebus javanicus* females can continue to give birth until at least 15-18 years. Despite family connections, once an infant disperses, even if it settles in a neighbouring home range, the parents will treat it as a territorial outsider.

1.8.5 Predation and threats

Natural predation events of slow lorises have rarely been observed. Predation has been reported for wild *N. coucang* in Malaysia (reticulated python *Python reticulatus*) and reintroduced *N. coucang* in Southern Sumatra (monitor lizard – species unspecified); wild *N. hilleri* in Northern Sumatra (Sumatran orang-utan *Pongo abelii*, changeable hawk-eagle *Nisaetus cirrhatus*); *N. javanicus* in Java (domestic dog); wild *N. borneanus* in Tuanan, Borneo (Bornean orang-utan *P. pygmaeus*); reintroduced *N. pygmaeus* in Vietnam (monitor lizard and unknown bird for released animals; rats through cage eating limbs of animals); captive *N. bengalensis* in Phuket Thailand (unknown snake entered rehabilitation cage). Although slow loris venom can repel some predators (Alterman, 1995), it is not its primary function.

The greatest threat to slow lorises is humans. All slow lorises are threatened with extinction (Table 1), largely due to illegal wildlife trade. *N. pygmaeus* is heavily exploited for use in traditional medicine and is traded as a pet and in the related tourist photo prop trade. *N. bengalensis* is hunted for food, as medicine, used as key rings and other talismans, and is heavily traded as a pet and in the related tourist photo prop trade. *N. pygmaeus* and *N. bengalensis* are the most frequently confiscated species in international trade. *N. coucang* is used in the pet and medicinal trade, and they are occasionally shot as a crop pest. *N. hilleri* individuals often enter trade when forest is converted for oil palm, at which time loris collectors remove individuals from felled trees. Shepherd (2010) recorded heavy impact of the pet trade on the *Nycticebus hilleri*, recording it as the most traded protected primate in Medan markets; it is also common in the markets of Java (Nijman et al., 2015). *N. javanicus* is frequently captured for use as pets as well as for traditional medicine, the latter practice occurring particularly in East Java and Bali. The evident decline and increasing and unsustainable hunting of the *Nycticebus javanicus* led to it being placed, in 2008, on the list of the world's 25 most endangered primates, where it has since remained. *N. borneanus* and *N. kayan* are threatened by burning of forests and habitat conversion, especially to oil palm plantations, but are not frequently seen in trade. *N. bancanus* only remains in small pockets on the island of Bangka, where little forest remains, but does not seem to be traded. The smaller and more widely distributed *N. menagensis* has only occurred in illegal wildlife trade at a wider scale in the last few years, especially in Internet sales. Intensive exploitation of smuggled animals on social media may lead the public to think that it is acceptable to have these protected species as pets, and in some countries, including Japan, Saudi Arabia and Russia, demand for smuggled lorises remains high. Legal penalties for illegal hunting, trafficking or selling lorises across their range are often not enforced, and the current penalty is not seen as a significant deterrent. Lack of awareness by scientists, governments and rescue centre workers to recognise the species is also a threat, with species being introduced outside their range and even introduced into completely new countries where laws cannot protect them. Hybridisation poses a real threat to these species both in the wild and to confiscated individuals in rescue centres. Furthermore, lack of attention to the IUCN Translocation Guidelines means that species never studied in the wild are released without knowledge of their diet, social organisation, or habitat needs. Similarly, animals living in anthropogenic landscapes are often "rescued" and released into forests; where studies have been conducted, most animals die. Because of their slow and shy nature, slow lorises are also subjected to being collected by commercial and tourist photographers for snapshots, often moved many kilometers from the capture site, where they are then released. They are also frequently killed when crossing powerlines and, on the road (Nekaris, 2014).

Section 2: Management in Zoos

Authors:
Section 2.1 (Habitat design – enclosure): Francis Baines, Lynsey Bugg, Nic Dunn, Sergey Hlyupin, Cecilia Tang
Section 2.2 (Feeding): Francis Cabana, Lynsey Bugg, Marcel Stawinoga
Section 2.3 (Social structure and compatibility): Katarzyna Byczyk, Nils Dijkgraaf, Marcel Stawinoga
Section 2.4 (Reproductive biology and behaviour): Paige Bwye, Katarzyna Byczyk, Nic Dunn, Douay Guillaume, Barbara Jantschke, Cecilia Tang, Jan Vašák
Section 2.5 (Behavioural enrichment): Marcel Stowinga, Cecilia Tang
Section 2.6 (Handling): Lucie Čižmářová, Nic Dunn
Section 2.7 (Considerations for health and welfare): Douay Guillaume, Cecilia Tang
Section 2.8 (Specific problems): Katarzyna Byczyk, Cecilia Tang
Section 2.9 (Recommended research): Katarzyna Byczyk, Cecilia Tang
Section 2.10 (Conservation Links): Kateřina Holubová, František Příbrský
Section 2.11 (Rescue centres): Lucie Čižmářová, František Příbrský, Kateřina Holubová

2.1 Habitat design – enclosure

A few aspects to be considered when designing the enclosure for *Nycticebus* species include their arboreality, nocturnality as well as their recorded home range. Recorded home range varies from *N. pygmaeus* (0.03 km²) to *N. coucang* (0.25 km²) (Wiens, 2002; Wiens & Zitzmann, 2003b; Nekaris & Bearder, 2007). Larger enclosures provide more options for enrichment variety and engagement as well as exploration opportunity for the slow lorises.
Generally, most *Nycticebus* species show complex patterns of home range overlap which must be accounted for when housing more than one individual together. Typically, compatible breeding pairs, dam-offspring pairs as well as siblings who have been kept together since young, are combinations that have worked and are recommended by the TAG. Feeding points and nest boxes should increase based on the number of individuals housed together in the habitat; at least two of each per individual should be provided. Importantly, sufficient space, furniture, pathways, and visual barrier should be provided; animals should always have the option to roam, hide or interact with each other.

The enclosure design should also allow for physical separation during feeding if need be. In the ideal set-up, each slow loris should have their own enclosure with a common/shared area – simulating the “territory overlap” in the wild. When designing the facility, all dens should be connected via sliding doors to facilitate the transferring and rotation of animals. This will also allow flexibility in separation of pairs if required, especially during offspring rearing, or aggression occurrences. This will also be useful if individuals require specialist care such as supplementary feeding or medical treatment.

As *Nycticebus* species are arboreal, a minimum of 2.5 m enclosure height is highly recommended due to their nature and new enclosures should take this into consideration.
Minimum enclosure requirements:
Length (L): greater than 5 m
Width (W): greater than 2 m
Surface Area: greater than 15 m^2
Height (H): greater than 2.5 m

2.1.1 Environmental parameters

As the genus *Nycticebus* is geographically widely distributed, preferred natural climatic conditions for each species also vary. On the one hand, *Nycticebus coucang* and *Nycticebus javanicus* often find themselves within a relatively stable temperature range (29°C to 32°C) in Sumatra region. On the other hand, *Nycticebus pygmaeus* are exposed to a wider range of temperatures; during summer, the temperature can reach a high of 29°C while in the winter months from December to February, the daily average minimum temperature can fall below 15°C, or daily absolute minimum reach below 5°C.

Granted, food resource often tends to be scarce during the colder months, and *N. pygmaeus* in northern Vietnam can undergo torpor to save energy. Interestingly, *N. pygmaeus* in southern Vietnam regions, where the temperature is more stable and does not drop below 27°C during the day and 17.5°C at night, are active throughout the year, and maintain relatively constant body weight throughout the year. As such, institutions should note that body weight of *N. pygmaeus* may fluctuate, as with their coat condition, physiology, activity pattern and behaviour. Such changes could be attributed to seasonality adaptation, and adjustment of environmental parameters may be an option to help them acclimatise accordingly. Any seasonal changes in environmental parameters could be aligned with seasonal changes in diet to promote seasonal cues. More evidence is needed, but this might be a factor in improving breeding success.

Temperature range for *Nycticebus* species should be kept between 19°C to 28°C. Fans, misting systems and ventilators can be used during the warmer days while heat lamp or electrical floor heating systems should be provided for colder days, especially in the temperate region. A humidity level of 70% to 80% is good for *Nycticebus* species. Ventilators should be used to ensure good circulation in enclosures where airflow is restricted.

Outdoor housing in temperate climate

At Night Safari, Singapore, stainless steel meshing (opening size ~0.5 inch or 1.3 cm) is used for the aviary or enclosure set-up to facilitate airflow. An outdoor habitat will allow *Nycticebus* species access to natural lighting and hence encouraging the keeping of natural circadian rhythm, if the ideal environmental parameters can be met outdoors. This includes temperature, humidity, and ventilation – as well as providing suitable lighting levels. In Monkey World Ape Rescue Centre, Dorset UK, where the climate is temperate, we have attempted to achieve this using a mesh-built aviary covered in a permeable membrane which allows air movement and rain ingress whilst keeping the light levels low and simulate moon light (Figure 1). The strength of the sun simulates the variation of moon light.
This was an opportunity to provide the loris with a more natural habitat including live plants, access to weather variability and natural substrates. In order to create a stimulating

environment, we have included only natural materials and a misting system to help cool the space on warmer days.

There have been drawbacks which include the overheating of the space which has required adaptions to allow greater ventilation. Outside enclosures are not required.

Photos credit: Monkey World Ape Rescue Centre, Dorset UK
Figure 1. Tunnel and outdoor enclosure in Monkey World Ape Rescue Centre, Dorset UK. The inside of the outdoor enclosure is perched using bamboo as well as a natural hawthorn tree. The access is via a tunnel that is solid to eliminate light but with a mesh underside to see the animals.

2.1.2 Substrate

Concrete flooring with an epoxy resin surface can be adopted for ease of washing and cleaning, but ideally, a natural substrate should be provided; this can range from natural earth/soil to pine bark mulch, deciduous tree bark, wood chips or orchid bark (Figure 2). Sand and wood shavings can also be used. In general, the substrate layer should be a minimum of 10 cm thick. Dry leaves can also be added to simulate natural forest litter habitats. It is important to ensure that the substrate is free of pesticides before use.

Photo credit: Sergey Hlyupin – photo on the left and Monkey World Ape Rescue Centre, Dorset UK – photo on the right
Figure 2. Suitable substrate for *Nycticebus* species includes bark, dry leaves, soil, etc.

2.1.3 Furnishing

Live plants, tree stumps, trunks and branches of varying diameters are suitable furnishings for the facility to enrich the living environment for *Nycticebus* species. Importantly, vines and connecting branches of differing flexibility should be provided where the animal can use for climbing, locomotion and express a wide range of other behaviours.

Non-toxic tree species should be selected. Several sources will give information on suitable plants and trees such as the following link to Zooplants.net. Plant species that have been used in Moscow Zoo include oak, birch, beech, pine, hazel, willow, or silk plants. Gouging behaviour was observed to be engaged by *Nycticebus* species on certain tree species – Boxelder maple (*Acer negundo*) at Jaszbereny Zoo and fruit trees (apple, pear, plum, cherry plum) at Moscow Zoo. Conifers such as pines, spruces, and firs are also safe plants that have been tried before during periodical enclosure refurbishment; these plants and logs not only serve as additional shelters, sleeping places, enrichment (olfactory), but also as an added structure for them to mark their territory (Figure 2). Trees should be well-secured in the habitat, through the use of external support or cement. Some such methods used by Moscow Zoo are depicted in Figure 3. Artificial trees (e.g., cement material) can also supplement natural trees in the habitat. A diameter of about 20 cm is a good gauge, and holes can also be incorporated to allow natural branches to be inserted. Freshly cut branches of willow or other non-toxic plants can be replaced on a weekly basis.

Photo credit: Sergey Hlyupin
Figure 3. Concrete base holders and cement can be used to secure trees in the habitat.

Horizontal branches are important for breeding, as copulation occurs in a hanging posture on these inclined branches. Figure 4 depicts a good network of climbing tiers and pathways which maximises utilisable space and allows them to explore, as well as provide opportunities to disperse and disengage, should there be conflict (if more than one individual shares the same habitat). Some branches can also be fixed vertically, with one end fastened to the ceiling or horizontal branches using safety hooks, screw rings, etc., and leaving the other end freely hanging. Wooden blocks, processed wood, *Ficus*, and lianas are all suitable considerations for this purpose.

Nycticebus habitat set-up at Night Safari, Singapore.

Photo credit: Marcel Stawinoga
Nycticebus habitat set-up at Dortmund Zoo, Germany

Photo credit: Sergey Hlyupin
Figure 4. Branches, vines, bamboo stems serve as good climbing tiers and network pathways for the *Nycticebus* species.

These attachments (ropes, vines, etc.) stretch across the entire area of the enclosure, thereby increasing locomotion and behaviour repertoire, as well as overall functional three-dimensional space. The freely suspended branches can increase the climbing structure dynamics for the arboreal *Nycticebus* species while adding a layer of complexity to the environmental enrichment through fixing treats to the harder-to-reach areas to encourage the animals to practise their balance and to think of ways to reach these rewards (Figure 5). Hammocks and baskets are other forms of such arboreal furnishing as seen in Figure 5 as well. The material type and opening size of the hammock net should be considered carefully to ensure animal safety i.e., they will not be tangled or snagged when using these structures.

Photo credit: Sergey Hlyupin
Figure 5. Arboreal furnishings for *Nycticebus* species include dynamic ropes, bridge, freely suspended logs by chains and screws, hammocks and hanging baskets.

Furnishing can also incorporate specially fitted food holders. Since *Nycticebus* species are known to gouge tree barks to access gum in the wild, some feeder prototype designs for consideration are reflected in Figure 6.

Photo credit: Sergey Hlyupin
Figure 6. Moscow Zoo's efforts in creating a gum feeder prototype design.

Feeding sites should be arboreal, and it is also necessary to provide several feeders at various locations. This is to encourage spatial use by each animal as well as reduce aggression due to resource competition (if the habitat is shared by more than one animal). Randomising the feeding sites can be a form of environmental enrichment as the animals will be encouraged to "forage" more. Stainless steel bowls are suitable receptacles for their diets. These receptacles can be inserted into rings fixed to trunks and tree branches in the enclosure (Figure 7).

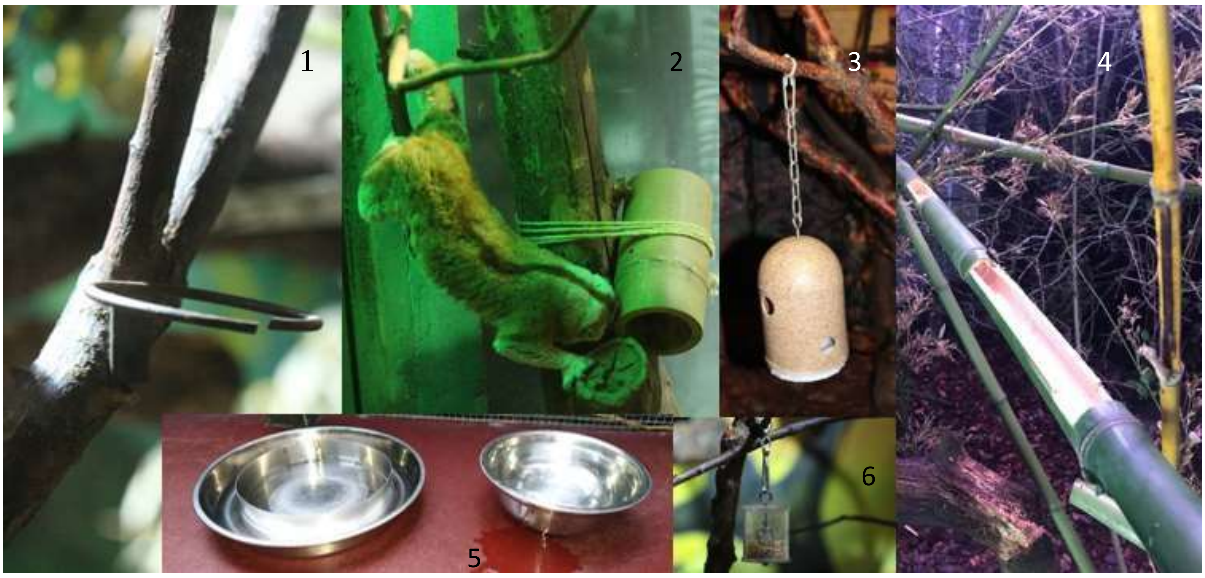


Photo credit: Sergey Hlyupin – photo 1, 2, 3, 6; Monkey World Ape Rescue Centre, Dorset UK – photo 4; Mandai Wildlife Group, Singapore.
Figure 7. Various forms of food and water receptacles used for *Nycticebus* species.

2.1.4 Resting area

Tree trunks and bamboo plants can be used to create resting areas for *Nycticebus* species. At Moscow Zoo, bamboo stems (~3cm in diameter) span across the *Nycticebus* habitat; the top end is fastened to the mesh ceiling while its base is buried in substrate. Artificial stem holder bases can also be used in lieu of substrate for the shorter stems (Figure 3). Thickets of leaves and leafy branches are incorporated at high levels of the habitat for the loris to rest in. These thickets are also areas in which live insects can be placed where *Nycticebus* species are encouraged to put their hunting skills and dexterity to use (Figure 8).

Photo credit: Sergey Hlyupin
Figure 8. Plant thickets and hanging (resting) structures can double up as live insect receptacles enrichment for *Nycticebus* species.

Nest boxes are another important component for *Nyceticebus* species. They can be fixed at accessible, varying heights. Having two exit points would also be an added advantage when it comes to aggression avoidance of conspecifics. Ideally, the nest box should be comfortable for the animals to rest, while allowing animal care staff the option to secure animals in them – either for transportation purposes, or for them to work safely in the shared space if required. *Nycticebus* species would typically sit and curl into a ball when sleeping or resting. However, San Diego Zoo noted that their slow loris occasionally slept on their backs during warmer days. Some nest box designs in use by animal institutions are depicted in Figure 9. Arboreal platforms can also serve as a resting furniture for the *Nycticebus* species. Mesh tunnels are another option to facilitate movement of animals from one area to another and can double up as “transfer devices” as well.

Photo credit: Sergey Hlyupin

Nycticebus nest box design at Night Safari, Singapore.

Figure 9. Nest box dimensions for reference. Top: Moscow Zoo, Russia. Bottom: Night Safari, Singapore.

2.1.5 Maintenance

All leftover feed items should be removed daily and food and water receptacles cleaned on a daily basis. As *Nycticebus* species' faecal matter is often small, dry and has no strong odour, daily spot cleaning should suffice for spaces with natural substrate. The top layer of substrate can be removed gradually during cleaning but periodically (once every few months) the substrate layer should be completely removed, and the enclosure must be disinfected. New mulch top-ups can be done once a week. Scent-marking (via urine) will likely be repeated by the animals after washing down since it is associated with territorial marking. Hence, branches where they frequently urinate on should be replaced or washed every few weeks. Branches and vines where the animals gouge or gnaw on should also be replaced accordingly.

2.1.6 Safety considerations

Great care should be taken when working alongside these category 1 venomous primates. It is the opinion of *Nycticebus* EEP coordinators that animal care staff should only carry out husbandry in the same (shared) space with non-aggressive *Nycticebus* specimens that are assessed to be of a calm temperament. There have been incidents where caretaker(s) of *Nycticebus* species sustained bites leading to anaphylaxis and required urgent medical attention. A risk assessment that covers all aspects of safe working practices with this species is advised. Where possible, *Nycticebus* specimen should be confined or secured in the nest box during the servicing of the enclosure to mitigate the risk of staff being trapped or attacked by the animal. It is for this reason that we recommend all holders to plan and design their facility to facilitate the shifting of animals between dens and enclosures through operant conditioning or allow their staff to secure the animals in a safe way before entering the enclosure and servicing the area. A closed-circuit surveillance system is also recommended to enhance animal monitoring efforts. Night vision cameras are especially helpful in capturing the nocturnal activity and behaviour of the *Nycticebus* species (Figure 10).

Photo credit: Sergey Hlyupin
Figure 10. Infrared / night vision cameras and CCTV system in place for *Nycticebus* species at Moscow Zoo, Russia.

2.1.7 Lighting and circadian cycle

Nycticebus species are most often held in zoo enclosures under reverse cycle lighting. Whether natural or reverse cycle lighting regimes are employed, it is important to consider provision in both day and night phases and during the transition between the two (Figure 11, 12, 13). Numerous studies have been conducted on the effects of light at night, both for *Nycticebus* in captivity (e.g. Fuller et al., 2013, 2016; Henton, 2000; Kavanau and Peters, 1976, 1979; Redman, 1979; Tenaza et al., 1969; Trent et al., 1977) and in the wild (e.g. Reinhardt et al., 2019; Rode-Margono and Nekaris, 2014; Starr et al., 2012). However, very little attention appears to have been paid to lighting during the day. Both the spectral quality of a light (the wavelengths it contains) and its intensity have profound effects upon animals, both during the day and at night.

The following points must be considered when planning the lighting for the **day phase**:
The spectrum of the "daylight"

The illuminance (intensity) of the "daylight"
Cutaneous synthesis of vitamin D3 by a UVB component in the light
The important transition periods of dawn and dusk, i.e., "twilight".

Four major factors must also be considered when providing the **night phase**:
The effect of any light upon the animal's vision
The effect of any light upon the human observers' vision
The effect of light at night upon the animal's behaviour
Non-visual perception of light at night by the animal, in particular short-wavelength (blue) light and its effect on circadian rhythms.

Photo credit: Paige Bwye, Bristol Zoo Gardens
Figure 11. *Nycticebus pygmaeus* exhibit at Bristol Zoos nocturnal house.

Photo credit: Paige Bwye, Bristol Zoo Gardens

Figure 12. *Nycticebus pygmaeus* exhibit at Bristol Zoo during the day when animals are active.

Photo credit: Paige Bwye, Bristol Zoo Gardens

Figure 13. Second *Nycticebus pygmaeus* exhibit at Bristol Zoo Gardens, to the right with the lights off.

Light during the day phase

Nycticebus are usually described as exclusively nocturnal. However, full spectrum daylight plays an important role in their lives. Wiens (2002) reported that *Nycticebus coucang* exclusively slept on branches, twigs, palm fronds, or on lianas, hidden from view by foliage. Svensson et al. (2018) described *N. bengalensis, N. pygmaeus, N. coucang, N. hilleri, N. kayan* and *N. menagensis* as using “dense tangle” or a tree fork or branch as sleep sites; all except *N. menagensis* also used bamboo; none were found to use nests or tree hollows. In these sleeping positions, all would be exposed to varying amounts of daylight although shaded from direct sunlight by foliage. Exposure to daylight, which includes UVB radiation, enables cutaneous vitamin D3 synthesis in most vertebrates studied to date, including primates (Power et al., 1995; Ullrey and Bernard, 1999; Uhl, 2018). This is the primary source for non-carnivores. The natural foods of lorises - insects, nectar, gum exudates and sap - contain little or no vitamin D3.

Although there appears to be no published studies on the natural UV exposure of wild mammals, a key study of reptile microhabitats (Ferguson et al., 2010) identified crepuscular and shade-dwelling species exposed to UV levels in daylight up to UVI 1.4 ("Zone 1"), and those exposed to partial sun, such as forest edge species, up to UVI 3.0 ("Zone 2"). Although still in the experimental stage, growing numbers of zoos are providing UVB to mammals, especially diurnal primates, housed indoors. There seems no reason to exclude nocturnally active species which would naturally experience daylight in their sleeping places. Modern full spectrum lighting, originally designed for supplying UV to reptiles, can be used to create levels of UVB typical of daylight across any size of enclosure, and the so-called "Ferguson Zones" may be useful in determining suitable exposures (Baines, 2020). Artificial sources of UVB are effective in raising vitamin D3 levels in primates (e.g., Gacad et al., 1992; Lopez et al., 2001)

The spectrum and irradiance (intensity) of daylight is also important for establishing natural sleep. Daylight, even in forest shade, may reach thousands of lux. In the understorey of primary rainforest and lowland forest in Malaysia, for example, daytime lux readings reach 1,800-3,000 lux (Faridah-Hanum et al., 2009). Kavanau and Peters (1979) reported that although under artificial lighting, 10 lux was sufficient to inhibit movement; much brighter light up to 3,000 lux was required to ensure complete cessation of activity. When installing lighting for the diurnal phase for *Nycticebus*, it may be beneficial to include bright full-spectrum lighting in one part of the enclosure, to simulate a "patch of sunlight" which initiates sleep and also allows at least some illumination, including low levels of UVB, to reach the animals in their sleeping positions.

Studies of sleep patterns by Reinhardt et al. (2019) revealed brief periods of daytime wakefulness and activity, rarely exceeding ten minutes, between long periods of sleep. After sunset, high levels of nocturnal activity were seen, punctuated by brief "naps". A very clear circadian photoentrainment is evident; several studies map a synchronised emergence from sleeping places, with activity beginning about 20 minutes before sunset, increasing for about an hour afterwards. At the end of the night, activity reduces about one hour before sunrise, and ceases about 40 minutes after sunrise (Reinhardt et al., 2019; Wiens, 2002). The photic zeitgeber is the twilight period before sunrise and after sunset, with the sun just below the horizon (Kavanau and Peters, 1976). This lasts approximately one hour in the tropics, when blue light from the sky predominates and the light level changes very rapidly. This type of entrainment in mammals is dependent on non-visual perception of light during the day by intrinsically photosensitive retinal ganglion cells (ipRGCs), most sensitive to wavelengths in the blue range, with further input from retinal cones in daylight, rods after dark, and both during twilight (Dacey et al., 2005; Lall et al., 2010). Signals are relayed to the suprachiasmatic nucleus (SCN) of the hypothalamus, which governs the setting of circadian rhythms and suppression of melatonin synthesis during daylight hours, thereby controlling body clocks and activity levels (Kavanau and Peters, 1976).

Light during the night phase

This section is primarily of relevance to facilities using reverse cycle lighting regimes.

Nycticebus eyes are adapted for excellent vision in low light. The retina contains primarily rods, with maximum sensitivity at around 500 nm (blue-green light – likely insensitive to red wavelengths), and a single cone type with a mid-wavelength photopigment having maximum sensitivity at 543 nm (like the human M-cone with peak sensitivity at 530-540 nm, therefore with a sensitivity range including red wavelengths). Having just one functional cone type suggests monochromatic vision regardless of light level (Surridge et al., 2003; Kawamura and Kubotera, 2004). However, red light bright enough to stimulate this cone type will not be invisible to *Nycticebus*. Lower levels, however, will not stimulate retinal rods or ipRGCs, and should not be visible to them nor affect their circadian rhythms. It follows that if very dim red lighting is used in the Nocturnal House during the night phase, it is possible for the illumination to be sufficient for humans to observe the animals in a faint red glow, with minimal effect upon the loris.

However, many human observers find red light unpleasant. A "moonlight" effect is preferred, using very dim white light, with the human eyes becoming at least partially dark-adapted. Any white light bright enough to allow human colour vision will weaken visitors' dark adaptation by bleaching out rod vision, another reason to use red light or keep white light close to moonlight levels as far as possible. (i.e., at or below 0.75-1 lux, equivalent to the full moon). Strongly dimmed incandescent lamps or "warm white" LEDs are most suitable for simulating moonlight as they have relatively lower levels of blue wavelengths in their spectra. Covering lamps with neutral density filters, as described by Frederick and Fernandes (1994) is an option if adequate dimming is not possible.

Blue lights, and white lighting with a high concentration of blue wavelengths (such as "cool white" LEDs) must be avoided owing to the profound effects of short-wavelength light at night upon circadian and circannual rhythms, mediated by stimulation of ipRGCs as described above. The resulting suppression of melatonin synthesis, well documented in primates, is known to have adverse effects on a wide range of physiological functions. In humans, nocturnal melatonin suppression is associated with elevated cancer risk, cardiovascular disease, major depression, metabolic syndrome, and decreased fertility (Fuller et al., 2013, 2016; Navara and Nelson, 2007).

Pygmy slow lorises, but not slow lorises, are seasonal breeders (Fitch-Snyder and Jurke, 2003) with cycles which could be affected by melatonin suppression. Fuller et al. (2016) demonstrated levels of nocturnal activity in *N. pygmaeus* to be significantly lower under blue light than red and advised against its use. Frederick and Fernandes (1994) described highly significant increases in nocturnal activity levels and natural behaviours in a potto (*Perodicticus potto*) following lighting improvements. They reduced night lighting to a minimum and removed blue wavelengths at night by replacing blue, fluorescent tubes with incandescent lamps fitted with neutral-density filters. They also increased day lighting to a maximum of nearly 7,500 lux using white fluorescent tubes, which effectively inhibited abnormal activity during the day. Incidental observations in some zoos have also found improved activity levels and breeding success with the removal of blue lighting and the addition of low level warm white lighting (under 1 lux) in *N. pygmaeus*.

Wild *Nycticebus* species are most active in evening twilight and on dark, clear moonless nights; moonlight suppresses activity. The lunar cycle creates a very regular monthly rise and fall in nocturnal illumination, from the almost total darkness of starlight at new moon, to the night-long low-level irradiance of the full moon just two weeks later. Temperature also plays a role; on bright moonlit nights that are also cold, activity is further suppressed (Rode-Margono and Nekaris, 2014; Starr et al., 2012; Rogers and Nekaris, 2011). Night illumination preferences for a group of three *N. coucang* were determined by Kavanau and Peters (1979) to be between 0.07 lux ("clear moonless night") to 0.19 lux (described as "full moonlight"), but they also noted that total darkness inhibited activity, presumably owing to complete loss of vision. In captivity, Trent et al. (1977) demonstrated maximum activity in *N. coucang* under dim incandescent (white) lights when a range from 0.25 to 3.2 lux (average 0.66 lux) was available; this is, however, brighter than moonlight. When illumination was increased further to a range from 2.2 to 16.1 lux (average 4.1 lux) activity was reduced. Bristol Zoo had a similar experience, where keepers working with *N. pygmaeus* saw a reduction in activity when lux levels increased beyond 1 lux and activity ceased completely when it got between 2.5 and 3 lux (Paige, 2019).

Practical recommendations

Light phase

The most important feature of daytime lighting is provision of bright full spectrum lighting including natural levels of blue light (facilitating sleep) and which also incorporates suitable levels of UVB (affording opportunity for cutaneous vitamin D synthesis).

A large, effective area of full spectrum illumination is possible using multi-tube T5-HO fluorescent fixtures fitted with a combination of "daylight" 6500 Kelvin T5-HO fluorescent tubes and UVB T5-HO tubes such as the Arcadia T5-HO 2.5%, 6%,12% or 14% UVB range (Monkfield Nutrition Ltd., Ely, UK) (Figure 16). Suitable hydroponics lighting fixtures with aluminium reflectors are available in a range of sizes up to eight-tube, 120 cm x 66 cm units. These can be suspended from the ceiling of the enclosure. The location of the fixture in relation to the loris sleeping places and the number and type of UVB tubes used will determine the UV Index obtained. A UV Index meter (Solarmeter 6.5 or 6.5R, Solar Light Company, Inc., Glenside PA, USA) is essential to be used to aid positioning and monitor UV levels (Figure 15). Appropriate UVI levels for sleeping loris are unknown. However, provision of sleeping locations with varying degrees of illumination from zero in deep shade to UVI 1.4 in dappled light would recreate a "Ferguson Zone 1" microhabitat and afford the animals choice. Restricting access to a maximum of UVI 3.0, the equivalent of morning sunlight, in more open areas under the lights would seem appropriate ("Ferguson Zone 2").

These units are unlikely to provide optimum visible light levels of up to 3,000 lux. LED floodlights, placed to complement the fluorescent fixtures, will achieve these levels. At the beginning and end of each day, a suitable "twilight" is required, with a transition over a period of approximately one hour between bright full-spectrum daylight and near-total darkness with little or no blue light. This can be achieved with dimmable LED floodlights, with the fluorescent tubes timed to switch on after the LEDs have ramped up to full brilliance after "dawn" and turned off before the LED dimming programme begins at "sunset". A lux meter should be used to establish lighting levels (Figure 14).

Photo credit: Paige Bwye, Bristol Zoo Gardens
Figure 14. Lux reader used to record light levels at Bristol Zoo in nocturnal exhibits.

Photo credit: Frances M Baines

Figure 15. A Solarmeter 6.5R UV Index Meter. These are extremely useful for setting up suitable UVI ranges in enclosures, and monitoring the lifespan of UVB-emitting lamps.

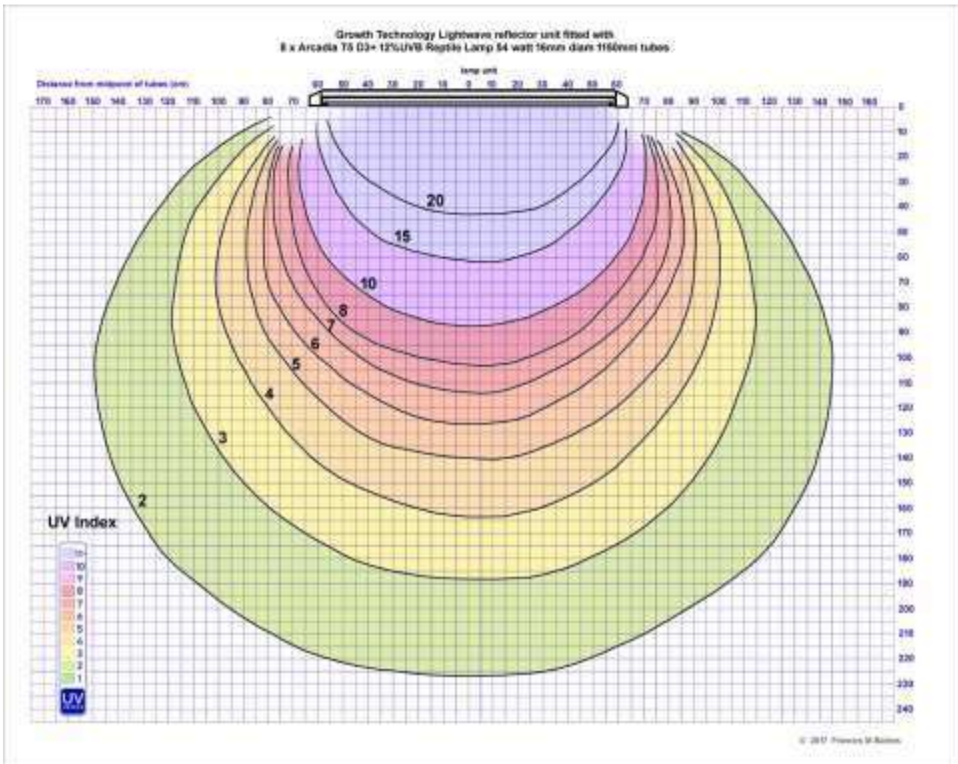


Photo credit: Frances M Baines

Figure 16. A UV Index iso-irradiance chart for a multi-tube T5-HO fixture which can produce very wide low-level UV coverage at considerable distances from the lamp unit. For the lorises, a UV Index from a maximum of UVI 3.0 in open areas to zero in full shade would seem appropriate to simulate daytime sunlight.

Night phase

For human visitors to see the animals in a Nocturnal House, and to progress through the exhibit safely, some low-level lighting is necessary. Visitors' walkways and signage can be illuminated by dim LED lamps positioned or shielded in such a way as to be invisible from inside the enclosures. Reflections on glass, either from these lights or from the objects they illuminate,

must also be avoided as far as possible as they will hinder visitors' view into enclosures as well as being visible to the animals inside. A range of dim white LED spotlights can be placed strategically in the habitats to create the desired lighting results (Figure 17).
Suggested lux levels during the night phase would be between 0.75 and 1 lux, with an average reading being taken between lit areas (under lights) and dark areas (Figure 18).

Photo credit: Paige Bwye, Bristol Zoo Gardens
Figure 17. Lights used at Bristol Zoo: Flood lights for daylight and dim circular spotlights for night visibility.

Photo credit: Frances M Baines
Figure 18. Use of very low level "warm white" LED lighting in the walkways of the Nocturnal House to simulate moonlight - a more natural effect than the use of red or blue lights. (A time exposure was used here to enable better visualisation of the effect. The visitor's experience is of a much darker place).

Staff presence

Staff working around *Nycticebus* species should also consider how they can do that without affecting activity levels. Enclosure servicing should be done during the light phase, but of course good observations will only be possible during the night phase, when the animals are active and this is also when the animals will be fed. Head torches with red lights included can be a highly useful tool for keepers as they provide good visibility whilst keeping hands free for animal care duties. However, care should be taken as, already noted, strong red lights will be visible to the loris. Therefore, the amount of time these lights are used should be kept to only what is necessary.

2.2 Feeding

2.2.1 Basic diet

Nutrient recommendations of slow lorises have long been related to Old World monkeys' requirements, which are based on rhesus macaques. Slow lorises have very little in common with macaques, their feeding ecology, morphology, or digestive physiology. A more appropriate model would be the New World monkeys, based on a common marmoset, because of their similar diets in the wild and digestive strategies (NRC, 2003). Here, we repeat the recommendations of Cabana et al. (2017d) where the basal requirements for marmosets were expanded to factor in the estimated nutrient intake of slow lorises in the wild (Table 5). Diets should contain food items within the recommended list under the right proportions and avoid those in the discouraged list (Table 6). Historically, fruits and dog/cat food and animal products have been a predominant part of slow loris diets, with disastrous consequences. Diets were rather high in crude protein and soluble carbohydrates which correlates to commonly diagnosed dental diseases, kidney issues, abscesses, obesity, low breeding success, and high infant mortality (Cabana and Nekaris, 2015).

Table 5. Nutrient targets for slow lorises under human care, all based on a dry matter basis (from Cabana et al. 2017d and Cabana, 2020).

Nutrient (unit)	Target concentration on a dry matter basis
Crude protein (%)	23.5
Crude fat (%)	2.4-13.0
ADF (%)	11.0
NDF (%)	19.0
Ca (%)	0.50
P (%)	0.20-0.40
Copper (mg/kg)	8.80-11.20
Iron (mg/kg)	63.50-75.10
Magnesium (mg/kg)	0.30
Sodium (mg/kg)	0.10-0.30
Vitamin A (IU A/g)	2.1
Vitamin E (mg/kg)	100

Daily diets should comprise of insects, tree gum (or other exudates), vegetables and to a lesser degree pellets or concentrated foods. Eggs may be given sporadically; however, it is very possible to create a well-balanced diet without its use. Other animal products such as mice, chicks, meat, dairy (milk, cheese or yogurt) should not be used under any circumstances. Dairy is not beneficial to the slow loris's gut health and may lead to problems down the line, including systemic issues such as auto-immune reactions caused by a weak gut barrier (Cowgill and States, 1982).

Table 6. Recommended diets for slow lorises under human care based on proportion of weight of the food categories. *Nycticebus pygmaeus* should have the higher range of insects (25%) and lower vegetables whereas *Nycticebus bengalensis* should have a higher range of gum and vegetables to maximise their fermentation abilities.

Food Item	**Proportion of diet (%)**
Watery vegetable	30-40
Root vegetable	30-40
Concentrate (pellets/insects/egg)	10-25
Gum Arabic	10-20
Enrichment foods (fruit, nectar, etc.)	0-5

Insects should instead be the main source of crude protein and crude fat within the diet. Insects must be properly gut-loaded and sprinkled with a multimineral to ensure a positive calcium-to-phosphorus ratio. Gut loading means feeding the insects a high-quality food item, loaded with minerals, vitamins, and fatty acids two hours before feeding the insects to the slow lorises (Cabana, 2020). The standard protocol involves feeding insects once a day with a maintenance feed. Remove the portion of insects to be fed to the lorises that day and feed them high-quality gut-loading food instead of the maintenance feed. This will ensure high uptake of the diet. Commercial gut-loading formulas exist and are successful in increasing the calcium, omega-3, vitamin E, and carotenoid contents of zoo-reared insects (Oonincx and Van der Poel, 2011). The chitin possessed in insects may also have a prebiotic effect for the slow lorises gut microbe community (Cabana, 2020). The choice of insects can depend on local availability but locusts, mealworms, morio worms (large mealworms), and crickets are standard choices. Other options, such as stick insects and cockroaches can also be given if available. Commercial mealworms and crickets generally lack certain nutrients that would be necessary to make them nutritionally balanced. Strict gut loading and dusting practices must be followed.

Gum is a staple for wild slow lorises of every species, in every region. The most common gum used in zoos is called gum Arabic and is easy to source. It comes in two formats, raw gum (which looks like amber crystals) or refined gum (which looks like white powder). Both can safely and effectively be used with slow lorises. The crystals will need a longer soaking time, as they will absorb the water and become more gelatinous. Soaking overnight is a common strategy and using hot water can aid the process. Caution must be taken when feeding the dry raw crystals as they have been dehydrated and may be too hard for older animals to chew. The refined gum can be mixed and fed immediately, although its texture is more like a sticky paste than real tree gum. Slow lorises don’t seem to mind as they will all eventually find the gum palatable. Gum is also an excellent vector for measured supplements or medicine as the slow lorises will usually completely consume the gum. Consistency of desired gum depends entirely on how it is fed, firmer or more liquid gum are both adequate. Nectar is another popular food item. Commercial nectars are highly fortified and necessary for slow lorises that need quick energy. This isn’t the case in captivity therefore dilute commercial nectar or very dilute juice, or very dilute honey water solution are best used as enrichment and not necessarily as part of the diet.

Although fruits are readily eaten by slow lorises, this is more akin to chocolate cake rather than to a healthy meal. Successful diets have replaced fruits with vegetables and had a more desirable activity budget, a decrease in body condition, and it is believed to have reduced the odds of developing the dental disease (Cabana and Plowman, 2014; Cabana et al., 2017d). The only acceptable time that fruits may be used is during training when a strong reinforcer needs to be used. Fruits should be considered on a case-by-case basis. For example, if a *Nycticebus* specimen is already emaciated, or losing body condition but yet absolutely refusing the proper diet, fruits can be used to entice their appetite at the initial phase, and animal care staff can then gradually wean it off the fruit content through gradual adjustment, over the course of a few weeks or months. Fruits that are lower in soluble carbohydrates yet are still effective include berries, apples, and guava. Even then, we would recommend gum from a syringe be used as this is also very effective. For extra motivation, the gum in the syringe can be made with pureed fruit. Vegetables that have been successfully used include broccoli, cauliflower, celery, corn, cucumber, peas, sweet pepper, radish, tomatoes, and some root vegetables such as courgette, all kinds of squash, pumpkin, sweet potatoes, beetroot, carrot, celery root, parsley root, kohlrabi, aubergine.

Photo credit: Bristol Zoo Gardens
Figure A.

Although the effect it can have on captive slow loris is yet to be confirmed, we do know that some wild loris have to deal with seasonal changes in the availability of their diet. For example, research on the feeding ecology in *Nycticebus pygmaeus* and *Nycticebus javanicus* both show seasonal changes. In the wet season, a wider variation of food is consumed but this variety is

reduced in the dry season, which coincides with seasonal restrictions in food availability of certain fruits, flowers, nectar, and insects (Figure A).
Studies have also indicated a variation between males and females in how they cope with these seasonal changes. In *Nycticebus javanicus*, females were found to ingest more protein, gum, fruits and flower during the dry season, whereas males ingested more fibre. It is possible the burden of gestation and lactation place an additional burden on females to ensure adequate energy is obtained during this time.

A recent study conducted at Bristol Zoo, UK, explored how seasonal variation in diets can have impacts on pygmy slow loris health and reproduction. Indeed, adding in a seasonal variation in diet had a significant effect on the pygmy slow lorises' behaviour. The control diet consisted of gum Arabic, insects, nectar, pellets, and vegetables. Treatment diets were divided into three to mimic the insect availability of the wet/dry seasons of Southeast Asia. "Low" diets had more gum and less insects, "low/high" diets had intermediate amounts of both, and "high" diets had less gum and more insects. The energy content of the diet also went from low, medium and high as reflected by the quantity of insects. Pellets and vegetables were kept constant between the different diets. The *Nycticebus pygmaeus* increased feeding time, social behaviours, grooming behaviours and decreased resting behaviours as energy content increased seasonally (Bywe, 2020).

Historically, lorises that did show seasonal changes in behaviours have bred better at Bristol Zoo compared with those that have not (Bywe, 2020). Although there are cases of slow loris breeding throughout the year in captivity, there remains a peak of births between January and March (Feng et al., 1992). Promoting and encouraging these seasonal changes may improve breeding success overall. It's important to note that there does exist a difference in seasonal behaviours between the different slow loris species with the seasonal importance being particularly marked in the *Nycticebus pygmaeus* natural history. More research is needed to understand the importance of seasonal diets for the different slow loris species.

2.2.2 Special dietary requirements

Growing individuals need rich and nutrient-dense diets, this means giving the normal amounts of insects, concentrates, and gum. It is very important at this stage to gut load the feeder insects as well as dust the crickets with the appropriate calcium and vitamin D3 supplement. Produce is important to give at this life stage as it makes the slow lorises more flexible in terms of dietary choices as they mature. A large variety of vegetables should be rotated throughout its infancy to get them acquainted with as many types of vegetables as possible. Fruits are highly discouraged at this stage as they are not associated with a healthy microbiome in hindgut fermenting primates.
Gestating individuals do not need any additional supplements or food except for possibly the last 2 weeks of gestation. Their diet can be increased by 20% and another 20% after they give birth. This extra 40% of the diet will eventually serve as the offspring's diet after weaning.
Little research has gone into geriatric care of slow lorises. Suggested practices from the authors recommend soft gum (not raw hard crystals) as well as increasing water intake, a fish oil supplement (for omega3s), the addition of a calcium supplement to the gum, and lastly, a 5% increase in insects to increase overall protein.

2.2.3 Method of feeding

Gum

Gum should, where possible, be presented in a way to encourage natural feeding behaviours. Drilling holes into logs and trees within the exhibit will allow staff to syringe gum into them and encourage gouging (Appendix 2. Improving welfare of captive Pygmy slow loris by encouraging natural feeding behaviours). Alternatively, small log feeders with rings at one end can be added and removed from the enclosure as required. The mobility of these is good for muscle use. These smaller log feeders can also be frozen once filled with gum, to create a more natural feeding proposition, as the gum softens slowly once fed out, further encouraging gouging behaviours.

Photo credit: Marcel Stawinoga
Figure B.

In rescue centres, a lot of gum Arabic branches are distributed in the enclosures each night. They do not empty one branch after the next. They prefer to move from branch to branch, lick at a branch for a while and continue with the next one, so they frequent each gum Arabic branch multiple times a night, and spend a lot of time by moving from one gum spot to the next (Figure B, C).

Photo credit: Bristol Zoo Gardens
Figure C.

Nectar

A small amount of nectar can be put on flowers or browsed to encourage natural nectar-drinking behaviour. However, due to its high sugar content, giving the majority of nectar directly from a syringe should be considered, to allow consumption levels to be known. This can also work well when coinciding with any positive reinforcement training programme.
Institutions have used bird water feeders as slow loris nectar feeders, where the slow lorises can reach and lick the nectar with their long tongues. In Figure D, you can see our two N*ycticebus pygmaeus* at Dortmund Zoo taking out the nectar of a water feeder for birds.

Photo credit: Marcel Stawinoga
Figure D.

Insects

Insects and vegetables can be given in a range of enrichment items to encourage natural foraging and extend feeding times. For example, hanging balls, bamboo stems, willow balls, etc. (Figure E). Positioning of these should also be considered to promote feeding positions such as hanging.

Photo credit: Bristol Zoo Gardens
Figure E.

2.2.4 Water

Fresh water should be provided daily to all lorises. Placing it in a simple small dish somewhere in the enclosure is adequate. Slow loris will drink directly with their mouths but are also seen using their hands. Placing the container in a way to encourage natural positioning is important. Spraying or misting on large-leaved plants may also provide a natural way for slow lorises to obtain their water, licking droplets from leaves.

2.3 Social structure and compatibility

2.3.1 Intraspecific compatibility

Nycticebus species have long been regarded as solitary, however, they do exhibit different degrees of inter- and intra-specific sociability. Social behaviour is observed when they rest, mate, sleep in a group, or through vocal and olfactory communication (Nekaris, 2014). On the one hand, *Nycticebus javanicus* has been noted to be quite social (e.g. sleeping in pairs or in groups) and spend considerable periods of time (up to 65% of their time) in spatial proximity, including an average of 18% with body contact (Nekaris, 2014). Yet on the other hand, *Nycticebus coucang* only spend about 10% of their activity budget in social behaviors such as playing, grooming, and feeding together (Wiens, 2002; Nekaris, 2014).

In the wild, the territorial range of male *Nycticebus* tends to overlap with several females (Larson, 2001). For most zoological institutions, lorises are often kept in pairs or the same family group. Most *Nycticebus* tend to accept sharing the same enclosure with their siblings. The young *Nycticebus* can stay with their parents for up to a year before separation to prevent inbreeding. Some documented configurations include a male *Nycticebus coucang* with three adult females (Ehrlich & Musicant, 1977) and mixed-sex groupings in group sizes of up to nine individuals for *N. coucang*, *N. javanicus* and *N. menagensis* (Moore, 2012). Also mentioned in the literature are *N. javanicus* in groups of one male and four females (Putri et al., 2015), unrelated *N. pygmaeus* in single-sex female groups (Alejandro et al., 2021), and in pairs (both males) (Yamanashi et al., 2021).

While some institutions have had successes with keeping more than one *Nycticebus* specimen together, there were also cases where conspecific aggression occurred in pairings/groupings that were dynamically stable initially. As such, the introduction and mixing process should always be conducted with patience and care. For a start, the mixing enclosure or habitat should be (physically) large enough for individuals to have the option to retreat to, avoid or engage conspecific at their own comfort. It is crucial to provide safe hiding spaces (e.g., dense planting, cardboard tubes, or boxes) in these enclosures (Fitch-Snyder & Schulze, 2001). To mitigate aggression risks, Fitch-Snyder & Schulze (2001) suggested the "introductory housing cage" concept during the acclimation phase, where male *Nycticebus* can enter this smaller "cage" and then either be placed directly within the enclosure of the female *Nycticebus* for caretakers to observe their interaction across the cage mesh, without the female feeling overwhelmed.

Alternatively, both individuals can also be "introduced" to each other at a neutral ground i.e., an unfamiliar enclosure to both, whilst separated by a fence as a safety barrier – enabling visual, olfactory, and vocal interactions. This can be done by using two cages or using a plexiglass divider or double-wire screen at the contact fence. The pair should be monitored for possible aggression (or positive interactions). If the individuals appear to be relaxed and no aggression is seen, the physical barriers/dividers can then be removed. One way to encourage them to rest in close proximity is to place the nest boxes, cardboard tubes, or strategically install branch forks in dense planting or a heat source near the divider fence – such that they will continue to do so out of habit, when the fence is removed, or when the connecting door or window is opened. A small note for mixed-gender pairing, the best time to remove the divider barrier is often during the oestrus period of the female.

Alejandro et al. (2021) described a social introduction of solitary-housed female *Nycticebus pygmaeus* into group enclosures and introduced a group consisting of two females and a group consisting of four females. In the first step, the individuals were housed in solitary cages facing each other enabling visual, olfactory, and vocal contact, without giving them physical contact. In the next step, after a period of habituation of several weeks, the cages were placed closer to each other, but still without giving the slow lorises physical contact. The aimed group of two females was introduced after 90 days in solitary enclosures and the aimed group of four females after 150 days in solitary enclosures together in larges enclosures. The group consisting of two females showed minor hair clasps and leg grabs, which also could be playful and not antagonistic. The group constating of four females showed clasping and chasing each other and one bite on the introduction day, which did not require veterinary intervention. From day two they shared the same nest for sleeping and during further observation, no aggression occurred.

Yamanashi et al. (2021) described the successful social introduction of five pairs of male *N. pygmaeus*. Each pair was introduced in an enclosure that was unfamiliar to both individuals.

In some cases, when necessary, acclimatisation phases were set up by placing small cages close together for several days. Individuals showing immediately aggressive behavior to the potential partner were moved to another pair constellation. One male in the study always behaved aggressively and was not paired with another male. The five introduced pairs of male *N. pygmaeus* showed social and affiliative behaviors like allogrooming and nest box sharing.

2.3.2 Sharing enclosure with other species

Mixed species exhibits are possible with *Nycticebus* but need very careful monitoring to ensure that all the occupants are doing well. It is also important to note that breeding might be less likely to occur in this kind of exhibits, although this seems not to be a big problem within the consulted holding institutes. The success of mixing can depend on the species and indeed on the exhibit – size and furnishing, number of feeding and hiding sites.
Competition for food may occur and has happened with *Galago senegalensis* and *Hypogeomys antimena* in a single case in two different institutions. In one case the *Galago senegalensis* was separated into another enclosure and in the other case *Hypogeomys antimena* was blocked in its climbing route and deterred from reaching the diet of the *Nycticebus*. One institution kept *Nycticebus pygmaeus* with Javan mouse deer (*) for years without any problems. However, at some point, the mouse deer became ill while temporarily housed with a juvenile male (without his dam). This was a rare incident, and the institution decided to move the mouse deer to another enclosure in the end. Overall, *Tragulus spp.* and *Nycticebus spp.* appear to be quite popular mixed species combinations in zoological institutions.

Table 7. Shows all species that have **successfully** shared their enclosure with *Nycticebus pygmaeus* or *Nycticebus coucang* at various institutes within the EEP.

Common name	Scientific name	Institutions
Nycticebus pygmaeus *Successful, i.e. positive or neutral outcome for all involved species*		
Northern galago	*Galago senegalensis*	Poznan, Moscow, Novosibirsk, Amersfoort
Long-eared hedgehog	*Hemiechinus auritus*	Novosibirsk
Malagasy giant jumping rat	*Hypogeomys antimena*	Amersfoort
Grey mouse lemur	*Microcebus murinus*	Faunia
Sugar glider	*Petaurus breviceps*	Birmingham
Roderiquez fruit bat	*Pteropus rodricensis*	Jihlava
King quail	*Synoicus chinensis*	Dortmund
Southern three-banded armadillo	*Tolypeutes matacus*	Plock, Poznan
Javan mouse deer*	*Tragulus javanicus*	Bristol
Greater mouse deer	*Tragulus napu*	Moscow
Nycticebus coucang *Successful, i.e. positive or neutral outcome for all involved species*		
Lesser mouse-deer	*Tragulus kanchil*	Singapore

On the flip side, keeping *Nycticebus pygmaeus* together with large hairy armadillos did not seem quite successful for both the short and longer term; a male *N. pygmaeus* had disappeared one day in the mixed species enclosure and it is uncertain if the individual had been actively pursued by this member of the *Dasypodidae* genus or if he had died and fell within the reach of the armadillo. It is known from the wild that *Chaetophractus villosus* eats flesh from roadkill and other carrion but can also attack and kill prey as large as a domestic chicken or a newborn goat, as well as rodents up to the size of rats (Wilson, D.E. & Mittermeier, R.A., eds., 2018). There were also anecdotal records where *Chaetophractus villosus* attacked and killed brush-tailed bettong (*Bettongia penicillata ogilbyi*) in a mixed exhibit in Amersfoort Zoo in the Netherlands (personal correspondence). It is therefore not advisable to mix any *Nycticebus* individuals with species from the *Dasypodidae* family.

Table 8. Shows all species that have **unsuccessfully** shared their enclosure with *Nycticebus pygmaeus* at various institutes within the EEP.

Common name	Scientific name	Institution
Nycticebus pygmaeus *Unsuccessful, so negative outcome for at least one of the involved species*		
Large hairy armadillo	*Chaetophractus villosus*	Opole

2.4 Reproductive biology and behaviour

2.4.1 Mating, pregnancy and birth of *Nycticebus*

All species of loris in the *Nycticebus* genus perform copulation suspended from a branch in the wild. In order to replicate conditions in captivity, suitable perching at the highest levels of the enclosure is required. Enclosures with a meshed ceiling are also readily used by loris for mating. During nearly all matings observed, the female will go to the highest point of the enclosure and entice the male to join her in copulation.

With *Nycticebus bengalensis*, the females emit an audible high-pitched whistle when receptive to a male. Similar behaviour is observed in all *Nycticebus sp.* during mating. Observations from a number of captive lorises have shown that a female will actively pursue a male when she is receptive. Males approach the female with genital sniffing and licking to begin with and will mount the female who remains hanging either with all four limbs or two. The male will hold the perch or mesh with his hind legs and grasp the female to copulate. In some cases, it has been observed that an eager male will actually grasp the female with all four limbs. Several copulations are usually witnessed over 2-4 days.

In some cases, where males and females are housed separately, the female will become less tolerant of the male after copulation. A number of behavioural signs are clear such as “pant growling”, swiping or simply retreating, and curling into a defensive ball has been witnessed. If the male continues to pursue the female, it is recommended that they are separated once more. Further monitoring will determine whether the female starts showing signs of interest in which case an introduction can once again be conducted.

Nycticebus pygmaeus are considered seasonal breeders, although there are cases of them breeding throughout the year in captivity (Feng et al., 1992). Despite this finding, there remains a peak of births between January and March in captivity (Feng et al., 1992).

Fitch-Snyder and Jurke (2003) found that *Nycticebus pygmaeus* housed in pairs for more than thirty days before oestrus have more breeding success compared to pairs put together for oestruses. More evidence in general is beginning to suggest that *Nycticebus pygmaeus* are social animals, pair bonding, and spend much of their activity budget on social playing and grooming.

A different strategy from a private breeder is based on the separating of the pair during breeding. In this strategy, it is important to monitor the intensity of scent marking by females. The marked branches are then provided to the male for sniffing. At the moment the male strongly reacts, the couple can be joined together. After some initial fighting between the couple, a successful mating usually follows. Private breeders were very successful with this strategy. On the contrary, a private breeder mentioned that couples he kept together for a long time began to behave more like siblings and the breeding was unsuccessful. This information is based on private experience and we are not sure about the natural physiological mechanism of this species.

Oestrus in lorises is difficult to determine but oestrus signs include increased vaginal opening as well as reddening in colour and appearing turgid (Feng et al., 1992). By gaining trust through hand feeding and training, it is possible to get close enough to see a female's genitalia without causing any stress. Taking images of her genitalia over a few months is a useful method to determine when she was in oestrus by matching dated images to changes in her behaviour and interactions with the male. There may be individual differences between females, so taking images of multiple females may be a useful comparison to see different loris oestruses. Another tool to monitor the oestrus cycle in a female *Nycticebus sp.* can be done through bioacoustics. Schneiderová and Vodička (2021) conclude that bioacoustics represents a promising, completely non-invasive, and relatively easily applicable tool that allows detection and anticipation of the oestrus cycle in some females, thus improving the social management of slow lorises living in zoos.

Photo credit: Paige Bwye
Figure 1. Loris mating.

Photo credit: Paige Bwye
Figure 2. Lactating female at Bristol Zoo Gardens.

Female 1 vulva - oestrus cycle

Photo credit: Bristol Zoo Gardens
Figure 3. Pale, closed and dry.

Photo credit: Bristol Zoo Gardens
Figure 4. Slightly swollen, pinkish, may be some mucus and starting to open.

Photo credit: Bristol Zoo Gardens
Figure 5. Swollen, very pink, very open, mucus is present.

Female 2 vulva - Holly oestrus cycle

Photo credit: Bristol Zoo Gardens
Figure 6. Pale, closed and dry.

Photo credit: Bristol Zoo Gardens
Figure 7. Slightly swollen and open, some mucus may be present, but pale in colour.

Photo credit: Bristol Zoo Gardens
Figure 8. Swollen, pink, open and there may be some mucus.

Females give birth every 12-18 months, and the average postpartum oestrus is 169 days (Jurke et al., 1998). Pregnancy can be monitored through weighing, observation of behaviour, and recording body images. To weigh our lorises, they have been scale-trained by putting their live food on a wooden A-frame and having them fed here in the presence of a keeper. These A-frames stay in the enclosure and when we wish to weigh our lorises, we put small scales under the frames (Figure 9).

Photo credit: Paige Bwye
Figure 9. Loris being weighed on wooden A-frame design.

Taking body images once a month can also help identify pregnancy by comparing the female's body condition throughout pregnancy, looking for signs of lactation from 22 weeks onwards (Figure 10-13).

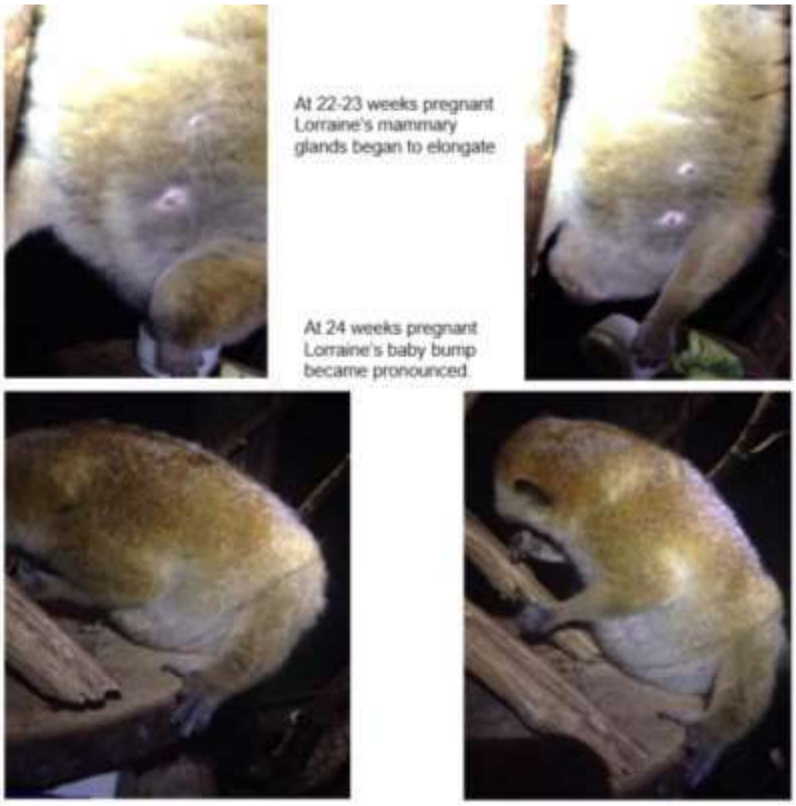


Photo credit: Paige Bwye
Figure 10-13.
Infant lorises weigh approximately 20-30 g at birth; therefore, towards late pregnancy, females may weigh more than their average weight indicating pregnancy, although this is not always

the case. Similarities may also be made between previous pregnancy weights, for example, at Bristol Zoo Gardens, a female was seen to gain 50 g at six weeks of pregnancy in 2012 and 2015 helping keepers identify from early stages that this female was pregnant.

By studying the female's oestrus cycle, an absence of oestrus may also indicate the female is pregnant. It is worth noting that these animals will still engage in social behaviour outside of oestrus, such as grooming, easily mistaken for oestrus behaviour, when seen licking each other's genitals.

Nycticebus pygmaeus give birth after an average gestation of 188 days (Jurke et al., 1997). Before parturition, preparations can be made to reduce the risk of infant mortality. For example, making sure the enclosure is as hazardless as possible to an infant by providing an extra thick layer of substrate on the floor in case the infant should fall, providing nest boxes with sealable bottoms, or adding additional platforms underneath regular resting spots, to reduce the likelihood of offspring falling to the floor. It is also worth reviewing the parents breeding history to see if the female has reared before and also if the male has a history of aggression towards offspring. Some collections remove sires however this is not always necessary. At Bristol Zoo, both males were seen knocking offspring off of branching and were removed; in one case, this was from a male desperately trying to get to the dam and possibly mate her. We tried mixing him back after a few days, but then he grabbed offspring aggressively and was removed again. Even though the pair was very well bonded prior to the parturition, she was hostile towards the male during the mix chasing him away when he tried to approach her and broke into fights.

Photo credit: Paige Bwye

Figure 14. Nest box design at BZG with removeable bottoms.

Around the time of parturition, ensure you are extra vigilant when moving around the enclosure in case the female has given birth and the offspring has fallen to the floor. Twins are also common in *Nycticebus pygmaeus*, so even if the female has one parked, ensure you check the floor for a second, often weaker, offspring.

Lorises will park their offspring for most of the day and the infant will emerge on its own from four to six weeks of age. Offspring can go up to four hours at a time between feeds. Offspring wean between four to six months of age. Females are sexually mature from 16 months of age and males from 18 months. They can be sexed from infancy if necessary. Male offspring have been known to stop sleeping on dams from eight months of age. Offspring are typically rehomed at one year of age, however, research on the age of separation from parents and breeding success would be very interesting and serve as an important guide on to the age we should be separating offspring in the future.

Indications that a female is rejecting her offspring include not making any contact with the offspring and therefore not providing any chance for suckling. If the offspring has fallen to the floor, this is a sign that it may be weak because it has not fed. If the female leaves the offspring on the floor, this again suggests she is rejecting the offspring.

In the event that the dam rejects or is unable to care for her offspring, hand-rearing or assisted rearing may be required.

In 2020, at Bristol Zoo Gardens, a female gave birth to twins. This was her first parturition and she rejected them both. Rather than removing the infants for hand-rearing, the decision was made to force the dam and offspring to have contact by shutting them in a nest box together. The thought process was that this would reduce the risk of the dam miss-mothering again in the future.

All branching was removed, and the nest box was lined with wood wool allowing offspring to climb onto the dam and suckle even if she was not encouraging them. They were left confined together 24 hours a day for 4 days. After this time, the nest box was relocated to a larger satellite cage (Figure 16) with access to the larger space between 10 am and 4 pm. No suckling was observed during these hours but was observed once confined to the nest box again.

At 1 month of age, when we tried to give the female more space, one twin began to lose weight and we could see from camera footage that she was not feeding it at all from 10 am to 5 pm so we began offering the smaller offspring 1 ml of Esbilac formula in the morning just to keep it going throughout the day. We offered the dam gum at the same time, so we did not have to take the offspring away to feed it. We offered this extra supplement in a syringe from 1 month of age.

After 4 weeks, all lorises were given access to the main enclosure from 10 am to 4 pm and shut into the satellite enclosure after this. Suckling was observed upon the return to the satellite.

At 9 weeks, they were given full access to the enclosure and camera footage observed the dam collecting the offspring and bringing them with her to her sleep site.

From 3 months of age, we began mixing the milk formula with baby rice for gradual weaning and the infant was weaned at 4 months.

This female began by rejecting the offspring and developed maternal behaviour including feeding, playing, grooming, and sleeping together as a result. The offspring went on to wean fully and continue to live in a social group with the dam.

Photo credit: Paige Bwye
Figure 15. Dam shut in a nestbox with initially rejected offspring.

Photo credit: Paige Bwye
Figure 16. Satellite cage to give dam and offspring more space for offspring to develop.

Photo credit: Paige Bwye
Figure 17. Twins at BZG, one with assisted rearing from keepers.

Breeding problems

Breeding issues experienced at Bristol Zoo in recent years include a lack of breeding and only since introducing seasonal-related conditions (temperature, diet, lighting) did we induce breeding, offspring rejection from the first-time dam, infant mortality (more likely when twins are born), sire aggression towards offspring both directly (grabbing infants) and indirectly by trying to get to the female and appearing as he would mate her, and during this process knocking the offspring to the floor. Both breeding males have had to be separated from offspring over the past few years at Bristol.

2.4.2 Birth & development of a captive born *Nycticebus coucang*

Reproductive seasonality & births

Consistent with the observation by Zuckerman (1932), females *Nycticebus coucang* appear to be polyoestrous and births were recorded throughout the year (Figure 1). ZIMS studbook records show that most numbers of births tend to occur in the month of January and remain high in the first half of the year, which supports the findings by Izard et al. (1988) postulating females tend to cycle more and preferentially conceive frequently during second half of the year. Of the recorded 139 captive births, apart from the 38 young that were not sexed, the remaining consists of 64 males and 37 females (≈1.5 ♂: 1 ♀) while the birth sex ratio recorded by Izard et al. (1988) tended towards 1:1 (n = 19). It is possible for studbook records' ratio to be slightly skewed due to the unsexed specimens (n = 38).

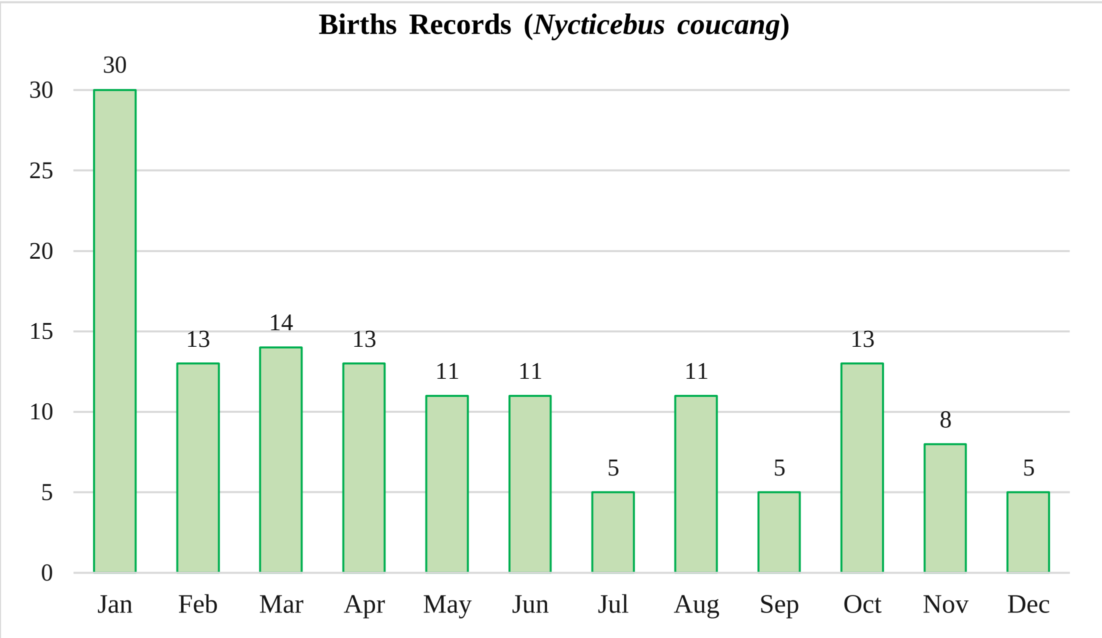


Figure 18. *Nycticebus coucang* captive births with known birth dates since 1952 (n = 139) in EEP indicated that approximately 22% of births occurred in the month of January.

Parturition

Statistics suggests that nocturnal prosimians in general tend to give birth in the day as part of an evolutionary adaptation (Jolly, 1973). One of the birth accounts recorded at Wildlife Reserves Singapore (WRS) took place in the morning of 10 August 2017, at around 11 am. Despite nest boxes being made available (and the fact that our female G13876 uses it to sleep in on most days), she has opted to give birth on the forked branches provided.

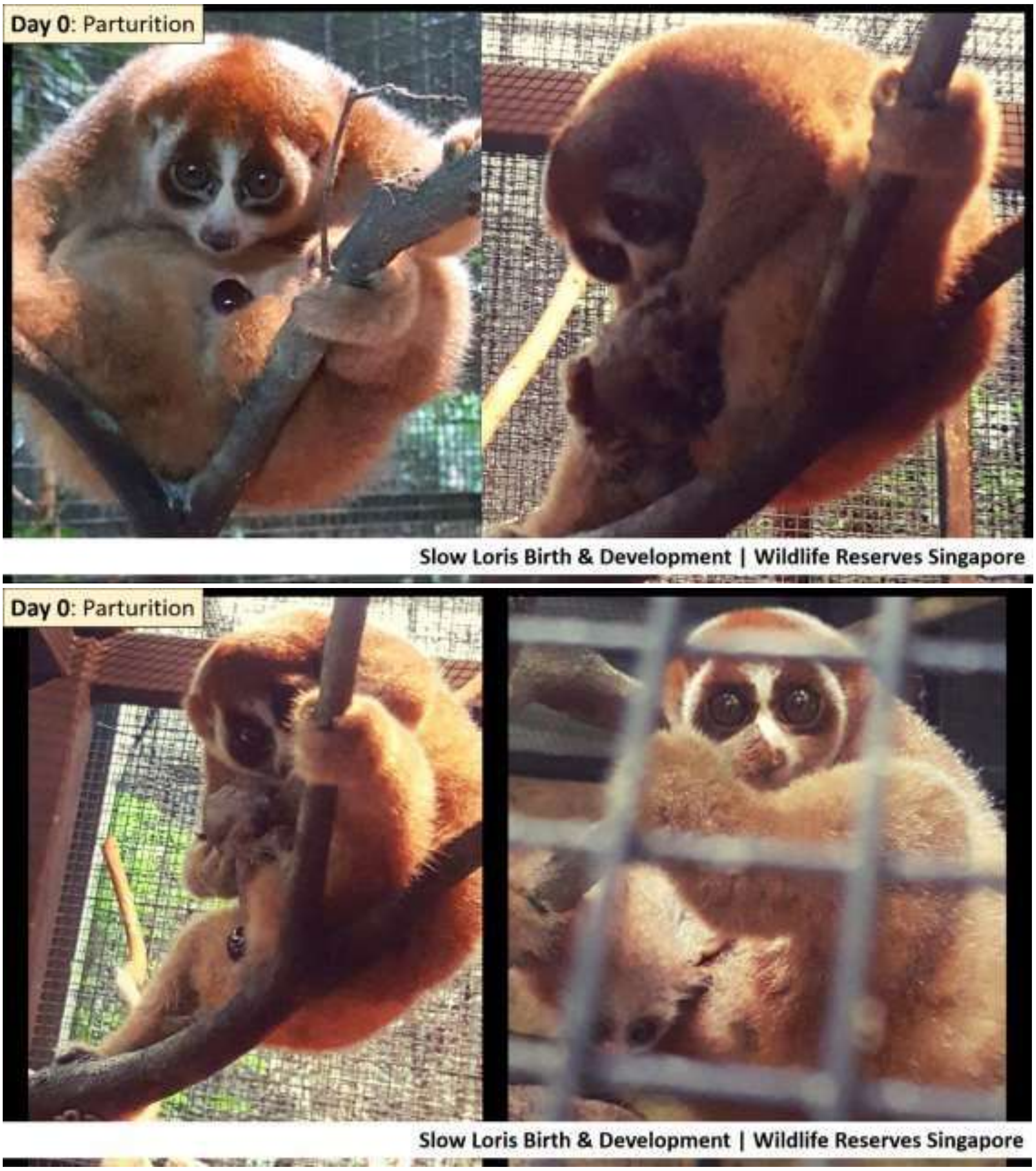


Figure 19. Parturition by 0.1 (G13876) showed her giving birth in the sitting position, as the foetus emerges (headfirst) from her birth canal.

The entire birthing process took about 20 minutes, and 0.1 (G13876) was observed to be licking and grooming the newborn post parturition. Two births by this same female were recorded in our institution and it was a singleton on both occasions, as with most births for this species according to Izard et al. (1988).

Morphometrics

Figure 20. *Nycticebus coucang* young at day 15 (left) and day 21 (right).

The newborn was fully furred with faint contrast for the dorsal stripe and eye fork. Both its eyes were also opened, consistent with literature documentation for this species by Zimmermann (1989). At week 2, the infant is still relatively dependent on the dam but is already able to cling onto branches. Its fur coat remains white – with a slight tinge of reddish-brown. Circumocular stripes were only more visible towards week 3 of the development phase. By week 3, the young measures approximately 14 cm (from inion to tail base), which is about twice the length of neonates at birth (7 cm) documented by Zimmermann (1989).

Growth & development

Although all maxillary teeth and most of the mandibular teeth are present at birth, sampling of solids for this species is typically observed between weeks 2 to 4 of their development; individuals were also observed to attempt at insect catching around this age (Zimmermann,1989). In the same paper, Zimmermann also documented milk dentition development is typically complete by day 90, permanent dentition transition by day 220 and young is usually weaned between 5 and 7 months of age.

Figure 21. Suckling is still observed on day 24 (left) and the family group resting comfortably in the same nest box together (right).

Zimmermann (1989) also recorded a wide repertoire of vocalisations among the young *Nycticebus coucang* (comparative to that of the adults) since early stages of development – with the exception of "whistle" and "snarl" calls that were more established only towards the weaning phase. We were also able to keep the sire with dam and young as a family group with no aggression seen post parturition on both accounts.

Weight trends

The birth weights of the neonates tend to be quite wide-ranging; 30 g to 46 g according to Zimmermann, (1989) and 44 g to 57 g according to Izard et al. (1988). Slight weight differences were found between both sexes, and hand-reared young were also noted to be gaining weight at a slower rate than the dam-reared individuals, albeit within a small sample pool (Zimmermann, 1989).

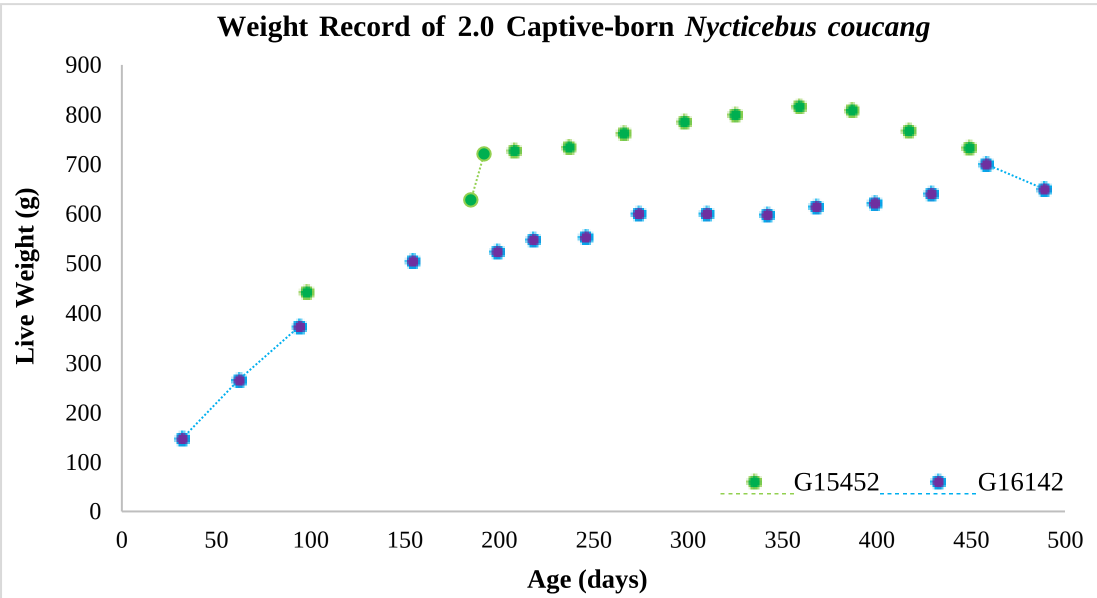


Figure 22. Live weight records of two *Nycticebus coucang* born at WRS; 1.0 (G15452) born 10 Aug 2017 & 1.0 (G16142) born 31 Jul 2018.

Weight increase was exponential for our two captive-born individuals at WRS for the first 150-200 days, and more gradual thereafter (Figure 22). Despite both young being born to the same set of parents (interval = 1 year), the overall weight range for the first young was higher than that of its sibling. The highest weight recorded for 1.0 (G15452) was 817 g (when he was about a year old), while that for 1.0 (G16142) was only 700 g (when he was about 1 year and 3 months old).

2.4.3 Hand rearing

Hand-rearing a *Nycticebus bengalensis*

The TAG should be contacted in the case of a failure to rear any offspring and a decision on whether to hand rear or not. Considerations for this decision may be the genetic value of the offspring and what role the animal may have in the population. Introduction back to a family group or conspecifics must be considered. This has been successful in a number of cases and below is a description of how hand-rearing can be done with attention to diet and socialization with other slow lorises.

Female *Nycticebus bengalensis* do not always carry their infants and regular infant parking is quite common in this species. Nevertheless, infants should be observed clinging frequently to their dam´s bellies for suckling. Furthermore, sires do carry their infants too.
If the parents show no interest in their offspring even though the baby is vocalizing, you can first try to mount it on the mother’s belly and after a few unsuccessful tries, you can think about hand rearing.

For the first weeks, the infant gets formula milk (for example Milupa Aptamil) 8-9 times within 24 hours. A syringe turned out to be a good nipple substitute. After every feeding, the infant’s genitals must be stimulated with a moist, warm cloth during the first weeks to stimulate urination and defecation. In general, infants do not defecate often. Mostly once a day, sometimes more rarely.
At the age of three weeks, you can offer commercial baby milk and cereal products such as Milupa once a day. From now on, milk feeds should be reduced stepwise; feeding with baby cereals should be therefore increased. At the age of two months, start with fruits (banana) and vegetables (cucumber).
At the age of three months, the first insects should be offered.
Because of the social structure of slow lorises, we did not think about reintroducing the hand-reared loris back to its parents but finding another place to start with a new pair.

Table 9. Weight in gram of hand-rearing *Nycticebus bengalensis* on particular days.

Birth Date 07.05.							
Date	Weight in g	Date	Weight in g	Date	Weight in g	Date	Weight in g
12/05	36	01/06	50	04/07	115	04/08	215
16/05	38	05/06	55	09/07	131	07/08	230
20/05	41	09/06	61	16/07	155	12/08	250
24/05	44	12/06	67	22/07	175	17/08	267
28/05	46			28/07	200	24/08	290

2.4.4 Details on contraception possibilities

Contraception of slow lorises remains a rare event within the breeding programs. The easiest and most effective method consists of separating both sexes.

Chemical contraception has been achieved with injection of Medroxyprogesterone acetate (Depo-Provera)® every 45 days and the use of Deslorelin implant. However, the duration of the effect and reversibility are dependent on the species and the individual and are not fully understood yet.

Seasonal breeders need to receive the contraceptive at least one month prior to the breeding season and for a duration of at least one-month post-breeding period. However, due to captive environment settings, the breeding period can differ from one institution to another. It is then important to have close monitoring of heat and breeding behaviours (Fitch-Snyder, 2020; Van Bolhuis, 2020).

There is one known case of contraceptive use in the population of the EAZA *Nycticebus pygmaeus* EEP, which is a female who received a 4.7 mg Suprelorin implant (in 2012) due to evidence of toxoplasmosis.

This EAZA Population Management Manual (PMM) provides a thorough overview of the rules and procedures for, and gives guidance in relation to, population management in EAZA.

This manual should be followed and referred to when making decisions on population management including euthanasia. Please refer to the EAZA statement on breed and cull if this is to be considered.

2.4.5 Using of hormonal support in *Nycticebus pygmaeus* breeding

The breeding of *Nycticebus pygmaeus* in human care has been challenging and thus we have not had a sufficient breeding record yet. The oestrus cycle of *Nycticebus pygmaeus* is complex. This species is monooestric which means that females are in anestrus for the most part of the year. It is believed that males can become frustrated during the early part of oestrus when the female is only partly receptive. This can lead to aggression until the male is able to fully mate with the female. During anestrus, the vagina is completely closed, followed by an initial phase where the vagina begins to open but not fully to the neck of the uterus.

Jihlava Zoo has experimented with hormonal support in *Nycticebus pygmaeus* after attempts of a private breeder (Jan Říha) during the 1980s and 90s proved successful. His findings were that some females remained in anestrus after physical checks showing some females‘ vaginas remaining closed during the normal breeding season. These females were injected (intramuscular) with Sergon (100 i. u.) and Pregnyl (100 i. u.). If there was no progress in the oestral cycle, then females were injected again after a week. This period was repeated up to three times and almost all females reproduced successfully. As an interesting fact, some females were able to breed again after that without any further hormonal support but others had to be supported every year. Mr. Říha's opinion was that autumn was the normal time of the mating season in the wild, as during this time males are more active, have bigger testicles and they also mark their home ranges much more intensively than at other times of the year.

In June 2017, Jihlava Zoo staff administered 0.3 ml of Receptal in a female that had previously been unable to breed. Following this, she gave birth to stillborn twins the following January. However, in the following years she was able to give birth and rear offspring successfully after having the same hormonal support in June. The conclusion is that despite this being a new technique, there seems to be evidence that hormonal support is a good option for females. It should be noted, however, that a number of factors could contribute to the seasonal triggers of oestrus including diet seasonality, temperature, and light levels, and possibly also phytohormones.

2.4.6 Population management

Nycticebus pygmaeus, *Nycticebus bengalensis* and *Nycticebus coucang* are managed in EAZA within the EEP. The *Nycticebus pygmaeus*'s population is the largest of the three species, therefore *Nycticebus pygmaeus* is a priority species for EAZA and its breeding and population increase are recommended. *Nycticebus pygmaeus* is supposed to contribute to the acquisition of knowledge about the breeding of species of the genus *Nycticebus*. The population of *Nycticebus bengalensis* and *Nycticebus coucang* accounts to several individuals in EAZA, and it is possible that the population will increase through confiscation or transport of animals from rescue centres rather than through reproduction. Currently, we do not see any competition of these species for the *Nycticebus pygmaeu*s.

2.5 Behavioural enrichment

2.5.1 Introduction

Environmental or behavioural enrichment is the basis for animal welfare in human care. In this chapter, we give an overview and some inspiration of different ways of environmental or behavioural enrichment for slow lorises (*Nycticebus spp.*)

Zoo animals don't have to search for food, work for food, look for mating partners, beware of predators, or defend their territory like animals in the wild. Resulting on that, animals in human care have a lot of free time. That they don't get bored having too much leisure time, their keepers are encouraged to create basics for meaningful leisure activities. This is called environmental enrichment, also known as behavioural enrichment or just "enrichment". It has been integrated as a basic principle of zoo and aquarium animal husbandry (Mellor, Hunt, and Gusset, 2015). There is no consensus definition of enrichment in the literature, but it can be loosely defined as the addition of stimuli or provision of choice that results in the improvement of animal well-being (de Azevedo et al., 2007). Enrichment offers should enable the animals to follow their natural behaviour, which positively impacts the quality of any zoo animal's life and should be more than an expression of only a few moments in an animal's day (Mellor, Hunt, and Gusset, 2015).

Animals kept in EAZA collections should be encouraged to perform as much of their natural behavioural repertoire as possible and acceptable. Whenever possible unnatural behaviour should be prevented or actively discouraged. Important elements in achieving this are enclosure design, environmental and behavioural enrichment and feeding regimes (EAZA Standards for the Accommodation and Care of Animals in Zoos and Aquaria .Approved by EAZA Annual General Meeting 25 April 2019, 2020, p.4).

Enrichment should be basic of an animal's zoo life and is not only a special way of offering food. It gives the animal alternations and experiences over time and includes also exhibit design. Enrichment provides animals with opportunities to keep mentally, emotionally, and physically fit and animals with good mental health tend to interact in their environment:

they rest peacefully, without an over-expression of vigilance; behave in a fashion that is not overly fearful with minimal and non-exaggerated startle responses; assimilate new information, demonstrated through learned tasks or modified behaviours; perform no abnormal behaviours; and have a diverse behavioural repertoire that includes regular exploration and investigation. (Mellor, Hunt, and Gusset, 2015, p.34).

Hoy and colleagues (2010) identified eight types of enrichment: feeding, tactile, structural, auditory, olfactory, visual, social, and human-animal and Maple and Perdue (2013) added cognitive enrichment to create a complete framework for identifying relevant categories of enrichment.

Table 10. Nine categories of enrichment according to Hoy et al. (2010) and Maple and Perdie (2013).

Enrichment category	Description	Examples
Feeding	manipulation of food, method of providing food	scattered food, hidden food, whole food, live food
Tactile	provision of novel objects, watering system	bags, balls, living plants, getting wet by watering system, search for insects in leaves
Structural	alteration of the physical space of the enclosure	addition or change of natural or artificial structures like branches or ropes
Auditory	addition of natural or artificial sounds, communication, sound of prey	animal vocalizations, music, insects rustling leaves in enrichment items
Olfactory	addition of natural or artificial odors	smell of food and prey
Visual	addition of visual stimuli	mirrors, televisions, reflectors, animals in other enclosures, searching for food
Social	group-housing, changes in group constellation, contact to other groups or individuals	“howdy doors”, which provide visual, olfactory and/or auditory contact at a fence between individuals, that must otherwise live apart.
Human-animal	interactions between animals and keepers	training, feeding, weighing
Cognitive	challenging and stimulating memory, decision-making, judgment, perception, attention, problem solving, executive functioning, learning	use of enrichment items, rotate something

2.5.2 Enrichment ideas and examples

Most lorises in EAZA zoos are housed in confined spaces where the natural behavioural repertoire can be limited. Most enrichment is food based as wild lorises spend such a large proportion of their time foraging for food. Environmental enrichment is however as important to the welfare of captive lorises and this should be taken into account when planning an enrichment schedule.

2.5.2.1 Feeding enrichment

Gum

Slow lorises are exudativores and consume sap and gum. They spend most time of their activity period feeding on gum in the wild. To get sap or gum, they must work hard and invest time. When consuming sap, slow lorises perforate the superficial layer of the cambium of trees or lianas by scraping with their toothcomb. Lapping of the exposed sap with the tongue lasts from a few seconds to about 4 min, with intermittent additional breaking of the hard surface. Gum is consumed for a longer period, from 2 to 20 min, and involves active gouging with the anterior teeth (Nekaris, 2010). According to this, slow lorises in human care should be given the opportunity to eat a variety of gum species presented in varying ways. It is therefore not sufficient to serve the gum at only one location in the enclosure.

Gum feeders, like branches with one or more deep holes, are a good opportunity to serve the Arabic gum at different places in the enclosure. Their places can be changed daily, weekly, or at other intervals. Slow lorises in the wild actively search for their gum sources. Trees with active wounds seem to be known to the slow lorises, as they move rapidly and directly to a feeding site (Nekaris, 2010). Both behaviours can be observed under human care, too. While placing the gum feeder at the same spots for several days, the slow lorises will directly move from feeder to feeder. Placing feeders at different locations or by using new devices, it is possible to increase the investigative behaviours of the loris and enable them to utilise more senses. It was often observed, that the slow lorises don't just lick a gum feeder directly empty but move from gum feeder to gum feeder and return to each feeder several times in their active period.

Enrichment examples:

Photo credit: Marcel Stawinoga

Figure 1. *Nycticebus pygmaeus* licking gum Arabic out of a gum feeder, where the gum was placed in a hole in a branch.

Photo credit: Marcel Stawinoga
Figure 2. Gum feeder. The Arabic gum was put into a hole in a branch and placed in the enclosure.

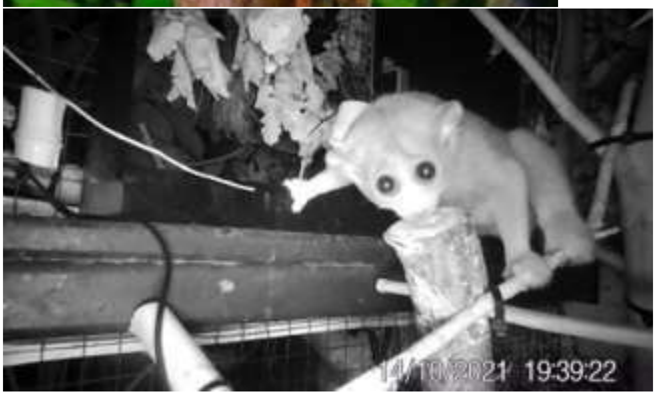


Photo credit: Marcel Stawinoga
Figure 3. *Nycticebus pygmaeus* licking Arabic gum out of a gum feeder.

Photo credit: Bristol Zoo Gardens
Figure 4. Gum feeder with holes in the branch to insert the Arabic gum.

Insects

Nycticebus search for animal prey by moving slowly along branches with their noses near the substrate. They catch insects with one or both hands, clinging with both legs to the branch, or standing bipedally. They lick smaller insects like ants off branches, while larger insects are eaten headfirst, the wings are dropped and other parts are disposed of by fierce head shaking (Streicher et al., 2012). *Nycticebus pygmaeus* also gouge into bamboo to reveal insects (Nekaris, 2010). Both behaviours can be simulated under human care. If possible, insects like locusts, crickets, and stick insects (*Phasmatodea*) can be exposed in the enclosure, so that the slow lorises have to look for them and catch them. But the locusts, crickets, stick insects, and also zoophobas or mealworms, for example, can be placed into enrichment items like buckets filled with leaves, where the insects can hide, paper sandwich bags also filled with leaves or shavings or bamboo, for example. Through rustling leaves, the slow lorises will become aware of the insects inside the enrichment item and auditory challenged. Also tactile and visual, when they start searching for the insect in the leaves and cognitive by trying to get them out of the item.

Enrichment examples:

Photo credit: Marcel Stawinoga
Figure 5. A bucket, that can be filled with leaves and locusts.

Photo credit: Marcel Stawinoga
Figure 6. *Nycticebus pygmaeus* searching for locusts in a bucket filled with leaves.

Photo credit: Marcel Stawinoga
Figure 7. Zophobas hiding in leaves in a smaller bucket.

Photo credit: Marcel Stawinoga
Figure 8. *Nycticebus pygmaeus* with a female thorny stick insect (*Aretaon asperrimus*) in his enclosure. Eating such a big insect takes the slow loris around 15 minutes. Also enriching for the loris is a variation of insects, that are offered.

Photo credit: Marcel Stawinoga
Figure 9. Paper sandwich bag filled with leaves and locusts. The slow lorises will hear the locusts rustling in the leaves. To get the insect, the loris must open the paper bag with his hands.

Photo credit: Sergey Hlyupin
Figure 10. An insect feeder made of plastic. It has two holes and a cover that unscrews from the bottom. It is possible to put mealworms, zophobas, crickets, or locusts inside.

Photo credit: Sergey Hlyupin – photo on the left and Monkey World Ape Rescue Centre, Dorset UK – photo on the right
Figure 11. Insect feeder made of bamboo. Zophobas or mealworms can be filled in and the slow lorises must take the insects out through the holes.

Photo credit: Marcel Stawinoga

Photo credit: Sergey Hlyupin

Figure 12. *Nycticebus pygmaeus* taking mealworms out of an insect feeder made of bamboo.

Photo credit: Sergey Hlyupin
Figure 13. Mobile feeder filled with shavings and locusts or crickets. *Nycticebus bengalensis* looking for the mobile feeder. Mobile insect feeder, bamboo sticks are connected inside with a wire. Inside the metal sphere is placed one half of a coconut shell filled with shavings, where mealworms or zophobas can be placed.

Photo credit: Bristol Zoo Gardens
Figure 14. *Nycticebus pygmaeus* looking for insects inside a puzzle feeder.

Nectar

Nycticebus javanicus eat nectar after stabilizing themselves in a standing or hanging position in a bush or tree and grabbing and bending a flower towards them by using one or both hands. Then they lick the nectar with their long tongue out of the flower, while the slow lorises do not damage the flower in that process (Moore, 2012). As nectar is high in sugar and very sweet, it is a very popular food for slow lorises and well suited for enrichment, or also to administer medications. For enrichment, nectar powder for hummingbirds, lorikeets, or honeyeaters can be used in small amounts. But it is hard to replace a fragile flower as an enrichment item. The nectar can be filled in small bowls, that are hidden behind leaves, that the slow lorises must take away to reach the nectar bowl. The nectar can be also offered in bird water feeders. The bowls or bird water feeders can be placed and hidden at different spots in the enclosure so that the slow lorises must search for them by sniffing and looking around, ensuring both visual and olfactory enrichment. Small blood sample pots used by vets are also a way to present small amounts of nectar to loris where they are able to use their tongues to access the nectar. Large flowers such as hibiscus or nasturtium are also suitable for loris investigation and enrichment.

Enrichment examples:

Photo credit: Bristol Zoo Gardens
Figure 15. *Nycticebus pygmaeus* licking nectar from a bowl behind leaves.

Photo credit: Marcel Stawinoga
Figure 16. Bird water feeder filled with nectar. *Nycticebus pygmaeus* licking nectar out of a bird water feeder.

Vegetables

In human care, vegetables like sweet pepper, tomatoes, pumpkin, sweet potatoes, carrot etc. (cf. 1.6 Diet and feeding behaviour) replace the fruits that slow lorises eat in a small amount in the wild. The vegetables can be placed on branches or filled in hanging food balls around the enclosure simulating fruits hanging from a tree in the wild. The slow lorises must grab the vegetables and their tactile, visual, and olfactory sense is challenged of course by sniffing and looking around for the food. It could be also a cognitive task for them by trying to get the vegetables out of a food ball, for example.

Enrichment examples:

Photo credit: Marcel Stawinoga
Figure 17. Pepper placed on a branch.

Photo credit: Marcel Stawinoga
Figure 18. *Nycticebus pygmaeus* taking vegetables out of a hanging food ball.

2.5.2.2 Structural enrichment

Apart from the foraging and feeding behaviour, slow lorises in the wild spend a lot of time travelling and moving from one place to another (Fauzi et al., 2018). As the opportunity for movement of slow lorises in human care is relatively restricted in quantity, the structure of an enclosure should offer the animals good quality. Slow lorises cannot leap and require canopy connectivity for movement. By grabbing bundles of small branches, they use different hanging and bridging postures while walking across their habitats and clutch typically three or more branches at once. They are very busy and constantly moving, typically more than five kilometers per night. They also climb big trunks up and down and can cling to trunks of more than 100 cm in diameter for extended periods of up to 45 min, while they gouge for exudates (Nekaris, 2014). *Nycticebus javanicus* use bamboo as sleeping, resting, and hiding sites, and for social activity (Voskamp et al., 2014). According to this, the enclosure should offer different kinds of horizontal branches or ropes for example in different diameters for moving around. Fine branches and bundles of small branches are necessary, as slow lorises always have branches somewhere to grab. But they also like to move fast along long horizontal branches. Bigger vertical trunks can be offered, where slow lorises can move up and down. And bamboo or dense planting should be somewhere in the enclosure for hiding, sleeping, and resting. Some slow lorises in human care also prefer to sleep in cardboard tubes or boxes. However, a dense planting will also give visual barriers between individuals, where they can hide, reducing agonistic encounters. Furthermore, when they do not see each other permanently, this will encourage natural behaviours of vocalisation.

Enrichment examples:

Photo credit: Paige Bwye
Figure 19. Bamboo will offer the slow lorises hiding, sleeping, and resting sites.

Photo credit: Sergey Hlyupin

Figure 20. Fine branches and bundles of small branches are necessary, as slow lorises have always branches somewhere to grab.

Photo credit: Marcel Stawinoga

Figure 21. Bigger vertically trunks can be offered, where slow lorises can move up and down.

Photo credit: Marcel Stawinoga

Figure 22. Dense planting can be offered for hiding, sleeping, and resting.

Nycticebus pygmaeus sleeping in a cardboard tube.

Photo credit: Marcel Stawinoga

Figure 23. Some lorises, like the *Nycticebus pygmaeus*, hide and rest in cardboard tubes or boxes.

Photo credit: Marcel Stawinoga
Figure 24. *Nycticebus pygmaeus*, that slept in dense planting.

Nycticebus pygmaeus hiding and resting in dense planting.

2.5.2.3 Training

Lorises will readily accept food items from keepers, and this will help when training slow lorises. Animals should have a conditioning plan using positive reinforcement to establish behaviours such as crate recall and scale training.

Enrichment examples:

Photo credit: Marcel Stawinoga
Figure 25. *Nycticebus pygmaeus* taking a locust out of a hand.

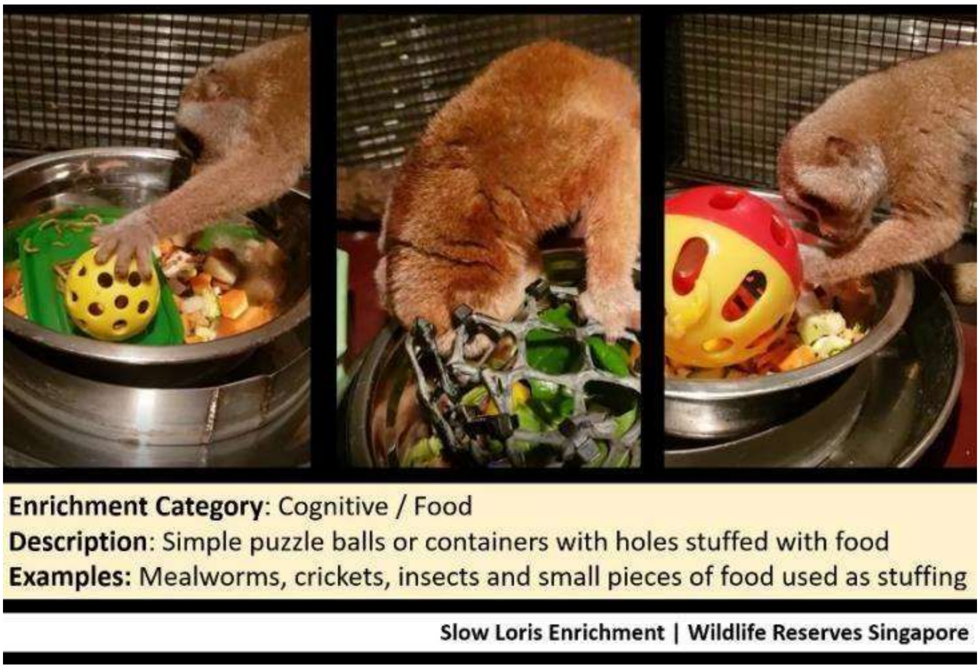
Photo credit: Martina Molch, Leipzig Zoo Photo credit: Marcel Stawinoga
Figure 26. *Nycticebus pygmaeus* that was lead to a scale with insects.

Table 11. List of enrichment which has been given before to our slow lorises at Wildlife Reserves Singapore.

Category	**Enrichment Description**	**Comments**
Cognitive / food	hiding/ concealing of food items in: ▪ bamboo feeder ▪ boxes ▪ rope knot ▪ seed pod ▪ pocket-hammock ▪ enrichment puzzle ball ▪ leave/grass bundle ▪ hessian cloth ▪ small bottles with holes	▪ food items can be in its actual state, blended or frozen ▪ food items also include live insects
Sensory / food	▪ frozen ice blocks (with food items) ▪ frozen insects	▪ given occasionally, during warm weather
Sensory/ physical habitat	giving of devices previously used by another conspecific	▪ device can include branches, climbing structures etc.
Food	▪ jackfruit ▪ coconut ▪ watermelon skin ▪ stick insects	▪ usually given in small amount ▪ items can be given its actual state, blended or frozen

Sensory	▪ pine leaves/branches ▪ rambutan leaves ▪ assorted flower species (e.g. hibiscus, banana, ficus) ▪ swapping of enclosures among conspecifics (scent) ▪ peacock feather ▪ smearing of essence/food flavourings on branches ▪ snake sloughs	
Physical habitat	▪ planting ▪ addition of new logs/branches/vines ▪ refurbishment ▪ installing dynamic climbing structures ▪ addition of new substrate (e.g. woodchip, sand, pine bark) ▪ addition of dry leaves (leaflitter)	

Enrichment examples:


Enrichment Category: Cognitive / Food
Description: Simple puzzle balls or containers with holes stuffed with food
Examples: Mealworms, crickets, insects and small pieces of food used as stuffing
Slow Loris Enrichment | Wildlife Reserves Singapore


Enrichment Category: Physical Habitat / Cognitive
Description: Dynamic climbing structures
Examples: Bridge, steps and ladder
Slow Loris Enrichment | Wildlife Reserves Singapore


Enrichment Category: Sensory / Food
Description: Scented / Frozen / Novel food items that are not part of their usual diet
Examples: (1) Hibiscus flower; (2) Frozen bamboo stuffed with food; (3) Watermelon skin
Slow Loris Enrichment | Wildlife Reserves Singapore

2.6 Handling

2.6.1 Age and sex determination of slow lorises (*Nycticebus*)

Age determination of slow lorises (*Nycticebus*)

By coat:
Young and Juveniles – Bigger contrast of the face mask. Light, fine, longer coat.
Adults – Darker, coarser, shorter coat.
Old individuals – Lighter contrast of the face mask. Darker face, limbs, and the area around the eyes. Darker, matte, dry coat (Figure 1).


Juvenile


Adult

Photo credit: Lucie Čižmářová, The Kukang Rescue Program
Figure 1. Juvenile and adult animal.

By teeth:
Young and Juveniles – Teeth are fully developed after 6 months of age, teeth are incomplete until then, pure white and sharp teeth.
Adults – Fully developed teeth that are already slightly yellowed, wear can be recognized.
Old individuals – Yellower teeth with stains, noticeable wear.

Sex determination of slow lorises (*Nycticebus*)

It is difficult to distinguish males from females at first glance, as females have a conspicuously protruding clitoris that is easily confused with the male genitals. The clitoris has a vertical slit at the tip, whereas the penis tip is blunter and the slit is absent. In females, the distance of the protrusion from the anus is shorter, and a more detailed search reveals the vulva. The urethra opens at the clitoris tip. The vaginal opening is V-shaped and situated at the root of the clitoris. The vagina of the slow loris is usually sealed when the female is not in oestrus. Females may sometimes have swollen or pigmented areas underneath the vagina, which can be mistaken for the scrotum. In males, the distance between the protrusion and the anus is longer, and by gently squeezing the protrusion, we often find a penis. Males are also larger, more aggressive, with larger canines. In adults, the male genitalia show seasonal changes, and the testes increase in size during late summer (Figure 2, 3).
In zoos, slow lorises are predominantly housed in pairs, so it is usually fairly easy to identify the individuals by sight for care staff as the male is often larger than the female, but sexing young or new slow loris to your collection can often prove to be difficult. Visual sexing is possible but there have been a number of cases of miss-sexing using this method so we would recommend that to be sure, hair samples are taken and sent off for testing.

Female Male

Photo credit: International Animal Rescue
Figure 2.

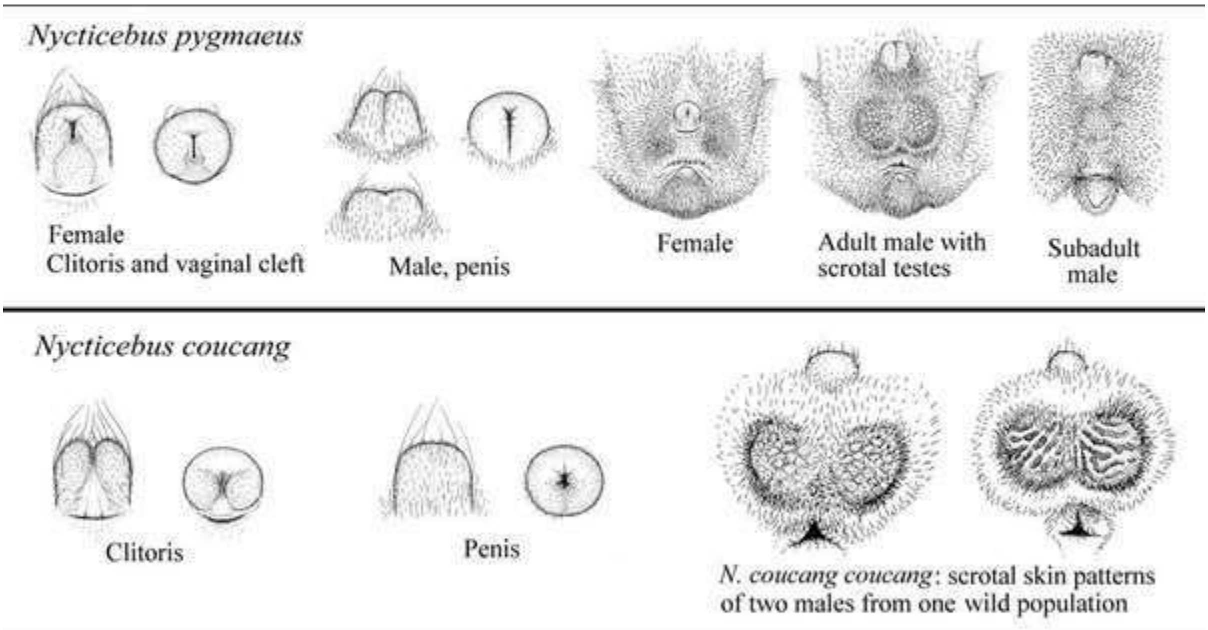


Figure 3. Discrimination of sex in lorises (Management of Lorises in Captivity. A Husbandry Manual for Asian Lorisines (*Nycticebus* & *Loris ssp.*). Edited by: Helena Fitch-Snyder and Helga Schulze)

2.6.2 General handling

Due to the potential for serious harm caused by slow loris bites, we recommend that any manual restraint and handling of slow lorises is only undertaken when absolutely necessary. Direct handling is often inevitable during morphometric measurement, health checks, and radio transmitter. Unlike many other small primate species, slow lorises are particularly hard to handle safely for a number of reasons. Firstly, they are extremely hard to remove from branches or mesh due to the capillaries in their wrists creating a very strong grip. Trying to remove a slow loris physically runs the risk of damaging the animal and also causing more risk to the care staff of being bitten. Even if you have a slow loris in a position to hold with nothing for it to grasp, you will find that all four limbs will grasp your hands and gloves or catching nets, so our advice is to utilize operant conditioning and remote catch-up boxes and crates where possible.

Slow lorises can be grabbed dorsally using one hand; their heads can be secured by placing our fingers under their lower jaw while using the other hand to stabilize their bodies between their hind leg. The handler has to ensure that his or her grip (on the head) is firm so that the slow loris cannot turn around and bite, but at the same time not too tight causing the animal to be choked.

For such procedures, avoid handling the specimens under direct sunlight as their eyes may be sensitive to strong light intensities.

2.6.3 Catching/Restraining

Any form of physical restraint will bring stress to the slow lorises inevitably and should be avoided where possible. It is advisable to use safety equipment such as a mask and gloves. The mask serves to protect against the transmission of respiratory diseases such as tuberculosis. Ordinary latex gloves can be used but they do not protect against animal bites. To protect against their bite, gloves that are specifically designed for handling wild animals are required; they are often made from leather or cut-resistant fabric. A bite from them can cause bacterial infection, flesh rot, or result in severe allergic reaction and anaphylactic shock if venom (i.e. the mixing of brachial gland exudate and their saliva) is injected during the bite.

Additional protection such as blankets or towels is also useful to place over an animal for restraint. These will also provide darkness if the animal is to be removed and taken to a light place such as a veterinary room. It is very difficult to remove a slow loris from mesh or perching due to their strong grip, so if restraint is required, the slow loris should be encouraged to a flat surface such as the floor to aid with the capture. Once on the floor, the slow loris often curls into a defensive ball, allowing the care staff to place a towel or blanket over it and secure it with gloved hands and place it into a transport crate or box. To achieve this, the majority of perching should be removed from the enclosure, leaving fewer opportunities for the animals to retreat into harder-to-reach places.

2.6.4 Transportation

Containers with opaque walls and a top lid that can be secured are preferred for the transfer of slow lorises. It is crucial to ensure airflow and circulation within the container to prevent suffocation. Classic bird cages or other open crates are not advised since the slow lorises may be unnecessarily stressed by the visual stimulants and it will also be challenging to retrieve them (i.e. they can grab or hold on to the cage). Small branches with leaves can be included in the carriers or containers to allow the slow lorises to climb or hide. For short-distance transfers, small pet containers or carriers designed for cats or small dog breeds are acceptable, but they should be covered with some form of visual barriers, e.g. towel/cloth, where applicable. Plastic or metal are suitable materials for transport boxes as they can be easily cleaned and disinfected. For individuals kept in zoos or rescue centres, a secured transfer box with a top lid or a small pet carrier is preferred for use during the capture. Slow lorises can be conditioned into pet carriers via positive reinforcement (i.e. food rewards such as gum or live insects) or target training, thereby minimising unnecessary stress inflicted on them during the restraint process (Figure 5). Once in a transport crate, ensure that the box or crate is secure. This can be achieved with a small lock and padlock. The crate should also be covered with a towel or blanket to keep out light during transport. A branch or wooden pole should be installed in the crate if the transport is to be of considerable length (such as transport to another collection) to allow the slow loris to feel secure during the transport (Figure 6). If the transport is to the vets, then we recommend that this is not included as the extraction of the slow loris at the vets would become very difficult.

The preferred method of restraint and transport for veterinary procedures is in an induction crate (Figure 4). These can be built into tunnels or placed in the enclosure. Slow loris should be habituated to them so it is recommended to build them into your enclosure design. Slow lorises will also choose to sleep in "sky kennels" when suspended high in an enclosure (Figure 4). This is a simple way to then secure the animal for transport as the door can be closed before the animal wakes up.

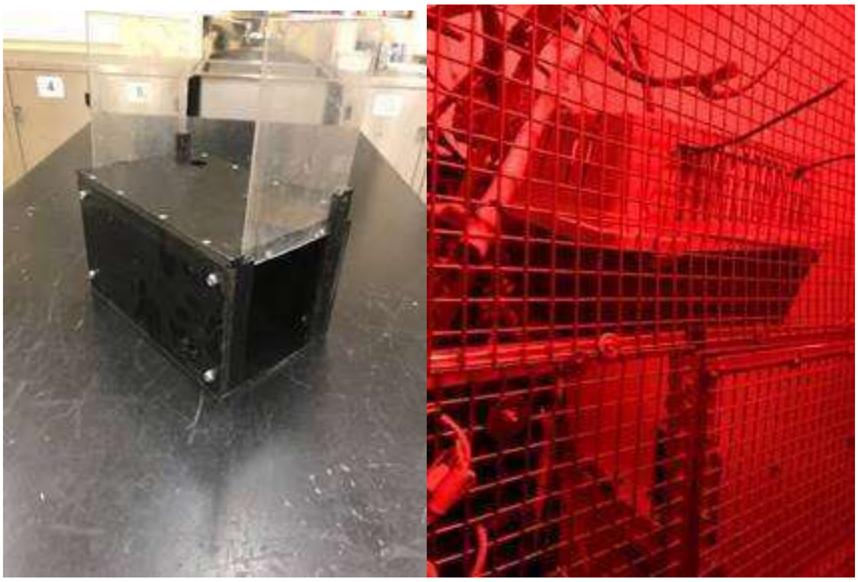


Photo credit: Monkey World Ape Rescue Centre, Dorset UK

Figure 4. Left: Induction box that is placed as part of the overhead tunnel system or fixed to enclosure walls. Right: sky kennel fixed to mesh which lorises are either encouraged into using training or allowed to sleep in.

Photo credit: Lucie Čižmářová, The Kukang Rescue Program
Figure 5. Box at The Kukang Rescue Centre in Sumatra, where animals are trained to go in to feed.

Photo credit: Katarzyna Byczyk
Figure 6. Transport cage for *Nycticebus sp.* in Poznan Zoo.

2.6.5 Safety to humans

It is important to note that slow lorises have the ability to cause extreme reactions by humans to their venomous bite. All individuals have the potential to bite and cause harm, even those that are deemed gentle or friendly. Hand-reared individuals who appear playful may also cause harm when playing as they can deliver a bite when doing this – albeit innocuously.
For this reason, we strongly recommend that, wherever possible, all-hands-on contact with a slow loris is discouraged, and at no time should animals be used for outreach, animal encounters, or keeper experiences.
All individuals should be risk assessed for their temperament and regardless of the outcome, systems, as outlined above, should be implemented wherever possible to minimize opportunities for human–animal contact. This does not mean that care staff should not work closely with the animals, as operant conditioning requires close contact and will greatly

improve the welfare of the animals. Weighing, syringe feeding, and other close contact tasks should be conducted through mesh where possible or at a safe distance with suitable exit opportunities for the care staff.

Table 12.

Risk assessment template

Company name: Assessment carried out by:

Date of next review: Date assessment was carried out:

What are the hazards?	Who might be harmed and how?	What are you already doing to control the risks?	What further action do you need to take to control the risks?	Who needs to carry out the action?	When is the action needed by?	Done
Slow loris bite causing anaphylactic shock	Animal keepers and vets	No physical contact with the loris without thick gloves or restraining PPE	Hold an EpiPen in the loris house			
Working in low light levels causing injuries	Animal keepers	Red lighting for most of day. Cleaning to be done before lights change and better levels of light	Give keepers red light head torches for working in the dark		ASAP	
Zoonoses	Animal keepers and vets	High levels of biosecurity and waste management. Regular testing of faecal samples. Staff trained in safe practices. PPE provided	N/A			
Lone working	Keepers	Radios are provided for contact for lone workers	Head of section to check in on keepers working alone every half hour by radio			

More information on managing risk: www.hse.gov.uk/simple-health-safety/risk/

Published by the Health and Safety Executive 09/20

NB:
The above is intended for a guide only. Your institution will have their own template and format for risk assessments, but we have listed some of the hazards associated with working with lorises in reverse lighting houses.
It is recommended that any collection holding slow lorises have an EpiPen onsite in case of accidental bite injuries leading to potential anaphylaxis.
Considerations should be given to staff working alone in low lighting levels in often confined spaces.

2.7 Considerations for health and welfare

All institutions housing slow lorises must provide medical care by qualified veterinarians. Should the institution's veterinarians need advice and help with the medical management of slow lorises, both the advisors and the coordinator will be available to discuss it.
Holders have the responsibility to notify the respective EEP coordinator and vet advisors of any significant medical problems with their animals and must send any post-mortem report as well. It is also encouraged that blood and other tissue samples should be collected on the request of the EEP Coordinator or opportunistically for the EAZA Biobank for genetic analysis of the monitoring of physiological parameters.

Euthanasia of slow lorises, like all animals, needs to follow the highest standards and up-to-date knowledge in this field. Death needs to be as painless and distress-free as possible and required two-stage euthanasia with first anaesthesia and then euthanasia. The euthanasia technique needs to result in rapid loss of consciousness followed by cardiac or respiratory arrest and the ultimate loss of brain function. Gentle restraint, careful handling, sedation, inhalation, or injectable anaesthesia is necessary to guarantee the best welfare possible before death.

2.7.1. Slow loris welfare

Animal welfare is the psychological state of an animal and is a balance between the animal's positive and negative experiences. To reach a stage of positive welfare (positive experiences are stronger than negative ones), the animal needs to be in good health, be able to express normal natural behaviour, have access to food and water adapted to their need, and be housed in an adapted and stimulating environment. It needs also to have some degree of choice and control over its environment and its daily activities (Mellor et al., 2015). All these aspects are covered in the different sections of these Best Practice Guidelines.
Importantly, a 24/7 approach needs to be implemented to be sure that the welfare of the slow loris is guaranteed even when the zoo is closed (Brando and Buchanan Smith, 2017) and adapted across the lifespan.
Finally, only with an "animal-first" approach (Brando & Herrelko, 2019) and a will for continuous improvement based on scientific evidence, slow loris holders will be able to highlight and promote optimal welfare for the species.

2.7.2. Routine health inspections

Routine health observation of slow lorises is like of other prosimian species. General appearance, behaviour, demeanour, appetite, water consumption as well as faecal and urine output need to be assessed daily for all individuals. Due to their peculiar nature, slow lorises can be difficult to observe. Feeding time is an appropriate time to observe the animal at a distance or for animals habituated or trained, close examination can be done when hand-fed. The close examination allows a more thorough assessment including coat quality and dentition. Any signs of diarrhoea, vomiting, hypersalivation, damp coat, lethargy, facial asymmetry, or abnormal behaviour yield medical attention.

Weight monitoring once a week or once every two weeks is an important part of the routine health assessment for slow lorises. These species are easy to weigh either by operant conditioning or by strategic positioning of a weighing scale as part of the enclosure design. Any loss of more than 10% should be addressed and communicated to the veterinarian. Body weight can be coupled with regular BCS assessment. Finally, daily food intake is also a significant indicator to monitor to decide between diet enhancement or medical attention.

Parasite checks should be conducted at least biannually or more often depending on the epidemiological context. It should include a direct smear, especially for the detection of protozoa, and floatation or sedimentation methods for other endoparasites such as nematodes, cestodes, or coccidia. Parasite treatments should be administered only upon positive results as blind treatment can lead to parasite resistance to dewormer. Slow lorises in captivity are known to be positive, especially for strongyles, giardia, and nematodes (Simpson et al., 2018; Frias et al., 2019). Special attention should be paid to identifying the species of the parasites, as some parasites such as *Pterygodermatites nycticebi* can be deleterious for other species such as callitrichids (Rode-Margono et al., 2015; Balsiger et al., 2018; Silva et al., 2021)

There is no official vaccination recommendation in prosimians and their use should be considered based on local epidemiological context and after a risk-based analysis. In the absence of information on the safety of the commercially available vaccines, it is recommended to use only killed vaccines in slow lorises. Vaccinations against tetanus and rabies in these species are reported but their use is at the veterinarian's discretion since no information exists on the efficacy of the vaccine nor the inclination to develop the disease (Williams, 2015).

Finally, pest rodents and insects are intermediate hosts for a wide range of pathogens, therefore their management is necessary as part of proactive preventive medicine (Ivanova et al., 2007). Methods used to control or eradicate pests need to be adapted to each enclosure and institution with the utmost attention to guarantee the safety of the lorises. Treatments and pests in contact with treatment must not be accessible to the lorises.

2.7.3. Anaesthesia and immobilization

Slow lorises are easy species to sedate and several methods are described. A fasting period of 4 to 8 hours is recommended in adults and the animal should be in a comfortable and familiar place to decrease stress. Volatile anaesthesia with isoflurane is the easiest method available. The anaesthetic agent can be administered by placing a face mask over the animal's face, or the animal can be placed in an induction chamber. The patient is then maintained under anaesthesia via the face mask or after intubation. Endotracheal tube size depends on the size of the animal but tubes between 1.5-2.5 mm are a good fit for slow lorises. It is recommended to intubate all patients that require the long procedures.

Injectable anaesthesia is a safe alternative when volatile agents are not available. Several drugs and protocols are reported (Table 13). A mixture of ketamine and medetomidine is a safe and easy protocol (pers. obs.). However, it is important to adapt dosages and protocols to each situation, procedure, and animal. The use of the protocol with at least one drug reversible is advised in case of emergency and to allow faster recovery.

Anaesthesia monitoring is similar to other mammals but needs to be adapted to the size and particularities of each species. The minimum monitoring consists of manual counting of breathing by visual assessment and heart rate by stethoscope auscultation. Small monitoring unit measures heart rate and pulsoximetry can be easily applied to slow lorises, with the probe applied on one finger or with the use of a rectal probe. Emphasis needs to be made on ensuring good thermoregulation for the animal under anaesthesia as these species are prone to hypothermia (Snyder et al., 2001; Williams et al., 2014)

Table 13. Drug combination regimes reported for slow loris species.

Drugs protocol	**Mean Dosage (mg/kg)**	**References**
Ketamine	10-25 mg/kg	Snyder and Schulze, 2001; Zims a, 2021; Zims b, 2021
Ketamine Diazepam	11-35 mg/kg 0.08-0.92	Zims a, 2021
Ketamine Midazolam	15-34 mg/kg 0.16-0.35	Zims a, 2021; Zims b, 2021
Ketamine Medetomidine	2 0.02	Personnal observation
Dexmedetomidine Ketamine	0.02 3-5 mg/kg	Williams & Junge 2014
Dexmedetomidine Midazolam	0.02 0.2	Williams & Junge 2014
Butorphanol Dexmedetomidine Ketamine	0.3-0.4 0.02 3-5 mg/kg	Williams & Junge 2014
Butorphanol Dexmedetomidine Midazolam	0.3-0.4 0.02 0.2-0.3	Williams & Junge 2014
Tiletamine/Zolazepam	4-14 mg/kg	Snyder and Schulze, 2001

2.7.4. Quarantine

Quarantine duration and testing need to follow local, national, and regional legislation. If a full health examination is needed during the quarantine period, a complete physical examination, including dental examination, blood parameters, faecal parasite check, faecal culture targeting Salmonella, Shigella, Campylobacter, and Yersinia and a comparative tuberculosis skin test should be performed. Animals should be treated accordingly based on the results of the tests.

2.7.5. Diseases, disorders and/or injuries

Based on data available for *Nycticebus* species on ZIMS as well as answers to a questionnaire from all *Nycticebus pygmaeu*s holders, some specific issues have been highlighted for the species.

Table 14. Health specific issues related to the species.

Dermatology	Dermatitis Pyoderma Alopecia Overgrooming Wound/Abscess
Dental	Exposed pulp Gingivitis/Periodontitis Root infection Calculus Tooth calcification Tooth decay
Orthopaedic	Rickets Degenerative joint disease Thumb flexion contracture
Respiratory	Pulmonary congestion/oedema Lung tumour/abscess Pneumonia
Gastrointestinal	Anorexia/Inappetence Constipation Parasitic diarrhoea
Others	Anaemia Septicaemia Cystitis Tumour (pancreatic/liver/bile duct)

The most frequent issues reported are wounds and trauma by conspecifics (Simpson et al., 2018). This affects both sexes, but it was noted that males have a tendency to be aggressive toward females when they are not sexually receptive. Trauma goes from bite wound with or without abscessation, up to bone fracture. In some cases, the injuries were reported to be severe enough to eventually require the euthanasia of the animal.

Another important condition reported in slow lorises are dental diseases (Simpson et al., 2018). While this condition is unfortunately well known from poached wild-caught slow lorises due to infected clipped teeth, it is mostly due to inadequate diet causing caries, periodontitis, and gingivitis in captivity (Cabana et al., 2015). Holders reported that diet changes with fewer sugar-rich food items helped in controlling and stopping the prevalence of teeth issues in their collection. However, treatment often required tooth extractions. In grave cases, the infection of the mandible leads to the euthanasia of the animal. Recently, the successful treatment of complicated cases with hemi-mandibulectomy bare some promising results for animals with severe osteomyelitis (Van Wessem et al, 2019).

Some *Nycticebus pygmaeus* holders report cases of respiratory disorders, especially during cold winters with rhinitis and pneumonia.

All *Nycticebus* are sensitive to stress that they express in different ways like fluctuation of body weight, overgrooming, alopecia, gastritis helicobacter, and in some cases also cystitis (Schrenzel et al., 2010; Simpson et al., 2018., pers obs.). Some reports of kidney diseases are also made by holders and in the literature, especially in old individuals (Boraski, 1981). Several tumors affecting the digestive, reproductive, and hematopoietic systems have been reported (Remick et al., 2010; Zadronzny et al., 2010; Felter et al., 2014). In some cases, the tumors were linked to a viral infection (Stetter et al., 1995; Canuti et al., 2014).

2.7.6. Individual identification

Permanent identification is a necessity for all individuals under human care. The implantation of a passive integrated transponder (PIT-tag) subcutaneously in the interscapular region is the method of choice. Once implanted, the corresponding ID number needs to be reported into ZIMS and communicated to the respective studbook coordinator of the species.

2.7.7. Post-mortem provisions

A complete necropsy examination needs to be done on all dead slow lorises even if the cause of death is already known. This allows a thorough examination providing additional information and the presence or absence of concurrent diseases. The same goes for newly born and stillborn lorises.
Search for pathogens (parasites, bacteria, viruses) should follow the gross necropsy examination.
Tissue should be fixed in formalin for histopathology and some should be stored at –20°C or below for further diagnostic analyses later and for research purposes.
Post-mortem reports must be sent to the respective species coordinators and vet advisors.

2.8 Specific problems

Nycticebus species are highly threatened by illegal pet trade – and it is not uncommon for zoological institutions to receive specimens that were either seized at customs or found abandoned (by irresponsible pet owners). When most of these specimens first arrive, they tend to be in compromised state, with pre-existing dental condition due to poor diet and care. Alopecia, overgrooming, inappetence, diarrhoea, and behavioural issues are also among some of the more common problems encountered.
Generally, *Nycticebus* specimens that used to be pet tend to overgroom themselves or display some form of stereotypy due to the sudden contrast in the amount of attention given to them by humans. Overgrooming can often result in either wet patches of matted/clumped fur or alopecia. One way to mitigate this will be by planning a properly structured enrichment program for these individuals. We also had previous case experience of minimising the

overgrooming frequency by allocating some time (workflow permitting) for keepers to comb the individuals and spend some time with them.
The gastrointestinal problems can often be resolved in due time with adjustments made to the diet (as advised in the Diet chapter). One point to note, the transition phase should be gradual and monitored. With the right diet, some of the less deep-seated dental and orthopaedic problems may also be alleviated. Another problem encountered would be related to compatibility changes. We ever encountered two cases of wound infliction by conspecifics/den mates that have shared the same enclosure for a few years (with no prior aggression, and not associated with sexual maturity). The only way to mitigate this would be to keep them in separate enclosures, or only mix them in enclosures that are large enough for them to mark their own territories.

Not all pairs of *Nycticebus pygmaeus* have reproduced in captivity. We have pairs who regularly have offspring and pairs who are together for several years and have no offspring. Research would need to be done to determine what the cause of this phenomenon is.
The population of *Nycticebus pygmaeus* suffers from diseases that are very often associated with an inappropriate diet e.g., obesity or dental problems.
In 2013, research was carried out on the *Nycticebus pygmaeus* diet in zoos by Francis Cabana (Cabana, 2014). It has been concluded that efforts should be made to remove fruit, vertebrate prey, dairy, and grain products from the diet and instead introduce more gum, nectar, and insects, which has a positive effect on the animal’s behaviour and reduces obesity and health problems. The research should be done to see if the zoos followed the recommended diet and if the diet had a positive effect on their health.

2.9 Recommended research

There are a few research areas which might be interesting to explore:

1. Determining species-specific genetic markers for *Nycticebus* genus.
2. Determining gregariousness differences between different *Nycticebus* species.
3. Disease and mortality in *Nycticebus* species.
4. Social science / survey-related studies to find out the most effective method to deter illegal pet trade, with a focus on *Nycticebus* species.
5. Further studies of the diet at the zoos and its effects on health (obesity, dental problems) and reproduction of *Nycticebus pygmaeus*.
6. Research on neonate mortality in *Nycticebus pygmaeus* (mortality of neonates and the mortality within the first year of life is very high. According to the studbook data, there are 36% of deaths during the first 30 days after the birth and 41% in the first year of life).
7. Research on fertility in *Nycticebus pygmaeus* and answering the question what is the reason for not all of them having offspring.

2.10 Conservation links

2.10.1 *In situ* conservation of slow lorises

Over the past decades, wild populations of slow lorises have seen steady decline. Therefore, all the representatives of the *Nycticebus* genus belong among threatened species. The main threats to these prosimians are posed by the illegal pet trade and traditional medicine as well as by habitat loss due to the encroachment of agriculture and human settlements. They are also being shot and killed as agricultural pests or just for entertainment. As a reaction to this worrying situation, the IUCN's Red List status of three slow loris species, namely greater slow loris (*Nycticebus coucang*), pygmy slow loris (*N. pygmaeus*) and Bengal slow loris (*N. bengalensis*) were uplisted from "Vulnerable" to "Endangered" in 2020 (Blair et al., 2020; Nekaris et al., 2020) (it should be noted that the pygmy slow loris might see taxonomic splitting into more species in the near future). In the same year, three new species were described, i.e. Bangka (*Nycticebus bancanus*), Sumatran (*Nycticebus hilleri*) and Kayan slow loris (*N. kayan*), and classified as "Critically Endangered", "Endangered" and "Vulnerable", respectively (Nekaris & Marsh, 2020; Nekaris & Poindexter, 2020; Nekaris & Miard, 2020). Javan slow loris (*N. javanicus*) is still listed as "Critically Endangered" (Nekaris et al., 2020) while the Bornean (*N. borneanus*) and Philippine slow loris (*N. menagensis*) have so far stayed in the "Vulnerable" category (Nekaris & Miard, 2020; Nekaris et al., 2020). However, populations of all the currently recognized nine slow loris species are considered to be declining and the conservation statuses of the slow loris species might be getting closer to "Extinct".

Neither *ex situ* nor *in situ* conservation efforts alone can save *Nyceticebus* species for our future generations. Poaching, habitat loss, and other human-imposed threats to wildlife have led to the sharp decline in *Nycticebus spp.* in the wild. There may come a day where *ex situ* populations may serve as an assurance colony to supplement the wild population. With this in mind, progressive zoological and conservation institutions have adopted the One Plan Approach – a unified, holistic conservation strategy that combines *in situ* conservation activities with *ex situ* conservation, i.e., coordinated breeding in human care in order to maintain stable and thriving backup populations in human care. This way, we have good chances to preserve rare species in the long term and, eventually, strengthen or even restore their populations in the wild. The One Plan Approach looks into the development of management strategies and conservation actions by all responsible parties for all populations of a species, whether inside or outside their natural range. EAZA Prosimian TAG is guided by this principle in our species conservation efforts, and we have been cooperating with several *in situ* projects closely, protecting slow lorises in their natural habitats together.

2.10.2 The partner projects endorsed by EAZA Prosimian TAG

Partner projects endorsed by EAZA Prosimian TAG are the following:

The Kukang Rescue Program

The Kukang Rescue Program is a program focusing on combating the illegal wildlife trade and on the conservation of greater and Sumatran slow lorises in Indonesia, mainly on the island of Sumatra. The objectives include cooperation with and support of local communities (employing ex-poachers, cooperation with farmers), raising awareness of wildlife trafficking and protection, operation of a rescue and rehabilitation centre for confiscated slow lorises, cooperation with local government agencies on law enforcement, and building an Indonesian conservation team. The program runs an English-environmental school and library for local children and supports the sustainable livelihoods of coffee farmers in exchange for them protecting wildlife in the adjacent forest (Kukang Coffee project). It has also been active in *ex situ* conservation by promoting the breeding of pygmy slow lorises among European zoos. Learn more at www.kukang.org.

Little Fireface Project

The Little Fireface Project is a project led by Professor Anna Nekaris from Oxford Brookes University that studies ecology and contributes to the conservation of slow and slender lorises both in the wild and in captivity. The current main field project is located in Java, Indonesia, with a focus on the critically endangered Javan slow loris. The project conducts research in various biological fields, such as chemical and behavioural ecology, genetics, taxonomy, acoustics, etc. The project is also dedicated to educating the public about the illegal pet trade as well as to engaging local people in conservation. Furthermore, among the project's goals is using its research outputs in helping rescue centers with reintroductions and aiding in the welfare of kept slow lorises. Learn more at www.nocturama.org.

2.10.3 Other *in situ* conservation and research projects not officially endorsed by the EAZA Prosimian TAG but caring for *Nycticebus* species

Endangered Asian Species Trust

The Endangered Asian Species Trust is a British non-profit organization founded by Monkey World-Ape Rescue Centre (United Kingdom) and the Pingtung Rescue Centre (Taiwan) with the aim of protecting endangered wildlife in Asia, particularly from the illegal wildlife trade. The place of operation is southern Vietnam. The project currently focuses on the rescue and reintroduction of endangered primates (including the pygmy and Bengal slow loris), community engagement through conservation education, and raising awareness as well as on promoting responsible tourism. Learn more at www.go-east.org.

Endangered Primate Rescue Center

Endangered Primate Rescue Center, located in Vietnam's Cuc Phuong National Park, is a non-profit organization dedicated to rehabilitation, breeding, research, and protection of endangered Vietnamese primates and their natural habitat. The center was established to provide care to endangered primates seized from the black market, including the pygmy and Bengal slow loris, and to establish their populations in human care. The center works with authorities and local communities to protect the primate habitat, especially within the reintroduction programmes. It also serves as a valuable training and research facility for Vietnamese and foreign students and researchers. Learn more at www.eprc.asia.

Plumploris

Plumploris is a German non-profit organization aiming at the conservation of slow lorises by the means of rescue and rehabilitation of confiscated individuals, protection of slow lorises in the wild, education and awareness of the public, and research. Their projects are dedicated to the conservation of greater and Sumatran slow lorises on the Indonesian island of Sumatra and Bengal slow lorises in Bangladesh. The Plumploris team also promotes optimization of slow loris husbandry in zoological gardens and sanctuaries. Learn more at www.plumploris.de.

2.11 Rescue Centres

2.11.1 Rescue and confiscation of slow lorises

Animals get to rescue centres in different ways (for example, individuals get confiscated through the cooperation of an NGO with law enforcement and/or conservation agencies; individuals get confiscated by the agencies on their own initiative or in cooperation with other organizations; individuals can also be voluntarily surrendered by their owners; injured individuals in the wild are reported, etc.). The goal is always to find out as much information as possible, such as, for example, on where exactly the animal comes from, how long it has been in captivity, how it was captured, if it shows any apparent health abnormalities, how it was fed, whether it was captured alone, etc. However, it is very important to prevent cases when local people catch animals just to bring them to the centre either for money or even for free, assuming it is a good thing to do. These cases must be preceded very thoroughly by sufficient education and awareness-raising of local communities.
The current extent of the illegal trade in slow lorises shall be monitored using surveys in animal markets. Of course, a desirable part of the work to eliminate this trade is an awareness-raising campaign. The data should be collected and gathered as intensively as possible, especially in places where slow lorises naturally occur. In recent years, with the expansion of the Internet and the moving of a large part of the illegal animal trade there, it is also important to monitor online trends of this trade.

If all the circumstances allow, the procedure before and/or during a rescue and/or confiscation of an illegally held or sold slow loris should be following:

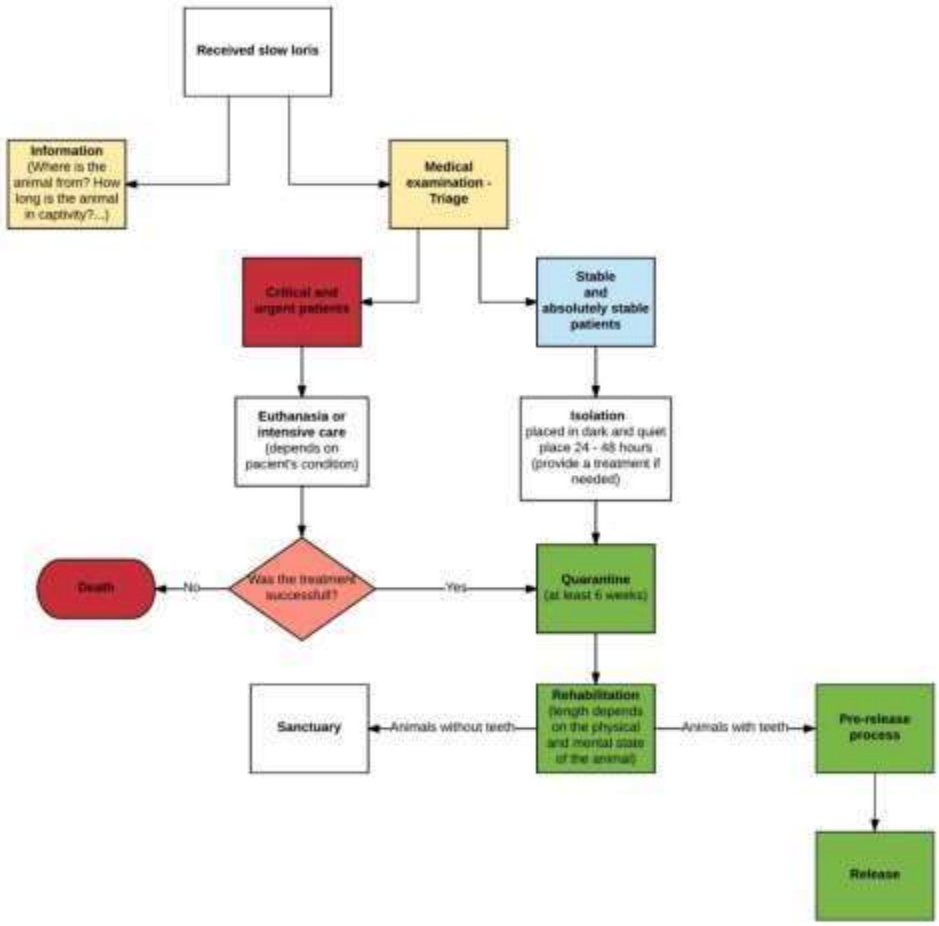
1. Take GPS coordinates of that location.
2. Conduct the necessary health examination of the animal.
3. Try to take a picture of the animal and the conditions in which the animal has been kept.
4. Report to/together with the enforcement and/or conservation agencies.
5. Support and alternatively also assist the confiscation of that animal.
6. In the case of confiscation, the animal should be accepted in a prepared rescue and rehabilitation centre.
7. In the case that the animal was kept illegally, the poacher/seller/owner should be punished according to the law. In exceptional cases, the owner (not a poacher or

merchant) should be at least informed and warned about the illegality of his actions and about the risk of punishment if the unlawful conduct is repeated.
8. It is necessary to avoid any corrupt practices both by the poacher/seller/owner and by the enforcement and/or conservation agencies.

The existence of a specialized rescue and rehabilitation centre for confiscated slow lorises is necessary as the absence of such a facility acts as a disincentive for effective law enforcement by the authorities (Shepherd, 2010). It is supposed that if a professional and efficient rescue and rehabilitation centre operates in the area, these endangered animals shall receive more attention, which will generally raise awareness of this species and its status of being endangered and protected. That way, enforcement authorities will be more motivated to enforce the law, which is crucial for improving the current alarming situation of illegal trade in slow lorises.

2.11.2 Rehabilitation and release of confiscated slow lorises

The rehabilitation process depends on the condition of each individual. Nevertheless, the following steps are crucial to stabilize the state of confiscated animals, which often come to rescue centres in very poor physical and mental condition.
Illustration of the rehabilitation process:



Medical triage

Individual steps of the rehabilitation process:

1. After an individual is received in the rescue centre, it must undergo an initial medical examination.

The first step is triage (the process of determining the priority of treatments of patients based on the severity of their condition), and if health problems are obvious, the animals receive the necessary treatment. If their state of health allows it, their sex and temperature are recorded, individuals are weighted and placed in a dark, quiet place with less space where they are provided with thermal comfort. Here they are placed for at least 24-48 hours, according to the individual needs. Each individual has its own card, which, in addition to medical examinations, also records the estimated age of the animal, its origin if known, and its history.

2. After the previous step, a sufficiently long quarantine for each individual shall follow.
In case there is no expression of an individual's clinical signs of illness or other disability, the quarantine process will take 6 weeks, as recommended by IUCN. In case of serious illness, the individual shall be placed in isolation.

Animals are provided with a diet respecting their natural requirements and adjusted according to their health condition. Insects and gum should be an important component of the diet, not only in terms of nutrition but also in terms of inducing natural feeding behaviour and prolonging the feeding time. Providing a wide variety of insects has been shown to significantly increase foraging behaviour and support natural postures, and when properly supplemented is more conducive to long-term health (Williams et al., 2015). Gum is an excellent source of fiber and certain minerals such as calcium (Cabana et al., 2018). With proper nutrition, we can minimize problems that can be frequently observed in animals in captivity, such as dental problems, facial abscesses, obesity, renal impairment and disturbed breeding. The quarantined animals are also served food that occurs in an environment where these individuals may be eventually released. This helps them to adapt to the future food source and thus increase their chances of survival after the release.

The size of the quarantine enclosures built in the Rescue and Rehabilitation Centre of The Kukang Rescue Program in Sumatra designed predominantly for the *Nycticebus coucang* and *Nycticebus hilleri* is 2.5 x 2.5 x 2.5 m. The enclosures are made mainly of mesh and designed with a raised bottom. Slow lorises are often in poor physical condition and could suffer numerous injuries if they fell to hard ground. This system also significantly simplifies the cleaning of the enclosures, contributing to better hygienic conditions, as excrements fall under the cages on the concrete ground, from where they are washed into the wastewater treatment plant. The quarantine is also equipped with branches and a sleeping box. When entering the quarantine enclosures, a disinfection bath is used to prevent any introduction of pathogens into and out of the quarantine.

After approximately a week, we proceed in the following way: animals receive a thorough health check under anaesthesia during which a special examination is performed, such as blood sampling, urine sampling, and X-Ray. The dental formula is noted and morphometric measurements are taken. Moreover, the animals are treated against parasites if they have positive results in faecal sampling and if the extent of infestation could potentially cause them health problems. Treated individuals can also receive an intradermal TB test, and a microchip is implanted. Last but not least, samples are taken for genetic identification. At the end of the quarantine period, individuals are eventually treated again against parasites based on the faecal sampling.

3. In the case of the successful quarantine process and confirmation of satisfactory health status, each individual shall be transferred to a rehabilitation enclosure.
Slow lorises shall stay in these enclosures for the period necessary to complete their recovery. These enclosures should be located in a quiet place with minimal interferences, and if needed, the rehabilitated individuals shall be prevented from any contact with their conspecifics. Ideal enclosures need to contain a continuous pathway of climbing structures, including vertical branches. Leafy vegetation is not only an important visual barrier, but it can also provide more complexity to the enclosure and encourage the animals to explore their environment (Fitch-Snyder et al., 2008). Sufficient sleeping space in the form of various pipes, baskets, and crates is also required. We have noticed that slow lorises very often look for V-shaped branches hidden in the leaves, which they use as a sleeping place. Crates can also be a good helper if one needs to capture the animals, as the stress caused by direct capture of an individual is reduced and the animals can be moved without any direct contact in the crate in which they have learned to hide.

Animals are provided with a balanced diet with a composition as close as possible to their natural diet. The enclosures are supplied with various types of enrichment using several food items to allow the animals to perform their natural feeding behaviour, prolong the feeding time, and minimize stress. It is important that the food is distributed differently around the enclosure, which also helps the animals to show better natural behaviour. The stress and very poor living conditions before confiscation are also causes of permanent physical and behavioural damage. To determine the confiscated animals' suitability for release, their captive behaviour must be observed, ensuring wild survival skills are intact (Collins, Sanchez, Nekaris, 2008). In behavioural analyses, considerable attention shall be devoted to abnormal behaviour or a series of behaviour performed repeatedly. Slow lorises which have been held captive for a long time often suffer from stereotypical behaviour (e.g. moving from one corner of the enclosure to another, continuous licking or swinging of the body in the same direction for a long time), unnatural behaviour (sleeping places on the ground), etc. It should be ascertained whether this abnormal behaviour is a way to deal with stress for the time the slow loris spends in captivity.

Behavioural observations during the rehabilitation process are very important to evaluate the skills of rehabilitated slow lorises and they shall be done by trained animal keepers.

4. Healthy individuals with adequate behaviour shall be moved to the pre-release part of the centre, where they will be prepared for the release.
This part presents the preparation of chosen candidates for their release. In this section, there might be visual contact between individuals of the same species. For some individuals, physical contact with individuals of the same species may be allowed. These enclosures are used to verify the natural behaviour of kept individuals.

The enclosures resemble the natural conditions, they are not fully roofed and are larger in size. The animals have to show more natural behaviour here, having to spend more time looking for food that tries to copy the food available in the place of their future release.

5. After a sufficiently long period of the demonstration of the likely ability of an individual to survive in the wild, the individual shall be marked with a radio collar and moved to a

habituation enclosure (i.e. a large forest patch enclosed by a plastic fence with open top and branches pruned so that the animals could not climb out of the enclosure), which is located in the area of release.

Released into an unknown habitat (a habitat where an individual is released always differs from the habitat where this individual lived and where it was captured, and for this released individual it thus becomes an unknown habitat), the animal is suddenly forced to contend with predators, aggressive conspecifics defending their territories, and to search for sufficient and appropriate food sources, all of which may lead to a slow and painful death from attacks, starvation, or stress-induced diseases (Yeager & Silver, 1999; Beck, 2010). Animals may be held for some period of time at the release site to allow them to accustom to the local conditions or to enhance the social group cohesion (IUCN Guidelines, 2013). In *Nycticebus javanicus*, there was a significant association between the size of the habituation cage and the survival success rate with longer survival of individuals that had access to larger habituation cages (Moore, Nekaris et al., 2014). The large (50 m perimeter) open-top cage situated at the release site provides an opportunity for the slow lorises to acclimatise to the new release environment and gives them time to recover from the stress from transportation. This "soft release" or "delayed-release" technique has been found to influence success in translocations in other species as well (Bradley et al., 2005; Parker et al., 2008).

Finding a suitable location for a habituation enclosure before the release is required. The goal is to find a suitable location(s) for the future release of rehabilitated individuals. This would be an unoccupied habitat, appropriate for the potential release of selected rehabilitated individuals. These individuals must be ready to return to their natural environment in terms of their health and ethological aspects. Survey suitability of the environment must be completed in the area beforehand. That will cover all relevant details, including checking the appropriateness of vegetation, occurrence of predators, determining the biodiversity, topography, suitability of food sources for the released individual, and social conditions in selected areas that should verify the results from previous surveys of local communities. No organisms should be released without an assessment of habitat quality in the destination area (IUCN Guidelines, 2013). Assessment of predators in the release area is important because in the studies of Moore (2014) and Streicher (2003), a number of released animals died due to predation. For example, 3 out of 5 greater slow lorises released after by Ciapus Primate Center into the Batutegi Reserve fell victim to predation (Moore, Nekaris et al., 2014). Also, the climate requirements of the target species should be understood and matched to the current and/or future climate at the destination site (IUCN Guidelines, 2013). The habituation enclosure should be placed in a carefully selected area to minimize any risk of mixing up individuals from different genetic populations or other risks associated with the release of confiscated individuals. Individuals currently confiscated in Sumatra have most probably also been caught in Sumatra and not in other islands.
Before the animals are moved to a habituation enclosure, medical control shall be done and the radio collar be installed. A radio collar with a strong operational signal, plus a spare, as well as items to secure the radio collar (for example, epoxy resin, shrink-wrap rubber coating, and lighter), are recommended (Nekaris et al., 2020).

In the habituation enclosure, animals are monitored and in case of illness or injuries, they can be translocated and adequately treated. The behaviour of slow lorises shall be observed using red lights. Not only do animals perceive the red light less intensively and engage in more normal behaviour during the observation, but the red light also preserves the human viewer's night vision (Finley, 1959). White lights, including the ones from one-site vehicles, have been shown to trigger a flight response in observed animals or, at the very least, dramatically alter their observed behaviour (King and King, 1994; Koli and Bhatnager, 2016; van Geffen et al., 2014). When using white lights, individuals often freeze or try to escape or hide somewhere, as opposed to the red light, where we can observe more natural behaviour, such as searching for food or grooming. Another thing is that pure white light, especially from LED torches, can injure the eyes of nocturnal animals (Harvey et al., 2012; Hunter et al., 2012; Peng et al., 2012).

It is important to observe the following before the release:

- Evaluating the ability of animals to adapt to the radio-tracking equipment (radio collars).
- Evaluating the ability of animals to eat while wearing the radio collar.
- Evaluating whether a given slow loris is fit and healthy.
- Training of basic skills (e.g. obtaining food).
- Evaluating the ability of animals to adapt to a different climate (Moore, 2010).

Before the release, we shall also consider the importance of instructing slow lorises to eat food from the wild diet, as well as of releasing slow lorises in a season where the food is easily available and during climatic conditions that are favourable for slow lorises. Individuals who have spent a long time in captivity and have been fed an inappropriate diet mostly including just a banana or rice suffer from malnutrition and have a low success rate of reintroduction. For example, the *N. coucang* in the wild eats 66% gum, 20% sap, 11% nectar, and 3% fruit (Cabana, 2016). In the *Nycticebus javanicus*, the success rate of reintroduction was 80% after 6 months of feeding on a diet with the same nutrition balance as in a wild diet (example of 5 individuals) (Cabana, 2016). The success rate before a new balanced diet was set up stood at ONLY 11% in *Nycticebus javanicus* (Moore, 2012). We still provide food to the slow lorises in the habituation enclosure, variously distributed throughout the enclosure, and the trained team monitors and records their food search behaviour and abilities. However, it is beneficial if there is also a natural food of slow lorises present in the habitat enclosure.

6. From the habituation enclosure, the individual is released into the selected area, and several months of monitoring of the released individual shall follow.
The reintroduction of wild animals back into the wild is a very complex and complicated topic. Many scientific articles have been published on this topic and there is also a basic handbook by the internationally recognized organization IUCN called "Guidelines for Reintroduction and Other Conservation Translocations". This handbook sets basic rules for translocations of animals. The basic principle of this guide is: "Conservation translocation is the deliberate movement of an organism from one site to another in order to release it. The ultimate goal must be a measurable conservation benefit at the levels of a population, species, or ecosystem, and not only to provide benefit to translocated individuals. Situations, which only the translocated individuals benefit from, do not meet this requirement" (IUCN Guidelines, 2013). Every situation is unique and thus every case requires a unique assessment and response. However,

we should always do maximum to follow as many points of this handbook as possible and to minimise the risks associated with the translocation of animals. These risks might influence local wild populations of animals or even a whole species or ecosystem. Releasing an animal into an already stable habitat may potentially disrupt the balance of the ecosystem and threaten other species of flora and fauna through competition, predation, or transfer of diseases (Burgman et al., 1998; Yeager & Silver, 1999; Teleki, 2001; Beck, 2010). The management of disease and known pathogen transfer is important, both to maximise the health of translocated organisms and to minimise the risk of introducing a new pathogen to the destination area (IUCN Guidelines, 2013). Protection of the habitat should be ensured prior to the release (Wickins-Dražilová, 2006).

The animals in the habituation enclosures, where their ability to behave normally is verified by observation, will be allowed to leave the enclosure. According to release procedures within The Kukang Rescue Program, after a certain time, a bridge in the form of a branch is created, which connects the enclosure with the surrounding environment. Behavioural observations both before (i.e. during the rehabilitation process) and after the release are conducted in order to help obtain a higher success rate of the programme. Trained teams of trackers do the observations regularly in the habituation enclosure as well as in the selected area after the release. It also allows the field teams to retrieve slow lorises not adapting well to the new environment. This monitoring process could provide a basis for comparison of the post-release behaviour, as well as help obtain a deeper insight into the behaviour and ecology of the slow loris. Behavioural observations will be carried out as often as possible during the post-release monitoring stage.

7. Post-release monitoring.
Releasing an animal is actually more detrimental to the ecosystem as a whole and needs to be addressed to individuals. This can be determined only through the selection of suitable and sustainable habitats, supplemented with long-term, post-release monitoring (Cheyne, 2009).

Post-release monitoring is important for released animals but monitoring results also provide the basis for either continuing or changing management regimes (IUCN Guidelines, 2013). Radio-telemetry supplemented by direct observation seems to be important as well. The animals spend time in thick vegetation, making direct observation impossible (Sandt, 2016). Monitoring should also identify new threats to the wild population, which were not part of the translocation design (IUCN Guidelines, 2013).

Radio-telemetry is applied/employed during the post-release monitoring, using the following equipment:

- Transmitter
- Lightweight Telonics receiver
- Telonics antenna.

Released slow lorises are followed as far as possible by direct observation using headlamps with the red light.
The success of the post-release monitoring is assessed by having trackers collect behavioural data attached to the released slow lorises and watching/observing what they feed on.

Post-release monitoring has to go on regularly and for as long as possible (minimum duration of 6 months).

This is a summary of the most fundamental problems associated with the reintroduction of wild animals back into the wild. Its aim was to show how complicated and complex this topic is on an example of slow lorises. Preceding paragraphs suggest that the release of wild animals back into the wild is associated with many risks that can be minimised and prevented by proper reintroduction management. This management should include a necessary quarantine of an animal, adjustment of its diet in case of long-term captivity, sufficiently long rehabilitation, checking of an animal´s good health and its mental readiness, assessment of the environmental suitability for release, and finally, the several months of monitoring of released animals.

As professional institutions, we should do the maximum to minimise problems and threats associated with the translocation of animals.

Summary for the Pygmy Slow Loris (*Nycticebus pygmaeus*)

Introduction

The *Nycticebus pygmaeus* population is the largest of the *Nycticebus* species managed in EAZA within the EEP, therefore *Nycticebus pygmaeus* is a priority species for EAZA and breeding and population increase are recommended. The pygmy slow loris as a representative of the entire genus *Nycticebus* is supposed to contribute to the acquisition of knowledge about the breeding of species of this genus.

This document briefly summarizes what we know of ecology, ethology, and keeping the pygmy slow loris. Its purpose is to provide zoological institutions interested in breeding this species with a basic set of needed information. All the information stated here has been excerpted from the official EAZA Best Practice Guidelines (BPG) for *Nycticebus* species which remains the primary, most detailed source of knowledge about this genus.

Taxonomy of *Nycticebus*

The genera *Nycticebus* comprises of nine currently recognized species: *N. pygmaeus*, *N. bengalensis*, *N. coucang*, *N. javanicus*, *N. menagensis*, *N. kayan*, *N. bancanus*, *N. borneanus* and *N. hilleri*. Ongoing genetic work suggests at least two genera within slow lorises, and there is also evidence for more species, particularly within the *Nycticebus pygmaeus* and N. *bengalensis*. Having diverged from other slow lorises 12-15 Mya and the only species regularly sympatric with another slow loris species, the only seasonal breeder and the only species that gives birth to twins, a proposal is currently in review to consider the *N. pygmaeus* a distinct genus. Furthermore, research suggests the high potential for two species in the north and the south of Vietnam.

Nycticebus pygmaeus

Common name: Pygmy slow loris, Lesser slow loris, Pygmy loris
IUCN Red List: Endangered (EN) (*N. pygmaeus* is heavily exploited for use in traditional medicine and is traded as a pet and in the related tourist photo prop trade.)
CITES: Appendix 1
Regional Collection Plan: EEP
It was originally classified within genus *Nycticebus* until it was transferred to the genus *Xanthonycticebus* in 2022.
Xanthonycticebus pygmaeus *(Nekaris and Nijman, 2022)*
Common name: Pygmy loris
Genus: *Xanthonycticebus*

1. Habitat and distribution

The species live in many different habitats like primary evergreen and semi-evergreen forests, limestone forests, secondary and highly degraded habitats and bamboo thickets in eastern Cambodia, southernmost China, Lao PDR, and Vietnam in elevations of up to 1,500 m. Wild *Nycticebus pygmaeus* are thus exposed to a wider range of temperatures; during summer, the temperature can reach a high of 29°C while in the winter months from December to February, the daily average minimum temperature can fall below 15°C, or daily absolute minimum reach below 5°C.

2. Physiology

Lorises usually fall into torpor late at night or in the early morning and return to euthermia in the early afternoon. *Nycticebus pygmaeus* are also able to significantly reduce their body temperature within euthermic levels on cooler days, but not below 30°C. The normal body temperature can span from 31°C to 36.6°C. According to the researchers, hibernation in this species is probably caused by an internal biological clock.

Institutions should note that as a consequence of seasonality adaptation, the body weight of *N. pygmaeus* may fluctuate, as with their fur coat condition, physiology, activity pattern, and behaviour. Adjustment of environmental parameters may be an option to help keep slow lorises acclimatise accordingly. Any seasonal changes in environmental parameters could be aligned with seasonal changes in diet to promote seasonal cues.

Nycticebus pygmaeus has been documented to live up to 20 years in captivity. According to studbook data, the longest-lived *Nycticebus pygmaeus* (Studbook # OOO182) was 22.4 years old.

3. Morphology

Pygmy slow lorises are distinct from other slow loris taxa based on their relatively small size, which is 360-580 g, naked large black ears, and a fully black nose. Its long dorsal stripe changes seasonally and may be related to camouflage or background matching for resource acquisition. In Vietnam and China, the species exhibits a regular coat colour change.

Like all slow lorises, pygmy slow lorises have brachial glands on their inner elbows that contain a toxin. This toxin becomes venomous when saliva is mixed with secretions from the gland. On its own, saliva can be cytotoxic – over-licking can cause necrosis, as can biting another slow loris. Venomous bites are the main cause of death of captive slow lorises, and many caretakers of slow lorises show allergic reactions to being bitten, handling them, or even being in the same room with them.

4. Social behaviour

All slow lorises are considered semi-gregarious, sleeping in pairs or in groups of up to six animals, and showing complex patterns of home range overlap. Most *Nycticebus* spp. appear to exhibit a uni male/uni female social organization, with the most common groupings being an adult male and female pair and their dependent offspring but mating is promiscuous. Social behaviours include allogrooming, foraging together and contact during the night, play between all age classes, intensive paternal care and interactive vocalizations, most calls of wild slow lorises being in pure ultrasound. Scent marking with urine is a dominant form of communication in captivity. Slow lorises are highly territorial and defend territories aggressively. Despite the large home ranges of males (0.03 km²), their core areas overlap 100% with their pair mates, and the larger excursions outside the home range are due to the male's promiscuous habits, visiting neighbouring females in oestrus. Fights are common leading to numerous scars and wounds generated from the slow lorises' venomous bites, whose principal purpose is intraspecific competition. A whistle or irritated "chitter" may be used during conflict.

5. Diet

Although slow lorises used to be described as frugivores, they have been shown to be exudativore – which means that gum and other exudates are the main components of their diet. Slow lorises bite through the bark of trees to cause an injury and return the next day after the gum has been produced and hardened. Their dentition is very specialised for this method of feeding. Exudates and insects form the most significant part of slow loris diets with various plant parts varying depending on location and season. *Nycticebus pygmaeus* has rarely been observed ingesting fruit but has a larger proportion of insects in its diet than larger slow lorises as its digestive physiology is rather adapted to digesting food items high in fiber.

Daily diets in human care should comprise tree gum (or other exudates), insects, vegetables, and to a lesser degree pellets or concentrated foods. Eggs may be given sporadically. Other animal products such as mice, chicks, meat, and dairy should not be used under any circumstances.

The following table shows recommended diets for slow lorises under human care based on the proportion of the weight of the food categories. Please, note that *Nycticebus pygmaeus* should have a higher range of insects (25 %) and lower vegetables.

Food item	**Proportion of diet (%)**
Watery vegetable	30-40
Root vegetable	30-40
Concentrate (pellets/insects/egg)	10-25
Gum Arabic	10-20
Enrichment foods (fruit, nectar, etc.)	0-5

Insects should be the main source of crude protein and crude fat within the diet. They must be properly gut-loaded with high-quality food (two hours before feeding the insects to the slow lorises) and sprinkled with a multimineral. The chitin possessed in insects may also have a prebiotic effect on slow lorises gut microbe community. Species of insects involve locusts, mealworms, morio worms (large mealworms), crickets, stick insects, and cockroaches.

The most common gum used in zoos is called gum Arabic and is easy to source. It comes in two formats, raw gum (which looks like amber crystals) or refined gum (which looks like white powder). Both can safely and effectively be used with slow lorises. The crystals will need a longer soaking time, as they will absorb the water and become more gelatinous. Soaking overnight is a common strategy and using hot water can aid the process. Caution must be taken when feeding the dry raw crystals as they have been dehydrated and may be too hard for older animals to chew. The refined gum can be mixed and fed immediately.

Nectar is another popular food item. Commercial nectars are highly fortified and necessary for slow lorises that need quick energy. This isn’t the case in captivity therefore, dilute commercial nectar or very dilute juice, or very dilute honey water solution are best used as enrichment and not necessarily as part of the diet.

A large variety of vegetables should be rotated. Suitable vegetables include broccoli, cauliflower, celery, corn, cucumber, peas, sweet pepper, radish, tomatoes and some root vegetables such as courgette, all kinds of squash, pumpkin, sweet potatoes, beetroot, carrot, celery root, parsley root, kohlrabi, aubergine.

Although fruits are readily eaten by slow lorises, this is more akin to chocolate cake rather than a healthy meal. The only acceptable time that fruits may be used is during training when a strong reinforcer needs to be used. Fruits should be considered on a case-by-case basis.

Research has shown that pygmy slow lorises increase feeding time, social behaviours, and grooming behaviours and decrease resting behaviours as energy content increases seasonally. In the wet season, a wider variety of food is consumed but this variety is reduced in the dry season, which coincides with seasonal restrictions on food availability of certain fruits, flowers, nectar and insects. Promoting and encouraging these seasonal changes may improve overall breeding success.

Special dietary requirements

For infants, insects are one of the first foods they learn to consume. They also can eat gum early on, related also to the early eruption of their toothcomb, while nectar is the last food item mastered. Growing individuals need rich and nutrient-dense diets, which means giving normal amounts of insects, concentrates, and gum. Gestating individuals do not need any additional supplements or food, possibly except for the last 2 weeks of gestation. Their diet can be increased by 20% and another 20% after they give birth, which will eventually serve as the offspring's diet after weaning. Little research has gone into geriatric care of slow lorises. Suggested practices from the authors recommend soft gum (not raw hard crystals) as well as increasing water intake, a fish oil supplement (omega 3s), the addition of a calcium supplement to the gum, and a 5% increase in insects to increase overall protein.

Note: Details on nutrient targets for slow lorises under human care can be found in the respective chapter of the full BPG document.

Method of feeding

It is imperative that slow lorises are given daily opportunities to perform natural feeding behaviours and gum is presented in such a way to create it, for example by drilling holes into logs and trees. A small amount of nectar can be put on flowers or browsed to encourage natural nectar-drinking behaviours. However, due to its high sugar content, giving the majority of nectar directly from a syringe (or bird water feeder) should be considered to allow consumption levels to be known. Insects and vegetables can be given in a range of enrichment items, such as hanging balls, bamboo stems, willow balls, etc., to encourage natural foraging and extend feeding times. Fresh water should be provided daily to lorises. Spraying or misting on large-leaved plants may also provide a natural way for slow lorises to obtain their water by licking droplets from leaves.

6. Reproduction

Nycticebus pygmaeus is a seasonal breeder. Sexual maturity is reached when they are 1.5-2 years old. Female oestrus occurs between July and September/October and the cycle typically lasts 30-54 days.

Mating

During mating season, the female slow loris tends to scent mark the area by urinating while making characteristic whistle calls to alert males slow lorises in the vicinity. If he urinates in her footsteps, whistles, and sniffs the genitals while approaching her, she will adopt a copulative position. Copulation normally lasts 30-45 minutes with the male suspended almost entirely on the female's body, hanging from a strong branch. The male leaves a copulatory plug in the female that can last multiple days.

In captivity, suitable perching at the highest levels of the enclosure is thus required. Enclosures with a meshed ceiling are also readily used by loris for mating. A female will actively pursue a male when she is receptive. Females in oestrus tend to vocalize more, and their vaginas also appear enlarged and reddish. Several copulations are usually witnessed over 2-4 days. In some cases, where males and females are housed separately, the female will become less tolerant of the male after copulation. If the male continues to pursue the female it is recommended that they are separated once more. Further monitoring will determine whether the female starts showing signs of interest in which case an introduction can once again be conducted. It should be noted, however, that not all pairs of *Nycticebus pygmaeus* have reproduced in captivity, the reason for which is yet to be researched.

Although *Nycticebus pygmaeus* are considered seasonal breeders, there are cases of them breeding throughout the year in captivity. Nevertheless, the peak of births in captivity remains between January and March. Fitch-Snyder and Jurke (2003) found that *Nycticebus pygmaeus* housed in pairs for more than 30 days before oestrus have more breeding success compared to pairs put together for oestruses. On the contrary, a private breeder mentioned that couples who he kept together for a long time began to behave more like siblings and the breeding was unsuccessful.

Pregnancy and birth

Females give birth every 12-18 months and the average postpartum oestrus is 169 days. After an average gestation of 188 days, *Nycticebus pygmaeus* offspring are born from January/early February to March. Usually, twins are born but also quadruplets have been recorded in human care. Female leaves the offspring in the branches periodically (i.e. behaviour called "parking") when she forages for food or explores. Although they are occasionally carried on the mother's stomach, young are scarcely seen until they are about 3 months old. The infant will emerge on its own from 4 to 6 weeks of age. The offspring are weaned after 6 months but they will stay with the female until their sexual maturity which is reached at 16 months in females and 18 months in males. In human care, offspring are typically rehomed at one year of age.

It is appropriate to make sure that the enclosure is safe for an infant by providing an extra thick layer of substrate, providing nestboxes with sealable bottoms, or adding additional platforms underneath regular resting spots in case of the young falling down. Twins are also common in lorises, so even if the female has one parked, ensure you check the floor for a second, often weaker, offspring.

Anyway, the mortality of neonates and the mortality within the first year of life are very high. According to the studbook data, there is 36% of deaths during the first 30 days after birth and 41% in the first year of life.

Using of hormonal support in *Nycticebus pygmaeus* breeding

Females staying in anestrus were checked and injected (intramuscular) with Sergon (100 i. u.) and Pregnyl (100 i. u.). If there was no progress in the oestral cycles, then females were injected again after a week. This period was repeated maximally three times and almost all females were reproduced successfully.

Contraception possibilities

Contraception of slow lorises remains a rare event within the breeding programs. The easiest and most effective method consists of separating both sexes. There is one known case of contraceptive use in the EEP *Nycticebus pygmaeus* population, and that is the female who received 4.7mg suprelorin implant (in 2012) due to evidence of toxoplasmosis.

7. Enclosure habitat design

A few aspects to be considered when designing the enclosure for *Nycticebus pygmaeus* include their arboreality, nocturnality as well as their recorded home range. In the wild, slow lorises spend half to up to two thirds of their time feeding, traveling, and exploring. They can move more than 600 m/hour and more than 5 km in a night on a straight plane, not counting vertical distances.

Generally, most *Nycticebus* species show complex patterns of home range overlap which must be accounted for when housing more than one individual together. Feeding points and nest boxes should increase based on the number of individuals housed together; at least two of each per individual should be provided. Importantly, sufficient space, furniture, pathways, and visual barrier should be provided; animals should always have the option to roam, hide or interact with each other.

The enclosure design should also allow for physical separation during feeding if necessary. In the ideal set-up, each slow loris should have their own enclosure with a common/shared area. All dens should be connected via sliding doors so as to facilitate the transferring and rotation of animals and to allow flexibility in the separation of pairs if required. A small satellite enclosure should be incorporated for the animal to retreat to, which will also be useful if individuals require special care such as supplementary feeding or medical treatment.

Considering that *Nycticebus* species are arboreal, these enclosure size parameters are recommended:

- Length (L): greater than 5 m
- Width (W): greater than 2 m
- Surface Area: greater than 15 m^2
- Height (H): greater than 2.5 m

The temperature range should be kept from 19°C to 28°C, the humidity level should be maintained between 70% and 80%. Ventilators should be used to ensure good circulation in enclosures with restricted airflow. An outdoor habitat will allow slow lorises access to natural lighting and hence encourage the natural circadian rhythm.

Substrate

Ideally, a natural substrate such as natural earth/soil, pine bark mulch, deciduous tree bark, wood chips, orchid bark, etc. should be provided. Sand and wood shavings or dry leaves can also be used. The substrate layer should be a minimum of 10 cm thick. It is important to ensure that the substrate is free of pesticides before use.

Furnishing

Live plants, tree stumps, trunks, and branches of varying diameters as well as vines and connecting branches of differing flexibility are suitable furnishings for the facility. Only non-toxic tree species should be selected. Safe plants to use include oak, birch, beech, hazel, willow, and silk plants. Several sources will give information on suitable plants and trees such as the following link to Zooplants.net. Gouging behaviour was observed for example on boxelder maple (*Acer negundo*) and on fruit trees such as apple, pear, plum, and cherry plum. Conifers, e.g. pines, spruces, and firs, can also be used. These plants and logs not only serve as additional shelters, sleeping places, and enrichment (olfactory) but also as an added structure for slow lorises to mark their territory. A diameter of about 20 cm is a good gauge, and holes can also be incorporated to allow natural branches to be inserted.

Horizontal branches are important for breeding, as copulation occurs in a hanging posture on these inclined branches. Some branches can also be fixed vertically, with one end fastened to the ceiling or horizontal branches using safety hooks, screw rings, etc., and leaving the other end freely hanging. Wooden blocks, processed wood, ficuses, and lianas are all suitable considerations for this purpose. Further, hammocks and baskets or specially fitted food holders can be used in enclosures. Feeding sites should be arboreal, and several feeders should be provided at various locations. Stainless steel bowls are suitable receptacles for the feed.

Resting area

Tree trunks and bamboo plants can be used to create resting areas. Leave thickets/bundles are also incorporated at strategic nodes and holes throughout the entire length of the bamboo to provide the animals with a hideout option. A nest box, preferably with two exit points, would also be another important component, especially if allowing animal care staff the option to secure animals in them. Arboreal platforms or mesh tunnels can serve as well.

N. pygmaeus nest box dimensions (as used at Moscow Zoo):

- Length (L): 40 cm, Breadth (B): 15 cm, Height (H): 15 cm
- Internal space is divided into two parts (L): 20 cm
- Box entrance - (L): 9 cm, (B): 11 cm, (H): 11 cm

Lighting and circadian cycle

Nycticebus species are most often held in zoo enclosures under reverse cycle lighting. Although they are nocturnal, full-spectrum daylight plays an important role in their lives. In the wild, they are exposed to varying amounts of daylight although shaded from direct sunlight by foliage. Exposure to daylight, which includes UVB, enables cutaneous vitamin D3 synthesis. The natural foods of lorises contain little or no vitamin D3.

Diurnal light phase: When installing lighting for the diurnal phase for *Nycticebus*, it may be beneficial to include bright full-spectrum lighting (approx 3,000 lux) including natural levels of blue light (facilitating sleep) in one part of the enclosure, to simulate a “patch of sunlight”

which initiates sleep and also allows at least some illumination, including low levels of UVB, to reach the animals in their sleeping positions.
Night phase: Lamps inside the enclosures should be either red or "warm white", as low wattage and as dim as possible (0.75-1 lux), ideally reproducing no greater illumination than moonlight, to prevent suppression of activity. Covering lamps with neutral-density filters is also an option. Blue lights and white lighting must be avoided. Head torches with red lights included can be a highly useful tool for keepers as they provide good visibility whilst keeping hands free for animal care duties. However, it should be noted that strong red lights will be visible to the lorises.

At the beginning and end of each day, a suitable "twilight" is required, with a transition over a period of approximately one hour between bright full-spectrum daylight and near-total darkness with little or no blue light. A lux meter should be used to establish lighting levels.

Note: Detailed practical recommendations on appropriate types and levels of lighting can be found in the respected chapter of the full BPG document.

Intraspecific compatibility
Nycticebus species exhibit different degrees of inter- and intra-specific sociability, especially when they rest, mate, sleep in a group, or through vocal and olfactory communication. They tend to accept sharing the same enclosure with their siblings, and the young can stay with their parents for up to a year before separation to prevent inbreeding. While some institutions have had successes with keeping more than one *Nycticebus* specimen together, there were also cases where conspecific aggression occurred. It is crucial to provide safe hiding spaces (e.g., dense planting, cardboard tubes, or boxes) in these enclosures. The "introductory housing cage" concept can be suggested during the acclimation phase, where males can enter this smaller "cage" and then either be placed directly within the enclosure of the female for caretakers to observe their interaction across the cage mesh. Alternatively, both individuals can also be "introduced" to each other in an enclosure unfamiliar to both, whilst separated by a fence as a safety barrier – enabling visual, olfactory, and vocal interactions.

Sharing enclosure with other species
Mixed species exhibits are possible with pygmy slow loris but need very careful monitoring. It is also important to note that breeding might be less likely to occur in this kind of exhibit. *Tragulus* spp. and *Nycticebus spp.* appear to be quite popular mixed species combinations in zoological institutions.
Enrichment
Slow lorises are very active and move and climb a lot around during their activity phase. The food presentation should be combined with different types of enrichment. In the wild, they spend most of the time of their activity period feeding gum, therefore, slow lorises in human care should not be served the gum at one point only. As slow lorises cannot leap and require canopy connectivity, the enclosure should offer different kinds of horizontal branches or ropes as well as fine branches and bundles of small branches. Bamboo or dense planting for hiding, sleeping, and resting should be present in the enclosure. Some slow lorises in human care also prefer to sleep in cardboard tubes or boxes.

8. Handling

Due to the potential for serious harm caused by slow loris bites, any manual restraint and handling of slow loris should be only undertaken when absolutely necessary. It is recommended that any institutions holding slow lorises have an EpiPen on site in case of accidental bite injuries leading to potential anaphylaxis.

Catching/restraining

Slow lorises are extremely hard to remove from branches or mesh due to the capillaries in their wrists creating a very strong grip. It is advisable to use safety equipment such as a mask and gloves specifically designed for handling wild animals which are often made from leather or cut-resistant fabric. Additional protection such as blankets or towels is also useful to place over an animal. If restraint is required, the slow loris should be encouraged to a flat surface such as the floor to aid with the capture.

Slow lorises can be grabbed dorsally using one hand; their heads can be secured by placing our fingers under their lower jaw while using the other hand to stabilize their bodies between their hind leg. The handler has to ensure that his or her grip (on the head) is firm so that slow loris cannot turn around and bite, but at the same time not too tight until the animal is choked. For such procedures, avoid handling the specimens under direct sunlight as their eyes may be sensitive to strong light intensities.

Age determination

<u>Young and Juveniles:</u> Bigger contrast of face mask; light, fine, longer coat; pure white and sharp teeth that are fully developed after 6 months of age.
<u>Adults:</u> Darker, coarser, shorter coat; fully developed teeth that are already slightly yellowed
<u>Old individuals:</u> Lighter contrast of face mask; darker face, limbs, and the area around the eyes; darker, matte, dry coat; yellower teeth with stains and noticeable wear.

Sex determination

It is difficult to distinguish males from females at first glance. The differences are the following:
<u>Females:</u> Conspicuously protruding clitoris that is easily confused with the male genitals; clitoris with vertical slit at the tip; the distance of the protrusion from the anus is shorter, and a more detailed search reveals the vulva; urethra opens at the clitoris tip; V-shaped vaginal opening situated at the root of the clitoris; the vagina of slow lorises is usually sealed when the female is not in oestrus; areas underneath the vagina can be swollen or pigmented, which can be mistaken for scrotum.
<u>Males:</u> The penis tip is blunter and the slit is absent; the distance between the protrusion and the anus is longer; by gently squeezing the protrusion, we often find a penis; male genitalia show seasonal changes and testes increase in size during late summer; males have larger body size and larger canines and are more aggressive.

Transportation

Containers with opaque walls and top lids covered with some form of visual barriers as well as appropriate air flow and circulation are preferred. Small branches with leaves can be included in the carriers or containers to allow the slow lorises to climb or hide. The preferred method of restraint and transport for veterinary procedures is in an induction crate. Slow loris should be habituated to them so it is recommended to build them into the enclosure design.

Routine health inspections

General appearance, behaviour, appetite, water consumption as well as faecal and urine output need to be assessed daily. Weight monitoring should be done once a week or once every two weeks. Any loss of more than 10% should be addressed and communicated to the veterinarian. Parasite checks should be conducted at least biannually. Slow lorises in captivity are prone especially to strongyles, giardia, and nematodes. Some parasites such as *Pterygodermatites nycticebi* can be deleterious for other species such as callitrichids. There is no official vaccination recommendation in prosimians, however, it is recommended to only use killed vaccines in slow lorises.

Holders have the responsibility to notify the respective EEP coordinator and vet advisors of any significant medical problems with their animals and must send any post-mortem report as well.

Diseases, disorders, and/or injuries

The most frequent issues of *N. pygmaeus* reported are wounds and trauma by conspecifics, followed by diseases often associated with an inappropriate diet, e.g. obesity and dental problems, such as caries, periodontitis, and gingivitis. All *Nycticebus* are sensitive to stress that can be expressed by fluctuation in body weight, overgrooming, alopecia, gastritis helicobacter and in some cases cystitis.

Anaesthesia and immobilization

Before anesthetizing an adult slow loris, a fasting period of 4-8 hours is recommended. Volatile anaesthesia with isoflurane is the easiest method available. Also, a mixture of ketamine and medetomidine can be used. Of course, dosages and protocols should be adapted to each situation, procedure, and animal (see the full BPG document for detailed dosage recommendations). It is recommended to intubate all patients that require a long procedure. Endotracheal tube size between 1.5-2.5 mm is a good fit for slow lorises. Emphasis needs to be made on ensuring good thermoregulation for the animal under anaesthesia as this species is prone to hypothermia.

Specific problems

Nycticebus species are highly threatened by the illegal pet trade – zoological institutions might receive specimens that were either seized or found abandoned (by irresponsible pet owners). Mostly, such specimens arrive compromised state. Generally, *Nycticebus* specimens that are used as pets tend to overgroom themselves or display some form of stereotypy due to the sudden contrast in the amount of attention given to them by humans. Allocating some time for keepers to comb the individuals and spend some time with them might help.

Population management

Permanent identification of kept specimens is a necessity. The implantation of a passive integrated transponder subcutaneously in the interscapular region is the method of choice. Once implanted the corresponding ID number needs to be reported into ZIMS and communicated to the respective coordinator.

In necessary cases, the regulation method called Breed and Cull can be used. This methodology is approached in successfully managed breedings in a way that simulates the processes in nature as much as possible and is implemented in the most ethical way possible.

The EAZA Population Management Manual (PMM) provides a thorough overview of the rules and procedures, and gives guidance in relation to, population management in EAZA.
This manual should be followed and referred to when making decisions on population management including euthanasia. Please refer to the EAZA statement on breed and cull if this is to be considered.

Editors and contributors to the EAZA Best Practice Guidelines for *Nycticebus* species:

- Katarzyna Byczyk, Ogród Zoologiczny w Poznaniu
- Nic Dunn, Wellington Zoo Trust
- František Příbrský, Ostrava Zoological and Botanical Garden, The Kukang Rescue Program
- Cecilia Tang, Mandai Wildlife Group

Contributors to the EAZA Best Practice Guidelines for *Nycticebus* species:

- Dr Frances M. Baines, M.A., Vet. M.B., M.R.C.V.S.,
- Lynsey Bugg, Bristol Zoo Gardens
- Paige Bwye, Bristol Zoo Gardens
- Dr Francis Cabana, Pet cubes
- Lucie Čižmářová, Olomouc Zoo, The Kukang Rescue Program
- Nils Dijkgraaf, DierenPark Amersfoort
- Dr Guillaume Douay, Mandai Wildlife Group
- Sergey Hlyupin, Moscow Zoological Park
- Kateřina Holubová, Ostrava Zoological and Botanical Garden, The Kukang Rescue Program
- Dr Barbara Jantschke, Zoologischer Garten Augsburg GmbH
- Prof K.A.I. Nekaris, Oxford Brookes University, Little Fireface Project, Nocturnal Primate Research Group
- Marcel Stawinoga, Plumploris e.V., c/o Zoo Dortmund
- Jan Vašák, Jihlava Zoo
- Ariana V. Weldon, Noctural Primate Research Group, Oxford Brookes University

Summary for the Pygmy Slow Loris (*Nycticebus pygmaeus*):

- Kateřina Holubová, Ostrava Zoological and Botanical Garden, The Kukang Rescue Program

Section 3: References

Alejandro, J.; Yamanashi, Y.; Nemoto, K.; Bercovitch, F.B.; Huffman, M.A. (2021). Behavioral Changes of Solitary Housed Female Pygmy Slow Lorises (*Nycticebus pygmeaus*) after Introduction into Group Enclosures. Animals, 11, 2751.

Al-Razi, H., Hasan, S., Ahmed, T., & Muzaffar, S. B. (2020). Home Range, activity budgets and habitat use in the Bengal Slow Loris (*Nycticebus bengalensis*) in Bangladesh. In K.A.I. Nekaris & A. Burrows, (Eds.), Evolution, Ecology and Conservation of Lorises and Pottos, 193-203.

Alterman, L. (1995). Toxins and toothcombs: potential allospecific chemical defenses in *Nycticebus* and *Perodicticus*. In L. Alterman, G.A. Doyle & M.K. Izard (Eds.), Creatures of the Dark (pp. 413-424). Springer, Boston, MA.

Ankel-Simons, F. (2007). Primate Anatomy (3rd ed.). Academic Press. ISBN 978-0-12-372576-9.

Baines, F.M. (2020). Making light work: If all of our animals need full spectrum lighting, how can we provide it? EAZA Nutrition Group News, July 2020. pp.8-10.

Balsiger, A., Federer, K., Grimm, F., & Deplazes, P. (2018). Transmission of *Pterygodermatites nycticebi* in a colony of goeldi's monkeys (*Callimico goeldii*) and evaluation of treatment and control. Journal of Zoo and Wildlife Medicine, 49(4), 893-901.

Barrett, M., Campera, M., Morcatty, T. Q., Weldon, A. V., Hedger, K., Maynard, K. Q., Imron M.A. & Nekaris, K. A. I. (2021). Risky business: The function of play in a venomous mammal—the Javan slow loris (*Nycticebus javanicus*). Toxins, 13(5), 318.

Bearder, S. K., Nekaris, K. A. I. and Curtis, D. J. (2006). A re-evaluation of the role of vision in the activity and communication of nocturnal primates. Folia Primatol. 77(1-2):50-71

Beck, B. B. (2010). Chimpanzee orphans: sanctuaries, reintroduction, and cognition. In: Lonsdorf E, Ross, S. R., Matsuzawa, T., Goodall, J. (eds) The mind of the chimpanzee: ecological and experimental perspectives. University of Chicago Press, Chicago, IL, 332−346.

Bernacky, B. J., Gibson, S. V., Keeling, M. E., Abee, C. R. (2002). Non-human primates. In: Fox JG (ed) Laboratory animal medicine. Academic Press, New York, NY, 676−777.

Bieber, C., Lebl, K., Stalder, G., Geiser, F. & Ruf, T. (2014). Body mass dependent use of hibernation: why not prolong the active season, if they can? Funct. Ecol. 28(1), 167-177.

Blair, M., Nadler, T., Ni, O., Samun, E., Streicher, U. & Nekaris, K.A.I. (2020). *Nycticebus pygmaeus*. The IUCN Red List of Threatened Species 2020: e.T14941A17971417. https://dx.doi.org/10.2305/IUCN.UK.2020- 2.RLTS.T14941A17971417.en. Downloaded on 24 August 2020.

Boraski, E. A. (1981). Renal disease in prosimians. Veterinary pathology, 18(6_suppl), 1-5.

Bradley, E.H., Pletscher, D. H., Bangs, E. E., Kunkel, K. E. and others. (2005). Evaluating wolf translocation as a nonlethal method to reduce livestock conflicts in the northwestern United States. Conserv Biol 19: 1498−1508.

Brando, S. and Buchanan-Smith, H.M., 2018. The 24/7 approach to promoting optimal welfare for captive wild animals. Behavioural Processes, 156, pp.83-95.

Brando, S. and Herrelko, E.S., 2021. Wild animals in the city: Considering and connecting with animals in zoos and aquariums. Animals in Our Midst: The Challenges of Co-existing with Animals in the Anthropocene, pp.341-360.

Burgman, M. A., Lindenmayer, D., Drill, C. (1998). Conservation biology for the Australian environment. Surrey Beatty & Sons, Adelaide.

Bywe, P. (2019). Bristol Zoo Gardens (pers coms).

Bywe, P. (2020). Bristol Zoo Gardens (pers comms).

Cabana, F. and Plowman, A. (2014). Pygmy slow loris *Nycticebus pygmaeus*: Natural diet replication in captivity. Endangered Species Research 23(3):187-204.

Cabana, F. (2014). Pygmy slow loris (*Nycticebus pygmaeus*) European zoo diet survey results. Journal of Zoo and Aquarium Research 2(2).

Cabana, F. & Nekaris, K. A. I. (2015). Diets high in fruits and low in gum exudates promote the occurrence and development of dental disease in pygmy slow loris (*Nycticebus pygmaeus*). Zoo Biology, 34, 547–553.

Cabana, F. (2016) Prosimian nutrition bites. EAZA Annual Conference 2016 Belfast. Prosimian Taxon Advisory Group (TAG).

Cabana, F., Dierenfeld, E., Wirdateti, W., Donati, G. and Nekaris, K.A.I. (2017a). The seasonal feeding ecology of the javan slow loris *(Nycticebus javanicus).* AmJPhys Anthropol. 162:768–781.

Cabana, F., Dierenfeld, E., Wirdateti, W., Donati, G. and Nekaris, K.A.I. (2017b). Slow lorises *(Nycticebus spp.)* really are slow: a study of food passage rates. International Journal of Primatology.

Cabana, F., Dierenfeld, E., Wirdateti, W., Donati, G. and Nekaris, K.A.I. (2017c). Exploiting a readily available but hard to digest resource: a review of exudativorous mammals identified thus far and how they cope in captivity. Integrative Zoology 13: 94-111.

Cabana, F., Dierenfeld, E., Wirdateti, W., Donati, G. and Nekaris K.A.I.(2017d). Trialling nutrient recommendations for slow lorises *(Nycticebus spp.)* based on wild feeding ecology. Journal of Animal Physiology and Animal Nutrition.

Cabana, F., Clayton, JB., Nekaris, K.A.I., Wirdateti, W., Knights, D., Seedorf, H. (2019). Nutrient-based diet modifications impact on the gut microbiome of the Javan slow loris *(Nycticebus javanicus).* Scientific Reports 9:4078.

Campera, M., Brown, E., Imron, M. A., & Nekaris, K. A. I. (2020). Campera, M., Brown, E., Imron, M. A., & Nekaris, K. A. I. (2020). Unmonitored releases of small animals? The importance of considering natural dispersal, health, and human habituation when releasing a territorial mammal threatened by wildlife trade. Biological Conservation, 242, 108404.

Canuti, M., Williams, C. V., Gadi, S. R., Jebbink, M. F., Oude Munnink, B. B., Jazaeri Farsani, S. M., Cullen, J.M., & van der Hoek, L. (2014). Persistent viremia by a novel parvovirus in a slow loris *(Nycticebus coucang)* with diffuse histiocytic sarcoma. Frontiers in microbiology, 5, 655.

Charles-Dominique, P. (1977). Ecology and behavior of nocturnal primates: Prosimians of equatorial West Africa. New York, NY: Columbia University Press.

Chen, J. -H., Pan, D., Groves, C. P., Wang, Y. -X., Narushima, E., Fitch-Snyder, H., Crow, P., Thanh, V. N., Ryder, O., Zhang, H. -W., Fu, Y., Zhang, Y. (2006). Molecular phylogeny of *Nycticebus* inferred from mitochondrial genes. International Journal of Primatology. 27 (4). 1187–1200. doi:10.1007/s10764-006-9032-5.

Cheyne, S. M. (2009). The role of reintroduction in gibbon conservation: opportunities and challenges. In: Lappan S, Whittaker DJ (eds) Gibbons. New perspectives on small ape socioecology. Springer, New York, NY, 477–496.

Coimbra-Filha, A. F., & Mittermeier, R. A. (1977). Tree-gouging, exudate-eating, and the short-tusked condition in *Callithrix* and *Cebuella*. In D. G. Kleiman (Ed.), The biology and conservation of the *Callitrichidae*. Washington, DC: Smithsonian Institution Press.

Collins, R., Sanchez, K. L., Nekaris, K. A. I. (2008). Release of greater slow lorises (Nycticebus coucang), confiscated from the pet trade, to Batutegi Protected Forest, Sumatra, Indonesia. IUCN Global Re-introduction Perspectives: re-introduction case studies from around the globe. Ed. P.S. Soorae. IUCN/SSC Reintroduction Specialist Group: Abu Dabhi, UAE, 192-195.

Cowgill, UM and States, SJ. (1982). Lacyodr inyoltanvr in spyibr nocyutnal prosimians *(Perodicticus potto)*: A twenty-one-year record. Primates 23(4): 598-604.

Dacey, D.M., Liao, H.W., Peterson, B.B., Robinson, F.R., Smith, V.C., Pokorny, J., Yau, K.W. and Gamlin, P.D. (2005). Melanopsin-expressing ganglion cells in primate retina signal colour and irradiance and project to the LGN. Nature, 433(7027), p.749.

Das, N., Nekaris, K. A. I. & Bhattacharjee, P. C. (2014). Medicinal plant exudativory by the Bengal slow loris *Nycticebus bengalensis*. Endanger Species & Research, 23, 149–157.

Daschbach, N. (1983). Cage-size effects on locomotor, grooming and agonistic behaviours of the slow loris, *Nycticebus coucang* (Primates, Lorisidae). Applied Animal Ethology, Vol. 9: 317.

De Azevedo CS, Cipreste CF, Young RJ. (2007). Environmental enrichment: A GAP analysis. Appl Anim Behav Sci 102:329–343.

EAZA (2020). EAZA Standards for the Accommodation and Care of Animals in Zoos and Aquaria .Approved by EAZA Annual General Meeting 25 April 2019. https://www.eaza.net/assets/Uploads/Standards-and-policies/2020-10-EAZA-Standards-for-Accomodation-and-Care.pdf

Ehrlich, A. & Musicant, A. (1977). Social and Individual Behaviors in Captive Slow Lorises. Behaviour, 60, 195–220.

Eudey, A. & Members of the Primate Specialist Group. (2000). *Nycticebus pygmaeus*. The IUCN Red List of Threatened Species 2000: e.T14941A4481382. Downloaded on 25 May 2020.

Farida W. R., Sari A. P. (2015). Mating behavior of Slow Loris *(Nycticebus coucang)* at Captivity. Jurnal Biologi Indonesia. 11. 188-191.

Faridah-Hanum, I., Mustapa, M.Z., Lepun, P., Tuan Marina, T.I., Nazre, M., Alan, R. and Mohamed, R. (2009). Notes on the distribution and ecology of Aquilaria Lam.(Thymelaeaceae) in Malaysia. Malaysian Forester, 72(2), pp.247-259.

Fauzi, ES., Sjahfirdi, L., Sigaud, M., Nekaris, K.A.I., Winarni, NL & Supriatna, J. (2018). Feeding position preferences of Javan slow loris (*Nycticebus javanicus* E. Geoffroy, 1812) at Talun Cipaganti Village, Garut, West Java. in Z Rohmah, L Hidayati, T Arisuryanti, Maryani & GR Aristya (eds), Inventing Prosperous Future through Biological Research and Tropical Biodiversity Management: Proceedings of the 5th International Conference on Biological Science., 020020, AIP Conference Proceedings, vol. 2002, American Institute of Physics Inc., 5th International Conference on Biological Science: Inventing Prosperous Future through

Biological Research and Tropical Biodiversity Management, ICBS 2017, Yogyakarta, Indonesia, 15/09/17. doi: https://doi.org/10.1063/1.5050116.

Feltrer, Y., & Pocknell, A. (2014). Ovarian dysgerminoma in a Pygmy slow loris *Nycticebus pygmaeus*: a case report with clinical follow-up. International Zoo Yearbook, 48(1), 212-217.

Feng, Q., Wang, Y.X. and Li, C.Y., (1992). Mother–infants interactions in captive middle slow loris *(Nycticebus intermedius)*. Acta Theriol. Sinica, 12, pp.167-174.

Feng, Q., Wang, Y., Li, C. (1992). Reproduction of slow loris *(Nycticebus intermedius)* in captivity. Dongwuxue Yanjiu/Zool Res 14: 21-26.

Feng, Q., Wang, Y. and Li, C. (1994). Progress of studies on intermediate slow loris in captivity. Chinese Primate Research 3: 11-12.

Ferguson, G. W., Brinker, A. M., Gehrmann, W. H., Bucklin, S. E., Baines, F. M., & Mackin, S. J. (2010). Voluntary exposure of some western-hemisphere snake and lizard species to ultraviolet-B radiation in the field: how much ultraviolet-B should a lizard or snake receive in captivity?. Zoo Biology, 29(3), 317-334.

Finley, R. B. (1959). Observation of nocturnal animals by red lights. Journal of Mammalogy, 40(4), 591-594.

Fitch-Snyder, H., Schulze, H. (2001). Management of Lorises in Captivity A Husbandry Manual for Asian Lorisines (*Nycticebus* & *Loris* ssp.). Center for Reproduction of Endangered Species (CRES) Zoological Society of San Diego.

Fitch-Snyder, H. and Jurke, M., (2003). Reproductive patterns in pygmy lorises *(Nycticebus pygmaeus)*: Behavioral and physiological correlates of gonadal activity. Zoo Biology: Published in affiliation with the American Zoo and Aquarium Association, 22(1), pp.15-32.

Fitch-Snyder, H., Schulze, H., Streicher, U. (2008). Enclosure design for captive slow and pygmy lorises.

Fitch-Snyder, H. 23 Husbandry and Reproductive Management Recommendations for Captive Lorises and Pottos (*Nycticebus, Loris* and *Perodicticus*). In: Nekaris, K.A.I. and Burrows, A.M. eds., (2020). Evolution, Ecology and Conservation of Lorises and Pottos' (Vol. 86). Cambridge University Press.

Fooden, J. (1991). Eastern limit of distribution of the slow loris, *Nycticebus coucang*. International Journal of Primatology 12(3): 287-290.

Frederick, C. and Fernandes, D. (1994). Increased activity in a nocturnal primate through lighting manipulation: the case of the Potto *Perodicticus potto*. International Zoo Yearbook, 33(1), pp.219-228.

Frias, L., Hasegawa, H., Stark, D. J., Lynn, M. S., Nathan, S. K., Chua, T. H., ... & MacIntosh, A. J. (2019). A pinworm's tale: The evolutionary history of *Lemuricola (Protenterobius) nycticebi*. International Journal for Parasitology: Parasites and Wildlife, 8, 25-32.

Fuller, G., Kuhar, C.W., Dennis, P.M. and Lukas, K.E. (2013). A Survey of Husbandry Practices for Lorisid Primates in North American Zoos and Related Facilities. Zoo Biology, 32(1), pp.88-100.

Fuller, G. (2014). The night shift: lightning and nocturnal strepsirrhine care in zoos. Case Western Reserve of Biology.

Fuller, G., Raghanti, M.A., Dennis, P.M., Kuhar, C.W., Willis, M.A., Schook, M.W. and Lukas, K.E. (2016). A comparison of nocturnal primate behavior in exhibits illuminated with red and blue light. Applied Animal Behaviour Science, 184, pp.126-134.

Gacad, M.A., Deseran, M.W. and Adams, J.S. (1992). Influence of ultraviolet B radiation on vitamin D3 metabolism in vitamin D3-resistant New World primates. American Journal of Primatology, 28(4), pp.263-270.

Gardiner, M., Weldon, A., Poindexter, S. A., Gibson, N., & Nekaris, K. A. I. (2018). Survey of practitioners handling slow lorises (Primates: *Nycticebus*): An assessment of the harmful effects of slow loris bites. Journal of venom research, 9, 1.

Glanville, EJ & Seebacher, F. (2010). Plasticity in body temperature and metabolic capacity sustains winter activity in a small endotherm *(Rattus fuscipes)*. Comp. Biochem. Physiol. A155(3), 383-391.

Groves, C. P. (1971). Systematics of the genus *Nycticebus*. In: J. Biegert and R. W. Leutenegge (eds), Taxonomy, anatomy, reproduction. Proceedings of the third international congress of primatology, pp. 44-53. S. Karger, Basel, Switzerland.

Groves, C. P. (2001). Primate taxonomy. Smithsonian Institution Press, Washington, DC, USA.

Groves, C., Maryanto, I. (2008). Craniometry of slow lorises (genus *Nycticebus*) of insular Southeast Asia. In Shekelle, M., Maryano, T., Groves, C., Schulze, H., Fitch-Snyder, H. (eds.). Primates of the Oriental Night. West Java, Indonesia: LIPI Press. 115–122. ISBN 978-979-799-263-7.

Harvey, E. S., Butler, J. J., McLean D. L., Shand, J. (2012). Contrasting habitat use of diurnal and nocturnal fish assemblages in temperate Western Australia. Journal of Experimental Marine Biology and Ecology, 426, 78-86.

Harrison, J. (1955). The Apes and Monkeys of Malaya (including the Slow Loris). Singapore: Malayan Museum Pamphlets, Government Printing Office.

Henton, R. (2000). The lifestyle of the loris: an investigation into the activity and husbandry of pygmy slow lorises (*Nycticebus pygmaeus*) at Paignton Zoo Environmental Park. In Proceedings of the 2nd Annual Symposium on Zoo Research, Paignton Zoo Environmental Park, Paignton, Devon, UK, 6-7th July 2000 (pp. 43-46). Federation of Zoological Gardens of Great Britain and Ireland.

Hoelzl, F., Bieber, C., Cornils, J.S., Gerritsmann, H., Stalder, G.L. & Walzer, C. (2015): How to spend the summer? Free-living dormice (*Glis glis*) can hibernate for 11 months in non-reproductive years. J Comp. Physiol. B185(8), 931-939.

Hoy, J. M., Murray, P., Tribe A. (2010). Thirty Years Later: Enrichment Practices for Captive Mammals. Zoo Biology 29 : 303–316.

Hunter, J. J., Morgan, J. I., Merigan, W. H., Sliney, D. H., Sparrow, J. R., Williams, D. R. (2012). The susceptibility of the retina to photochemical damage from visible light. Progress in Retinal and Eye Research, 31(1), 28-42.

Indrawan, M., Rangkuti, F. (2001). Status des Natuna-Langurs auf den Natuna Inseln. *ZGAP Mitteilungen*. 17(2). 20-21.

IUCN/SSC (2013). Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission, viiii + 57 pp.

Ivanova, E., Spiridonov, S., & Bain, O. (2007). Ocular oxyspirurosis of primates in zoos: intermediate host, worm morphology, and probable origin of the infection in the Moscow zoo. Parasite, 14(4), 287-298.

Izard, M. K., Weisenseel, K. A., Ange, R. L. (1988). Reproduction in the slow loris (*Nycticebus coucang*). American Journal of Primatology. 16(4). 331 339. doi:10.1002/ajp.1350160405.

Izard, M., & Weisenseel, K. (1989). Comparative reproduction of the *Lorisidae*. American Journal of Primatology, 18,140.

Jolly, A. (1973). Primate birth hour. International Zoo Yearbook, 13(1), 391–397. doi:10.1111/j.1748-1090.1973.tb02188.x.

Jurke, M.H., Czekala, N.M., Jurke, S., Hagey, L.R., Lance, V.A., Conley, A.J. and Fitch-Snyder, H. (1998). Monitoring pregnancy in twinning pygmy loris (*Nycticebus pygmaeus*) using fecal estrogen metabolites. American journal of primatology, 46(2), pp.173-183.

Kavanau, J.L. and Peters, C.R. (1976). Activity of nocturnal primates: influences of twilight zeitgebers and weather. Science, 191(4222), pp.83-86.

Kavanau, J.L. and Peters, C.R. (1979). Illuminance preferences of nocturnal primates. Primates, 20(2), pp.245-258.

Kawamura, S. and Kubotera, N. (2004). Ancestral loss of short wave-sensitive cone visual pigment in lorisiform prosimians, contrasting with its strict conservation in other prosimians. Journal of Molecular Evolution, 58(3), pp.314-321.

King, J. O., King, D. T. (1994). In my experience: Use of a long-distance night vision device for wildlife studies. Wildlife Society Bulletin (1973-2006), 22(1), 121-125.

Koli, V. K., Bhatnagar, C. (2016). Seasonal variation in the aktivity budget of Indian giant flying squirrel (*Petaurista philippensis*) in tropical deciduous forest, Rajasthan, India. Folia Zoologica, 65(1), 38-46.

Krane, S., Itagaki, Y., Nakanishi, K., & Weldon, P. J. (2003). Venom" of the slow loris: sequence similarity of prosimian skin gland protein and Fel d1 cat allergen. Naturwissenschaften, 90(2), 60-62.

Kuhar, C. W., Fuller, G. A., & Dennis, P. M. (2013). A survey of diabetes prevalence in zoo-housed primates. Zoo Biology, 32(1), 63-69.

Lall, G.S., Revell, V.L., Momiji, H., Al Enezi, J., Altimus, C.M., Güler, A.D., Aguilar, C., Cameron, M.A., Allender, S., Hankins, M.W. and Lucas, R.J. (2010). Distinct contributions of rod, cone, and melanopsin photoreceptors to encoding irradiance. Neuron, 66(3), pp.417-428.

Larson, L.C. et al. (2001). Management of Lorises in Captivity. A Husbandry Manual for Asian Lorisines (*Nycticebus* and *Loris ssp*.) Center for Reproduction in Endangered Species (CRES), Zoological Society of San Diego. San Diego.

Lopez, J., Wormell, D. and Rodriguez, A. (2001). Preliminary evaluation of the efficacy and safety of a UVB lamp used to prevent metabolic bone disease in pied tamarins Saguinus bicolor at Jersey Zoo. Dodo 37, pp. 41 – 49.

Lydekker, R. (1904). On two lorises. Proceedings of the Zoological Society of London, Vol (2), pp 345 - 346.

MacKinnon, J. and MacKinnon, K. (1987). Conservation and status of the primates of the Indo-Chinese subregion. Primate Conservation 8: 187-195.

Madani, G., & Nekaris, K. (2014). Anaphylactic shock following the bite of a wild Kayan slow loris (*Nycticebus kayan*): implications for slow loris conservation. Journal of venomous animals and toxins including tropical diseases, 20, 02-05.

Maple, T., & Perdue, B. M., (2013). Environmental enrichment. In T. Maple, & B. M. Perdue (Eds.), Animal welfare. (pp. 95–117). New York: Springer, vol. 14.

Maynard, K. Q., Birot, H., Campera, M., Imron, M. A., del Toro, C. J., Poindexter, S. A., & Nekaris, K. A. I. (2021). Slow learning of feeding skills in a nocturnal extractive forager. Animal Behaviour, 173, 1-7.

Mellor, D.J. and Beausoleil, N.J., 2015. Extending the 'Five Domains' model for animal welfare assessment to incorporate positive welfare states. Anim. Welf, 24(3), p.241.

Mellor, D. J., Hunt, S. & Gusset, M. (eds) (2015). Caring for Wildlife: The World Zoo and Aquarium Animal Welfare Strategy. Gland: WAZA Executive Office, 87 pp.

Moore, R.S., (2012). Ethics, ecology and evolution of Indonesian Slow Lorises (*Nycticebus spp.)* rescued from the pet trade. PhD thesis, Oxford Brookes University.

Moore, R. S., Wihermanto, N. K., Nekaris, K. A. I. (2014). Compassionate conservation, rehabilitation and translocation of Indonesian slow lorises. Endangered Species Research 26: 93-102.

Munds, R.A., Nekaris, K.A.I. and Ford, S.M. (2013). Taxonomy of the Bornean slow loris, with new species *Nycticebus kayan* (*Primates, Lorisidae*). American journal of primatology 75(1): 46-56. doi:10.1002/ajp.22071.

Navara, K.J. and Nelson, R.J. (2007). The dark side of light at night: physiological, epidemiological, and ecological consequences. Journal of pineal research, 43(3), pp.215-224.

Nekaris, K.A.I. and Jaffe, S. (2007). Unexpected diversity within the Javan slow loris trade: implications for slow loris taxonomy. Contributions to Zoology 76: 187-196.

Nekaris, A. & Streicher, U. (2008). *Nycticebus menagensis*. The IUCN Red List of ThreatenedSpecies 2008:e.T39760A10263652.doi: https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T39760A10263652.en. Downloaded on 01 June 2020.

Nekaris, A., Streicher, U. (2008). *Nycticebus coucang*. The IUCN Red List of Threatened Species 2008:e.T39759A10263403. doi: https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T39759A10263403.en. Downloaded on 26 April 2020.

Nekaris, K.A.I., Munds, R. (2010). Chapter 22: Using facial markings to unmask diversity: the slow lorises (*Primates*: *Lorisidae*: *Nycticebus spp.)* of Indonesia". In Gursky-Doyen, S.; Supriatna, J (eds.). Indonesian Primates. New York: Springer. 383–396. doi:10.1007/978-1-4419-1560-3_22. ISBN 978-1-4419-1559-7.

Nekaris K.A.I., Munds R.A. (2010). Using facial markings to unmask diversity: the slow lorises (*Primates: Lorisidae*: *Nycticebus*) of Indonesia. In: *The primates of Indonesia*. Gursky S., Supriatna J. (eds). New York: Springer, 383–396.

Nekaris KAI, Starr CR, Collins RL, et al. (2010). Comparative ecology of exudate feeding by lorises (*Nycticebus*, *Loris*) and pottos (*Perodicticus*, *Arctocebus*). In: Burrows AM, Nash LT, editors. The evolution of exudativory in primates. New York: Springer. p 155–168.

Nekaris K.A.I., Bearder S.K. (2011). The strepsirrhine primates of Asia and mainland Africa: diversity shrouded in darkness. In: Primates in Perspective. Campbell C., Fuentes A., MacKinnon K., Panger M., Bearder S.K. (eds) Oxford: Oxford University Press, 24–45.

Nekaris, K. A. & Pambudi, Aji & Ahmad, R. & Susanto, D. & Raharjo, B. & Nijman, V. (2013). Densities, Distribution and Detectability of a Small Nocturnal Primate (Javan Slow Loris *Nycticebus javanicus*) in a Montane Rainforest. Folia Primatologica. 84. 306-306.

Nekaris, K.A.I., Shekelle, M, Wirdateti, Rode, E.J. & Nijman, V. (2013). *Nycticebus javanicus*. The IUCN Red List of Threatened Species 2013: e.T39761A17971158. doi: https://dx.doi.org/10.2305/IUCN.UK.2013-2.RLTS.T39761A17971158.en. Downloaded on 26 April 2020.

Nekaris K.A.I. (2014). Extreme primates: Ecology and evolution of Asian lorises. Evolutionary Anthropology: Issues, News, and Reviews 23, 177–87.

Nekaris, K.A.I. (2014). Russell A. Mittermeier, Anthony B. Rylands, and Don E. Wilson (eds.). 2013. Handbook of the Mammals of the World: 3. Primates. Chapter Lorisiformes. Lynx Ediciones, Barcelona, Spain, 953 pp. ISBN: 978-84-96553-89-7

Nekaris K, Weldon A, Imron MA, Maynard KQ, Nijman V, Poindexter SA, Morcatty TQ (2019). Venom in furs: Facial masks as aposematic signals in a venomous mammal. Toxins. 11(2):93.

Nekaris, K.A.I., Al-Razi, H., Blair, M., Das, N., Ni, Q., Samun, E., Streicher, U., Xue-long, J. & Yongcheng, L. (2020). *Nycticebus bengalensis* (errata version published in 2020). The IUCN Red List of Threatened Species 2020:e.T39758A179045340. https://dx.doi.org/10.2305/IUCN.UK.20202.RLTS.T39758A179045340.en.

Nekaris K.A.I. & Burrows, A.M. (2020). Introduction: Overview of Lorises and Pottos. In, K.A.I. Nekaris and A.M. Burrows (eds.), Evolution, Ecology and Conservation of Lorises and Pottos (pp. 1-16). Cambridge University Press, Cambridge UK.

Nekaris K.A.I., Campera M, Nijman V, Birot H, Rode-Margono EJ, Fry BG, Weldon A, Wirdateti W, Imron M.A. (2020). Slow lorises use venom as a weapon in intraspecific competition. Current Biology. 2020 Oct 19;30(20): R1252-3.

Nekaris, K. A. I., Handby, V., Campera, M., Birot, H., Hedger, K., Eaton, J., & Imron, M. A. (2020). Implementing and monitoring the use of artificial canopy bridges by mammals and birds in an Indonesian agroforestry environment. Diversity, 12(10): 399.

Nekaris, K.A.I. & Marsh, C. (2020). *Nycticebus bancanus*. The IUCN Red List of Threatened Species 2020: e.T163015864A163015867. https://dx.doi.org/10.2305/IUCN.UK.20202.RLTS.T163015864A163015867.en.Downloaded on 08 September 2020.

Nekaris, K.A.I. & Miard, P. (2020). *Nycticebus borneanus*. The IUCN Red List of ThreatenedSpecies 2020:e.T163015906A163015915. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T163015906A163015915.en.

Nekaris, K.A.I. & Miard, P. (2020). *Nycticebus kayan*. The IUCN Red List of Threatened Species 2020:e.T163015583A163015849. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T163015583A163015849.en.

Nekaris, K.A.I., Miard, P. & Streicher, U. (2020). *Nycticebus menagensis*. The IUCN Red List of Threatened Species 2020:e.T163013860A17970781. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T163013860A17970781.en.

Nekaris, K. A. I., Munds, R. A., Pimley, E. R. (2020). Trapping, Collaring and Monitoring the Lorisinae of Asia *(Loris, Nycticebus*) and Perodicticinae (*Arctocebus, Peroducticus*) of Africa. Evolution, Ecology and Conservation of Lorises and Pottos. Cambridge University Press, 281-294.

Nekaris, K.A.I. & Poindexter, S. (2020). *Nycticebus hilleri*. The IUCN Red List of Threatened Species 2020:e.T163019804A163020000. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T163019804A163020000.en.

Nekaris, K.A.I., Poindexter, S. & Streicher, U. (2020). *Nycticebus coucang*. The IUCN Red List of Threatened Species 2020: e.T163017685A17970966. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T163017685A17970966.en.

Nekaris, K. A.I., Nijman, V. (2022). A new genus name for pygmy lorises, *Xanthonycticebus* gen. nov. (Mammalia, Primates), Zoosyst. Evol. 98 (1) 2022, 87–92

Nijman V, Spaan D, Rode-Margono EJ, Wirdateti, Nekaris KAI (2015). Changes in the primate trade in Indonesian wildlife markets over a 25-Year period: less apes and langurs, more macaques and slow lorises. American Journal of Primatology DOI: 10.1002/ajp.22517.

NRC (National Research Council) (2003). Nutrient requirements of nonhuman primates, 2nd revised edition. WDC, USA: The National Academies Press.

Oonincx, D.G.A.B. and Van der Poel, A.F.B. (2011). Effects of diet on the chemical composition of migratory lcousts (*Locusta migratoria*). Zoo Biology, 30(1), 9-16.

Parker, I. D., Watts, D. E., Lopez, R. R., Silvy, N. J., Davis, D. S., McCleery, R. A., Frank, P. A. (2008) Evaluation of the efficacy of Florida Key deer translocations. J Wildl Manag 72: 1069−1075.

Payne, J., Francis, C.M. and Phillipps, K. (1985). A field guide to the mammals of Borneo. The Sabah Society and WWF Malaysia, Kota Kinabalu and Kuala Lumpur, Malaysia.

Peng, M. L., Tsai C. Y., Chien, C. L., Hsiao, J. C. J., Huang, S. Y., Lee C. J., ….., Tseng, K. W. (2012). The influence of low-powered family LED lighting on eyes in mice experimental model. Life Sciences Journal, 9(1), 477-482.

Pliosungnoen, M., Gale, G., & Savini, T. (2010). Density and microhabitat use of Bengal slow loris in primary forest and nonnative plantation forest. American Journal of Primatology, 72, 1108–1117.

Poindexter, S. A., & Nekaris, K. A. I. (2017). Vertical clingers and gougers: Rapid acquisition of adult limb proportions facilitates feeding behaviours in young Javan slow lorises (*Nycticebus javanicus*). Mammalian Biology, 87(1), 40-49.

Power, M.L., Oftedal, O.T., Tardif, S.D. and Allen, M.E. (1995), May. Vitamin D and primates: Recurring problems on a familiar theme. In Proceedings of the First Conference on Zoo and Wildlife Nutrition, AZA Nutrition Advisory Group, Scarborough, OT.

Putri, P.R.; Moore, R.S.; Andayani, N. & Sánchez, K.L. (2015). Effects of Environmental Enrichment on the Social Behaviour of Javan Slow Loris, *Nycticebus javanicus*. TAPROBANICA J. Asian Biodivers, 7, 29.

Rasmussen, DT., Izard, MK. (1988). Scaling of growth and life history traits relative to body size, brain size, and metabolic rate in lorises and galagos (*Lorisidae, Primates*). Am J Phys Anthropol 75:357–367.

Ratajszczak, R. (1998). Taxonomy, distribution and status of the lesser slow loris *Nycticebus pygmaeus* and their implications for captive management. Folia Primatologica 69: 171-174.

Ratajszczak, R. (2004). The European Lesser slow Loris *Nycticebus pygmaeus* studbook; Poznan July 2004

Ravosa, M. (1998). Cranial allometry and geographic variation in slow lorises (*Nycticebus*). American Journal of Primatology 45: 225-243.

Redman, J.F. (1979). Effect of light on the circadian activity rhythm of the slow loris, *Nycticebus coucang*. Thesis. Stockton (CA): University of the Pacific.

Reinhardt, K.D., Vyazovskiy, V.V., Hernandez-Aguilar, R.A., Imron, M.A. and Nekaris, K.A.I., 2019. Environment shapes sleep patterns in a wild nocturnal primate. Scientific reports, 9(1), pp.1-13.

Remick, A. K., Van Wettere, A. J., & Williams, C. V. (2009). Neoplasia in prosimians: case series from a captive prosimian population and literature review. Veterinary Pathology, 46(4), 746-772.

Rode-Margono, E. J., Nijman, V., Wirdateti, W., & Nekaris, K. A. I. (2014). Ethology of the Critically Endangered Javan slow loris *Nycticebus javanicus* E. Geoffroy Saint-Hilaire in West Java. Asian Primates, 4, 27–41.

Rode-Margono, E.J. and Nekaris, K.A.I. (2014). Impact of climate and moonlight on a venomous mammal, the Javan slow loris (*Nycticebus javanicus* Geoffroy, 1812). Contributions to zoology, 83(4), pp.217-225.

Rode-Margono, E. J., Albers, M., Wirdateti, W., Abinawanto, A., & Nekaris, K. A. I. (2015). Gastrointestinal parasites and ectoparasites in wild Javan slow loris (*Nycticebus javanicus*), and implications for captivity and animal rescue. Journal of Zoo and Aquarium Research, 3(3), 80-86.

Rode-Margono, J., & Nekaris, K. (2015). Cabinet of curiosities: venom systems and their ecological function in mammals, with a focus on primates. Toxins, 7(7), 2639-2658.

Rogers, L.D. and Nekaris, K.A.I. (2011). Behaviour and habitat use of the Bengal slow loris *Nycticebus bengalensis* in the dry dipterocarp forests of Phnom Samkos Wildlife Sanctuary, Cambodia. Cambodian Journal of Natural History, 2011(2), pp.104-133.

Roos, C. (2003). Molekulare Phylogenie der Halbaffen, Schlankaffen, und Gibbons. Technischen Universität.

Ruf, T., Streicher, U., Stalder, G., Nadler T., & Walzer Ch. (2015). Hibernation in the pygmy slow loris (*Nycticebus pygmaeus*): multiday torpor in primates is not restricted to Madagascar. Scientific RepoRts.

Ruf, T & Geiser, F. (2015). Daily torpor and hibernation in birds and mammals. Biol. Rev.90, 891-926.

Sand, C. M. G. (2016). Towards a successful translocation of captive slow lorises (*Nycticebus spp.)* in Borneo: a review and recommendations. BioRxiv The Preprint Server For Biology.

Schneiderová, I., Vodička, R. (2021). Bioacoustics as a tool to monitor the estrus cycle in a female slow loris (*Nycticebus sp.).* Zoo Biology, 1–9.

Schrenzel, M. D., Witte, C. L., Bahl, J., Tucker, T. A., Fabian, N., Greger, H., Hollis, C., Hsia, G., Siltamaki, E., & Rideout, B. A. (2010). Genetic characterization and epidemiology of Helicobacters in non-domestic animals. Helicobacter, 15(2), 126-142.

Shepherd, C. R. (2010). Illegal primate trade in Indonesia exemplified by surveys carried out over a decade in North Sumatra. Endangered Species Research. 11. 201-205.

Silva, L. M., Voelker, I., Geiger, C., Schauerte, N., Hirzmann, J., Bauer, C., Taubert, A., & Hermosilla, C. (2021). *Pterygodermatites nycticebi* infections in golden lion tamarins (*Leontopithecus rosalia rosalia*) and aye-ayes (*Daubentonia madagascariensis*) from a German zoo. Zoo Biology, 40(1), 59-64.

Simpson, G. M., Fuller, G., Lukas, K. E., Kuhar, C. W., Fitch-Snyder, H., Taylor, J., & Dennis, P. M. (2018). Sources of morbidity in lorises and pottos in North American zoos: A retrospective review, 1980–2010. Zoo biology, 37(4), 245-257.

Smith, A. C. (2010). Exudativory in primates: Interspecific patterns. In A. Burrows & L. Nash (Eds.), The evolution of exudativory in primates (pp. 25–44). New York: Springer Science+Business Media

Snyder, H. F., & Schulze, H. (2001). Management of Lorises in Captivity, a Husbandry manual for Asian Lorisines (*Nycticebus* & *Loris ssp.).* Centre for Reprd. of Endangered Species- Zoological Soc. of San Diego, USA.

Starr, C.R., Nekaris, K.A.I., Streicher, U., Leung, L. (2011). Field surveys of the threatened pygmy slow loris (*Nycticebus pygmaeus*) using localknowledge in Mondulkiri Province, Cambodia. *Oryx* 45: 135–142.

Starr, C., Nekaris, K.A.I. and Leung, L. (2012). Hiding from the moonlight: luminosity and temperature affect activity of Asian nocturnal primates in a highly seasonal forest. PloS one, 7(4), p.e36396.

Starr, C.R., Nekaris, K.A.I. (2013). Obligate exudativory characterizes the diet of the pygmy slow loris *Nycticebus pygmaeus*. American Journal of Primatology 75: 1054–1061.

Stetter, M. D., Worley, M. B., & Ruiz, B. (1995). Herpesvirus-associated malignant lymphoma in a slow loris (*Nycticebus coucang*). Journal of Zoo and Wildlife Medicine, 155-160.

Streicher, U., Nadler, T. (2003). Re-introduction of pygmy lorises in Vietnam. Reintroduction News 23: 37-40.

Streicher, U. (2004). Aspects of the ecology and conservation of the pygmy loris *Nycticebus pygmaeus* in Vietnam. Inaugural-Dissertation, Ludwig-Maximilians Universität.

Streicher, U. (2005). Seasonal Body Weight Changes in Pygmy Lorises *(Nycticebus pygmaeus).* Verhber. Erkrg. Zootiere 42, 292–298.

Streicher, U., Ngoc Thanh, V., Nadler, T., Timmins, R.J. & Nekaris, A. (2008). *Nycticebus pygmaeus*. The IUCN Red List of Threatened Species 2008: e.T14941A4481461. https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T14941A4481461.en. Downloaded on 24 May 2020.

Streicher, U., Singh, M., Timmins, R.J. & Brockelman, W. (2008). *Nycticebus bengalensis*. The IUCN Red List of Threatened Species 2008:e.T39758A10263081. https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T39758A10263081.en. Downloaded on 22 June 2020.

Streicher, U. (2009). Diet and feeding behaviour of pygmy lorises (*Nycticebus pygmaeus*) in Vietnam. Vietnamese Journal of Primatology 3: 37–44.

Streicher, U., Wilson, A., Collins, R.L., Nekaris, K.A.I. (2013). Exudates and animal prey characterize slow loris (*Nycticebus pygmaeus, N. coucang* and *N. javanicus*) diet in captivity and after release into the wild. In: Leaping Ahead: Advances in Prosimian Biology. Masters J., Genin F., Crompton R. (eds). New York: Springer, 165–172.

Streicher, U., Nowack, J., Stalder, G., Walzer, Ch., Nadler T., and Ruf T. (2017). Hibernation in pygmy lorises (*Nycticebus pygmaeus*) –what does it mean? Vietnamese Journal of Primatology vol.2(5), 51-57.

Surridge, A.K., Osorio, D. and Mundy, N.I. (2003). Evolution and selection of trichromatic vision in primates. Trends in Ecology & Evolution, 18(4), pp.198-205.

Svensson, M.S., Nekaris, K.A.I., Bearder, S.K., Bettridge, C.M., Butynski, T.M., Cheyne, S.M., Das, N., de Jong, Y.A., Luhrs, A.M., Luncz, L.V. and Maddock, S.T. (2018). Sleep patterns, daytime predation, and the evolution of diurnal sleep site selection in lorisiforms. American journal of physical anthropology, 166(3), pp.563-577.

Swapna, N., Radhakrishna, S., Gupta, A. K., & Kumar, A. (2010). Exudativory in the Bengal slow loris (*Nycticebus bengalensis*) inTrishna Wildlife Sanctuary, Tripura, Northeast India. American Journal of Primatology, 72, 113–121.

Tan, C.L. (1994). Survey of *Nycticebus pygmaeus* in southern Vietnam. XVth Congress International Primatological Society: 136.

Tan C.L., Drake J.H. (2001) Evidence of tree gouging and exudate eating in pygmy slow lorises (*Nycticebus pygmaeus*). Folia Primatologica 72: 37–39.

Teleki, G. (2001). Sanctuaries for ape refugees. In: Beck BB (ed) Great apes & humans: the ethics of coexistence. Smithsonian Institution Press, Washington, DC, 133−149.

Tenaza, R., Ross, B.A., Tanticharoenyos, P. and Berkson, G. (1969). Individual behaviour and activity rhythms of captive slow lorises (*Nycticebus coucang*). Animal Behaviour, 17(4), pp.664-669.

Timm, R.M. and Birney, E.C. (1992). Systematic notes on the Philippine slow loris, *Nycticebus coucang menagensis* (Lydekker, 1893) (*primates, Lorisidae*). International Journal of Primatology 13(6): 679–686.

Trent, B.K., Tucker, M.E. and Lockard, J.S. (1977). Activity changes with illumination in slow loris *Nycticebus coucang*. Applied Animal Ethology, 3(3), pp.281-286. Uhl, E.W. (2018). The pathology of vitamin D deficiency in domesticated animals: an evolutionary and comparative overview. International journal of paleopathology, 23, pp.100-109.

Ullrey, D.E. and Bernard, J.B. (1999). Vitamin D: metabolism, sources, unique problems in zoo animals, meeting needs. Zoo and Wild Animal Medicine, 4th ed. WB Saunders Co., Philadelphia, Pennsylvania, pp.63-68.

Van Bolhuis, H. (2020). Prosimii. EAZA RMG factsheet.

Van Geffen, K. G., van Grunsven, R. H., van Ruijven, J., Berendse, F., Veenendaal, E. M. (2014). Artificial light at night causes diapause inhibition and sex-specific life history chNGES IN A MOTH. Ecology and Evolution, 4(11), 2082-2089.

Voskamp A, Rode EJ, Coudrat CNZ, Wirdateti A, Wilson RJ, Nekaris KAI. (2014) Modelling the habitat use and distribution of the threatened Javan slow Loris *Nycticebus javanicus*. Endanger Species Res. 2014; 23:277–86.

Wickins-Dražilová, D. (2006). Zoo animal welfare. J Agric Environ Ethics 19: 27−36.

Wiens, F. (2002). Behavior and ecology of wild slow lorises (*Nycticebus coucang*): social organization, infant care system, and diet. Ph.D. thesis, Bayreuth University, Bayreuth.

Wiens, F., Zitzmann, A., & Hussein, N. A. (2006). Fast food for slow lorises: Is low metabolism related to secondary compounds in high-energy plant diet? Journal of Mammal Evolution, 87, 790– 798.

Williams, C. V., & Junge, R. E. (2014). Prosimians. Zoo animal and wildlife immobilization and anesthesia, 551-559.

Williams, E., Cabana, F., Nekaris, K. A. I. (2015). Improving diet and activity of insectivorous primates in captivity: Naturalizing the diet of Northern Ceylon gray slender loris, *Loris lydekkerianus nordicus.* Zoo Biology, 34(5), 473-482

Wilson, D.E. & Mittermeier, R.A., eds. (2018). Handbook of the Mammals of the World. Vol. 8. Insectivores, Sloths and Colugos. Lynx Edicions, Barcelona.

Withaningsih, Susanti & Parikesit, Pampang & Ayundari, Astrini & Prameswari, Ghitaswati & Megantara, Erri & Husodo, Teguh. (2018). Distribution and habitat of Javan slow loris (*Nycticebus javanicus* É. Geoffroy, 1812) in non-conservation area. AIP Conference Proceedings. 2019. 060006. doi: 10.1063/1.5061915.

Yamanashi, Y.; Nemoto, K. & Alejandro, J. (2021). Social Relationships Among Captive Male Pygmy Slow Lorises (*Nycticebus pygmaeus*): Is Forming Male Same-Sex Pairs a Feasible Management Strategy? Am. J. Primatol, 83.

Yeager, C. P., Silver, S. C. (1999). Translocation and rehabilitation as primate conservation tools: Are they worth the cost? In: Dolhinow P, Fuentes A (eds) The nonhuman primates. Mayfield Publishing, Mountain View, CA, 164−169.

Zadrozny, L. M., Williams, C. V., Remick, A. K., & Cullen, J. M. (2010). Spontaneous hepatocellular carcinoma in captive prosimians. Veterinary pathology, 47(2), 306-311.

Zimmermann, E. (1989). Reproduction, physical growth and behavioral development in slow loris (*Nycticebus coucang, Lorisidae*). Human Evolution, 4(2-3), 171–179. doi:10.1007/bf02435445

Zuckerman, S. (1932). The Menstrual Cycle of the Primates – Part VI. Further Observations on the Breeding of Primates, with special reference to the Suborders *Lemuroidea* and *Tarsioidea*. Proceedings of the Zoological Society of London, 102(4), 1059–1075. doi:10.1111/j.1096-3642.1932.tb01576.x

(Primates,Lorisidae).https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T39758A10263081.en.

https://www.iucnredlist.org/species/39758/179045340#habitat-ecology

https://www.iucnredlist.org/species/163015906/163015915#bibliography

https://www.iucnredlist.org/species/163019804/163020000#bibliography

Section 4: Appendices

Appendix 1

JAVAN SLOW LORIS ETHOGRAM

Adapted from Fitch-Snyder & Ehrlich (2003), Nekaris (2001) and Schulze and Meier 1995

MAIN BEHAVIOURS		
Alert	**AL**	Remain stationary like in "rest" but active observation of environment or observer
Freeze	**FR**	Interrupt locomotion to maintain motionless, rigid posture in standing or sitting position for at least three seconds, extremely slow movement not associated with foraging
Exploring	**EX**	Movement associated with looking for food (often includes visual and olfactory searching) or exploring the habitat
Feeding	**FE**	Actual consumption of a food item
Rest	**RE**	Remain stationary, often with body hunched, eyes open
Sleep	**SL**	Remain stationary, head between the knees, eyes closed
Travel	**TR**	Continuous, directed movement from one location to another

Groom	**GR**	Autogroom, lick or use tooth comb on own fur
Social	**SO**	All interactions with conspecifics, including aggression, allogroom, play and other social behaviours. EXCEPT PROXIMITIES
Other	**OT**	Other behaviour not included in ethogram
Out of Sight	**OS**	Individual cannot be seen, and the signal of collar is not strong
Eyeshine	**ES**	No discernible behaviour, only eyeshine is visible or observers are sure of the loris location (signal of collar very strong)

ACTIVITY		
Active	AC	Locomoting or remaining in the same position but engaged in an activity (being alert, feeding, foraging, grooming, social behaviour…)
Inactive	IN	Resting, sleeping, sitting or standing motionless and unalert for more than a few seconds around the data point

INDIVIDUAL PROXIMITY		
Neutral Proximity	NP	Individuals are close to each other <20 m but don't show any sign of interest to each other
Affiliative Proximity	AFP	Individuals are <20 m to each other and demonstrate interest to each other
Agonistic Proximity	AGP	Individual are <20 m to each other and show agonistic interest to each other

SOCIAL BEHAVIOURS		
AFFILIATIVE BEHAVIOUR		
Approach	**AP**	Focal moves within 0.5 m of another individual
Being Approached	**BAP**	Focal is approached within 0.5 m by another individual
Depart	**DE**	Focal moves out of 0.5 m proximity with another individual
Being Left	**BLF**	Focal is being left out of 0.5 m by another individual
Lead	**LE**	Another individual follows the focal individual
Follow	**FW**	Focal follows another individual
Allogroom	**AM**	Lick or use tooth comb on another individual's fur
Receive Grooming	**RG**	Focal is groomed by another individual
Social grooming	**SG**	Involved in grooming behaviour with another individual but the direction of the grooming is unknown
Passive Contact	**PC**	Focal individual is in contact with another individual, but they are not engaged in any other social behaviour
Huddle	**HU**	Focal hunched in resting or sleeping position in contact with another individual
Play	**PL**	Focal engaged in mock fighting (low intensity biting, hitting, clasping, with no agonistic vocalisations or intent)
Mate	**MA**	Focal copulates with another individual
Attempting contact	**ATC**	Focal attempts physical or vocal behaviour to another individual

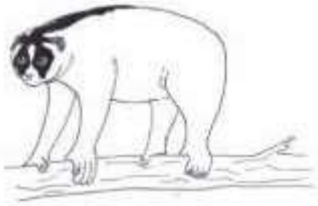
Reject	**RJ**	Focal pushes away and/or ignores physical and vocal behaviour of another individual
Affiliative Vocalisation	**VO**	Non-agonistic vocalisations e.g. contact calls
Scent Mark	**SM**	Rub scent glands on substrate (scent glands located on cheeks, anogenital area, and chest). TAKE AN ACCURATE GPS POINT TO MARK THE TREE
Olfactory Searching	**OL**	Sniffing intently on substrate, presumably for scent marks. TAKE AN ACCURATE GPS POINT TO MARK THE TREE
AGONISTIC BEHAVIOUR		
Agonistic Vocalisation	**AV**	Aggressive or submissive vocalisations e.g. growling
Submission	**SU**	Respond to aggression in submissive manner e.g. lowering head and turning body away, fleeing, backing away while maintaining eye contact with another individual
Fight	**FI**	Attack, bite, hit, push, and grapple vigorously
Chase	**CS**	Vigorously pursuing a fleeing individual with intent to attack
Flee	**FL**	Retreat from predator or conspecific threat
INDIVIDUAL-INFANT		
Individual Teach Foraging	**TF**	Another individual shows infant how to forage for food
Infant Learn Foraging	**ILF**	Infant observes or imitates another individual to learn foraging
Park	**PA**	Another individual leaves infant unattended. SPECIFY POSITION IN TREE
Infant being parked	**IPA**	Infant is parked by another individual
Carry	**CA**	Another individual carries an infant
Infant being carried	**ICA**	Infant is carried by another individual
VOCALISATION		
Kekker		
Chitter		
Growl		
Whistle		
Scream		Infant zic or tskk

POSTURE		
FOCAL POSTURE		
Sit	**SI**	Remain stationary with body hunched and head erect
Stand	**ST**	Remain stationary supported on all fours limbs (extended)
Sleeping Ball	**SB**	Remain stationary with body hunched and head erect, head between the knees
Venom Pose	**VP**	Place arms over head exposing brachial glands
Horizontal Suspension 1	**H1**	Hanging from one foot (rare but can occur when playing)
Horizontal Suspension 2	**H2**	Hanging from two feet or bipedal standing
Horizontal Suspension 3	**H3**	Hanging from three feet
Horizontal Suspension 4	**H4**	Hanging from four feet
Vertical Suspension 2	**V2**	Hanging towards the side of a support, with 2 feet (e.g. when foraging/observing)
Vertical Suspension 3 (up or down)	**V3U** **V3D**	Hanging towards the side of a support, with 3 feet, either facing upwards or downwards
Vertical Suspension 4 (up or down)	**V4U** **V4D**	Hanging towards the side of a support, with 4 feet, either facing upwards or downwards

BABY POSTURE		
Been Carried Dorsally	**ICD**	Baby is carried on back of another individual
Been Carried Ventrally	**ICV**	Baby is carried on front of another individual
Infant on teat	**IOT**	Infant on teat, whether suckling or not

Sit (SI)

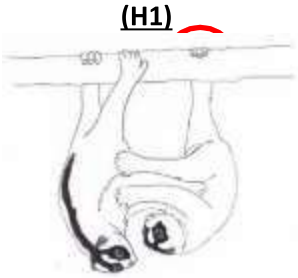
Stand (ST)



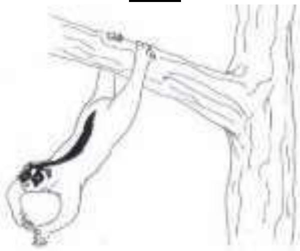
Sleeping Ball (SB)

Venom pose (VP)

Horizontal Suspension 1 (H1)



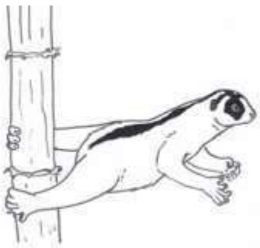
Horizontal Suspension 2 (H2)



Horizontal Suspension 3 (H3)

Horizontal Suspension 4 (H4)

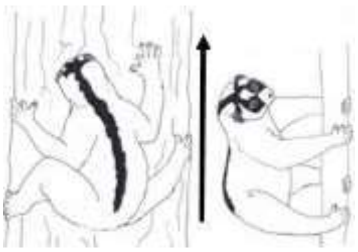
Vertical Suspension 2 (V2)



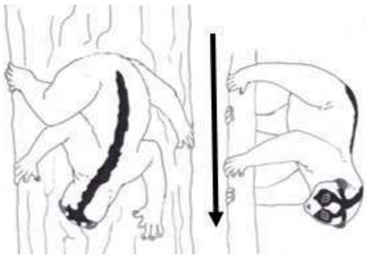
Vertical Suspension 3 up or down V3U/V3D

Like vertical suspension 4 but just with 3 limbs attached

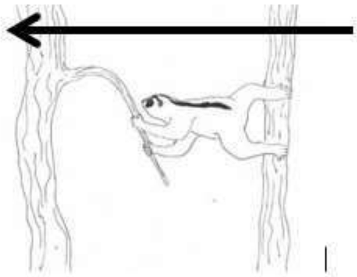
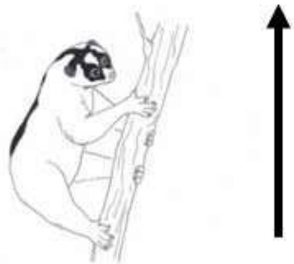
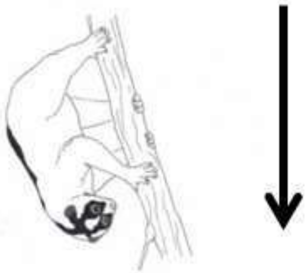
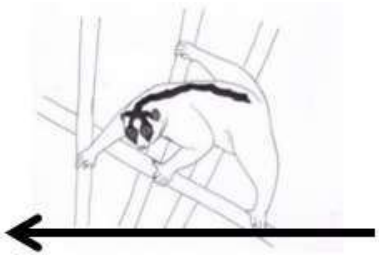
Vertical Suspension 4 Up (V4U)



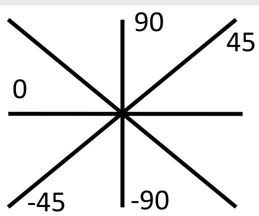
Vertical Suspension 4 Down (V4D)



LOCOMOTION		
Walk	**WA**	Quadrupedal walking on 0° to 45° degree support
Race Walk	**RW**	Fast quadrupedal walking on 0° to 45° degree support
Suspensory Walk	**SW**	Locomoting while hanging on 0° to -45° degree support
Bridge	**BG**	Climbing from one support to the next, (trunk or branches of same or different trees), stretching over a gap of more than 15 cm
Climb Up	**CU**	Moving upwards on +/-45° to +/-90° degree support
Climb Down	**CD**	Moving downwards on +/-45° to +/-90° support
Climb Horizontally	**CH**	Moving horizontally through 0° to +/-45° degree support

Walk (WA) **Race Walk (RW)**	**Suspensory Walk (SW)**	**Bridge (BG)**
		
Climb Up (CU)	**Climb Down (CD)**	**Climb Horizontally (CH)**
		

SUBSTRATE			
POSITION IN TREE			
Periphery	**PE**	In periphery leaves of tree, small branches, <2 m from last leaves	
Central	**CE**	In the centre of tree, >2 m from last leaves / half distance to last leaves for small tree	
Crown	**CW**	At top of tree, <2 m from the top / last quarter for small tree	
Undergrowth	**UG**	In bushes	
SUBSTRATE TYPE			**SUBSTRATE ANGLE**
Trunk	**TK**		0
Branch	**BR**		45
Terrestrial	**TE**		90
Waterline	**WL**		-45
Loris Bridge	**LB**		-90
Banana Leaf	**BA**		
Labu	**LA**		
SUBSTRATE SIZE			
Small	**1**	Smaller than the hand of a loris	
Medium	**2**	Up to twice the size of a loris hand	
Large	**3**	More than twice the size of a loris hand	



TREE CONNECTIVITY		
No	**0**	No immediate connection in the direction of travel
Yes	**1**	Immediate connection in the direction of travel

FEEDING		
FEEDING ITEM		
Gum	**GU**	# of seconds
Nectar	**NE**	# of flowers
Flower	**FS**	# of flowers
Insects	**IN**	# of insects
Fruit	**FT**	# of fruits
Vertebrate Prey	**VE**	# of seconds, SPECIFY THE SPECIES OF VERTEBRATE PREY
Bamboo Shoots	**BS**	# of shoots
Leaves	**LS**	# of leaves
Other	**OT**	# of other
FFEDING TECHNIQUE		
Mouth	**MO**	Only use mouth to catch insect or consume any other food source
Gouge	**GO**	Use lower incisors to access gum below bark
Grasp 1	**G1**	Bring food to mouth by grasping it with one hand (ONLY IF CANNOT IDENTIFY WHICH HAND IS USED)
Grasp Left Hand	**LH**	Bring food to mouth using only left hand
Grasp Right Hand	**RH**	Bring food to mouth using only right hand
Grasp 2	**G2**	Bring food to mouth by grasping it with two hands
Reel	**RL**	Bring food to mouth by reeling in terminal branches one hand over the other
FEEDING BRANCH		
Terminal	**TL**	Individual is feeding at the terminal of a branch
Central	**CE**	Individual is feeding in a trunk or central of a branch

Appendix 2

"Improving welfare of captive Pygmy slow loris by encouraging natural feeding behaviours"

Authors: Elana Barnes

Gum feeding methods

Gouging for gum consumes a large proportion of wild loris activity budget and diet acquisition serving nutritional and behavioural needs (Starr and Nekaris, 2013; Nekaris and Bearder, 2011). Gouging behaviour to acquire food resources is essential for survival of pygmy slow lorises in the wild that needs to be maintained in captive lorises if they are to serve as a backup population.

Different methods of gum presentation have been shown to affect gouging behaviour and feeding duration in captivity. Barnes (2022) offered variations of gum feeders using natural materials (logs and bamboo), with three designs (Figure 2), that get progressively more difficult for lorises to access gum, to increase the need for gouging.

***Figure 2**: Three different feeder designs using two natural materials that the loris would experience in the wild. (2a) Feeder 1, (2b) Feeder 2, (2c) Feeder 3*

Feeders:
Feeder 2a: log with multiple straight holes, 1.5 cm deep, 1cm wide.
Feeder 2b: log with 4 diagonally drilled holes, 4.5 cm deep, 1cm wide.
Feeder 2c: singular bamboo culm/cross section with 1 hole, 0.5 cm wide.

Findings:

- Lorises visited feeder 2b with diagonal holes most frequently, (~4-14) times a day, in comparison to the "easy" feeder 2a with straight holes (~2-4) and the "difficult" feeder 2c, the bamboo (~2-4).
- If the feeder is too difficult (2c) with gum entirely concealed (e.g. bamboo culm), lorises were found to dismiss it and spent both the least amount of time attempting to retrieve gum as well as minimal visits throughout the day.
- Lorises visited feeder 2a for a total of ~8-30 minutes. This is likely due to being able to directly reach the gum with minimal manipulation of the feeder required.
- Lorises visited feeder 2b the most and spent longer feeding there (30-50 minutes) when paired with either of the other two feeders.
- The most frequent gouging behaviour was seen on feeders 2b, as seen through gouge marks left on surrounding holes of feeders.
- Individual variability seen in gouging behaviour, where feeders were better able to promote gouging behaviour in loris with healthy dentition compared to geriatric loris with missing teeth.

Recommendations:

- Captive loris should be provided with multiple and mixed gouging opportunities using natural substrates from a young age to allow optimal learning of appropriate skills and dietary information to access gum through gouging. Gum should be presented in natural way in captivity such as on log feeders (Figure 2) designed to make resource acquisition more complex (Gray et al., 2015), so that lorises will have increased engagement to promote gouging behaviour and extended feeding durations. With that said, there needs to be a “happy medium” by not making the feeding device overly difficult as the loris may display a lack of knowledge or motivation to retrieve the gum concealed inside, as seen with the bamboo feeder. The complexity of the gum feeders will therefore depend on the age and individual needs/background of captive lorises, but loris holders should be promoting gouging behaviour and extended feeding durations by using mixed presentations of gum feeders suited to their individual lorises.

References:

Gray, A., Wirdateti, W. and Nekaris, K., 2015. Trialling exudate-based enrichment efforts to improve the welfare of rescued slow lorises *Nycticebus spp*. Endangered Species Research, 27(1), pp.21-29

Nekaris K, Bearder S.K. 2011. The strepsirrhine primates of Asia and mainland Africa: diversity shrouded in darkness. In: Primates in Perspective. Campbell C., Fuentes A., MacKinnon K., Panger M., Bearder S.K. (eds) Oxford: Oxford University Press, 24–45

Starr, C. and Nekaris, K., 2013. Obligate exudativory characterizes the diet of the pygmy slow loris *Nycticebus pygmaeus*. American Journal of Primatology, 75(10), pp.1054-1061