Aus dem
Institut für Zoologie, Fischkrankheiten und Fischereibiologie der
Tierärztlichen Fakultät der Ludwig-Maximilians-Universität München

Angefertigt am
Endangered Primate Rescue Center
Cuc Phuong National Park
Vietnam

Aspects of Ecology and Conservation of the Pygmy Loris *Nycticebus pygmaeus* in Vietnam

Inaugural-Dissertation

zur Erlangung der tiermedizinischen Doktorwürde
der Tierärztlichen Fakultät der Ludwig-Maximilians Universität München

vorgelegt von

Ulrike Streicher

aus
Bamberg

München, Oktober 2004

Dem Andenken meines Vaters

Preface

The first pygmy lorises came to the Endangered Primate Rescue Center in 1995 and were not much more than the hobby of the first animal keeper, Manuela Klöden. They were at that time, even by Vietnamese scientists or foreign primate experts, considered not very important. They were abundant in the trade and there was little concern about their wild status. It has often been the fate of animals that are considered common not to be considered worth detailed studies. But working with confiscated pygmy lorises we discovered a number of interesting facts about them. They seasonally changed the pelage colour, they showed regular weight variations, and they did not eat in certain times of the year. And I met people interested in lorises and told them, what I had observed and realized these facts were not known. So I started to collect data more or less to proof what we had observed at the centre. Due to the daily veterinary tasks data collection was rather randomly and unfocussed. But the more we got to know about the pygmy lorises, the more interesting it became. The answer to one question immediately generated a number of consecutive questions. After publishing a few small articles on pygmy lorises I got the chance to compile it all to a thesis. I do apologize for the mosaic-like character of the thesis, but that is what I had.

Probably we are still far from understanding the pygmy lorises' ecology. Despite its obvious shortcomings – being slow, unable to leap or jump, being small – the pygmy loris is a highly adapted animal, which has developed numerous strategies to survive in a seasonally hostile environment. The pygmy loris might at first glance not seem to be a very fascinating primate species, but it is an animal that deserves attention and I would be glad if with my thesis contributes to its understanding and conservation.

Abbreviations

CRES	:	Centre for Natural Resources and Environmental Studies
EPRC	:	Endangered Primate Rescue Center
FFI	:	Fauna and Flora International
FPD	:	Forest Protection Department
FZS	:	Frankfurt Zoological Society
IUCN	:	International Union for the Conservation of Nature
SFNC	:	Social Forestry and Nature Conservation
WAR	:	Wildlife at Risk
WFFT	:	Wildlife Friends of Thailand
WWF	:	World Wildlife Found
ZSCSP	:	Zoological Society for the Conservation of Species and Populations

Photographic and other sources:
Photographs used in the thesis have solely been taken at the EPRC by the author, Tilo Nadler or Elke Schwierz. Helga Schulze contributed the drawings of the dental comb and fur colouration.

Intention of this thesis

This thesis addresses aspects of conservation and ecology of the pygmy loris, which have previously not been considered. It addresses the overdue questions of what the pygmy loris actually looks like and its taxonomic status in relation to the other forms of *Nycticebus*. It discusses the situation of pygmy lorises in the illegal wildlife trade and the handling of confiscated lorises. It gives an overview about health problems in a population of trade-confiscated pygmy lorises and unveils a surprising new aspect of the animals' ecology, evaluates their possibilities for reintroduction and finally provides insight to the feeding behaviour of pygmy lorises in the wild. Though at first sight there might be no red string visible, the thesis follows a thread given by the pygmy loris itself: recognized - traded and confiscated – brought to a rescue centre - studied at a rescue centre – reintroduced –free-ranging.

Structure

The first chapter introduces the species and gives an overview about the current state of knowledge, the situation in Vietnam and introduces the site where the materials were compiled. For those who miss information in the introduction: the chapter refers exclusively to sources, specifically concerning *N. pygmaeus* (resp. *intermedius* as the junior synonym) or generally to the genus *Nycticebus*. It does not as commonly done infer information about *N. coucang* or *L. tardigradus* to *N. pygmaeus* because the aim is to show the actual state of knowledge on *N. pygmaeus* as a distinct species. And this inferring of information has already lead to misunderstandings of the species and a very unclear perception of *N. coucang* and *N. pygmaeus*. In all later chapters, however, information on all Asian loris species is taken into account and discussed.

Chapters 2, 3, 6 are each centred around a recent publication on lorises. These chapters start with an introduction and give a larger overview about the topic, briefly summarize the publication and finally discuss the topic in respect to the publication. The publications in full length are attached at the end of the dissertation. Chapters 4, 5 and 7 are data chapters and comprise unpublished materials and follow the normal structure of a scientific publication. Finally all findings of the thesis are briefly summarized in English and German.

Contents

1. Introduction – The Pygmy Loris *Nycticebus pygmaeus*

Taxonomy

Within the strepsirrhine primates there are two infraorders - the Lemuriformes and the Lorisiformes. Due to taxonomic changes the infraorder of the Lorisiformes only comprises one superfamily - the Loroidea. Within the Loroidea there are two families, the Galagidae and the Lorisidae (BULLETIN OF ZOOLOGICAL NOMENCLATURE, 2002). The Lorisidae comprises of the African (*Arctocebus* and *Perodictus* and possibly the new genus *Pseudopotto*) and the Asian slow climbers (*Loris* and *Nycticebus*). The commonly used term 'prosimians' includes all strepsirrhine primates and also a convergent group of secondary nocturnal haplorrhine primates, the tarsiers.

The genus *Nycticebus* formerly comprised two species, *Nycticebus coucang* and *Nycticebus pygmaeus*. Recent taxonomic revision has upgraded the northern form of the slow loris *N. coucang bengalensis* to full species level such that currently there are three distinct species recognized: *Nycticebus bengalensis, Nycticebus coucang* and *Nycticebus pygmaeus* (GROVES, 1971, 2002, 2004). Another possible species of slow loris from Java is being discussed (GROVES, in print). Since all publications prior to 2002 refer to the slow loris in Vietnam as *N. coucang*, for the purpose of this thesis we use *N. coucang* as a synonym for *N. bengalensis*, when referring to the Vietnamese slow loris.

The pygmy loris, pygmy slow loris or lesser slow loris *Nycticebus pygmaeus* was first described by BONHOTE in 1907. Though originally classified as a full species (BONHOTE, 1907) the taxonomic status of the species has been the subject of some controversy. Doubts were raised about the specific rank of the taxon (HILL, 1953, PETTER et al., 1970, PENG, 1990) and the description of a new species of loris, *Nycticebus intermedius* (DAO, 1960, ALTERMAN et al., 1997) further confused the situation. However, recent studies (ZHANG et al., 1993, WANG et al., 1996, GROVES, 2001, 2004, STREICHER et al., 2002, STREICHER, 2003, 2004, ROOS, 2004, see Chapter 2) did not support the existence of the new loris species and at present *N. pygmaeus* is considered a distinct species with no subspecies and *N. intermedius* is considered a junior synonym for the species.

Plate 1.1 *Nycticebus pygmaeus*

Anatomy

The pygmy loris is a small sized animal with a bodyweight normally between 350 and 600g (TAN, 1994, RATAJSZCZAK, 1998, FITCH-SNYDER et al., 2001) although -following recent taxonomic classification- even individuals with a bodyweight up to 800g are known (ZHANG et al., 1993). The head-body length of pygmy lorises is given as 210-290mm (CORBET et al., 1992, Fauna & Flora International, 1999). Sexual dimorphism has been suggested for bodyweight and size (KAPPELER, 1991, GROVES, 2004), but in 23 specimens at the EPRC no sexual dimorphism in size could be observed (Table 1.1, and Chapter 5).

Table 1.1 Morphometrics of pygmy lorises at the EPRC

Measurement	mean value in mm	number of animals n	min-max in mm
Head body length*	215 ± 10	23	195-230
Upper arm length	61 ± 4	24	55-70
Forearm length	63 ± 3	24	57-68
Tigh length	64 ± 3	24	57-69
Knee height	75 ± 4	24	68-84
Hand length	38 ± 3	24	32-48
Hand span	53 ± 3	24	45-58
Foot length	44 ± 5	24	33-54
Foot span	18 ± 3	24	15-25

* Head body length measured from vertex with the head at a 90 ° angle.

The pygmy loris exhibits a number of anatomical peculiarities.

The pygmy loris’ dental formula is:

$\underline{M_3\ M_2\ M_1\ P_4\ P_3\ P_2\ C\ I_2\ I_1\ I_1\ I_2\ C\ P_2\ P_3\ P_4\ M_1\ M_2\ M_3}$

$M_3\ M_2\ M_1\ P_4\ P_3\ P_2\ C\ I_2\ I_1\ I_1\ I_2\ C\ P_2\ P_3\ P_4\ M_1\ M_2\ M_3$

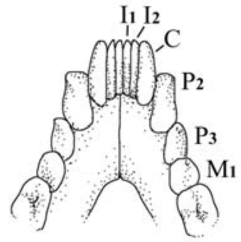


Fig.1.1: anterior mandibular dentition with toothcomb.

The mandibular incisors are long and slender and form a closed row, termed the dental comb (Fig.1.1). The lateral boundaries of the dental comb are formed by the canines, which represent functional incisors (BYRD et al., 1982). The dental comb has a horizontal procumbency and serves important functions during grooming and food acquisition.

As in all prosimians except the tarsiers, pygmy lorises’ eyes have a tapetum lucidum , which enhances night vision. Pygmy lorises also have a moist rhinarium to enhance the perception of smell (FLEAGLE, 1978), a fact reflected in the name of the order; strepsirrhini - the moist-noised primates.

The blood vessels on the lower arms and legs form a three-dimensional network, the rete mirabile (MIYAKE et al., 1991). They assure continuous perfusion of the muscles and enable the loris to maintain a grip for extended periods of time (FITCH-SNYDER et al., 2001, PUSCHMANN et al., 2004) and probably also play a role in thermoregulation.

The second digit on the hind and the front limbs is reduced, a result of their quadrupedal walking along the branch (PREUSCHOFT et al., 1995). The nail of the second digit on the hind leg has a long bent shape and forms the “grooming claw”.

Pygmy lorises have brachial glands located on the medial surface of the upper arm that produce scent (HILL, 1956). The function of the brachial glands is not quite clear, they seem to serve for scent marking and potentially they serve for allospecific defence. The brachial glands produce a secretion, which contains toxins (ALTERMAN, 1995).

The digestive system of the lorises is simple, without any chambered site to facilitate bacterial fermentation (HILL, 1953).

Other than in the anthropoids the uterus of the pygmy loris has two distinct horns (HILL 1972).

Reproduction

Pygmy lorises reproduction is strictly seasonal. Even under captive conditions they maintain their seasonal pattern and oestrus occurs only between the end of July and the first third of October (FENG et al., 1992, 1994, JURKE et al., 1997). During oestrus females show a distinct vaginal swelling and the testes of the males are visibly enlarged (FENG et al., 1992, FITCH-SNYDER et al., 2003). After a pregnancy of six months, births consequently occur in from January to mid March (FENG et al., 1992, JURKE et al., 1997, 1998, FITCH-SNYDER et al., 2001). In North American facilities, 45% of the litters born are singletons, the remainder are twins or triplets; even quadruplets have been seen (FENG et al., 1994, MASOPUSTOVA, 2001, FITCH-SNYDER, 1998, FITCH-SNYDER, et al., 2001). A typical behaviour is the parking of the infants from the first day of life onward, while the female goes foraging (FITCH-SNYDER, 2000). Maturity is reached at 18 months in males and 16 months in females (FITCH-SNYDER et al., 2001).

Longevity

Due to the short time the species has been kept in captivity longevity has not been determined; studbook data indicate life spans of at least 15 years in captivity (FITCH-SNYDER, 2002).

Social system

Pygmy lorises in the wild have mostly been observed as singly individuals (DUCKWORTH, 1994, TAN, 1994, TAN et al., 2001, POLET et al., 2004, NGUYEN, 2004) and they are assumed to have a solitary social pattern. Olfactory cues are probably the most important means of communication and pygmy lorises have an elaborate scent marking system (FISHER et al., 2003a, 2003b). Vocal communication also plays an important role (FITCH-SNYDER, 2000, ZIMMERMANN, 1995). However, no behavioural studies of pygmy lorises have yet been made in the field.

Distribution

The pygmy loris is distributed east of the Mekong River in Vietnam, eastern Cambodia, Laos and southernmost China (RATAJSZCZAK, 1988, NISBETT et al, 1993, DUCKWORTH, 1994, FOODEN, 1996, ZHANG et al., 2002, THANH, 2002). In Vietnam sightings have been reported from all over the country in a variety of different habitats, from primary forest to secondary forests and bamboo plantations (WOLFHEIM, 1983, GROVES, 1971, HUYNH, 1998, FITCH-SNYDER et al., 2002, NGUYEN, 2004, POLET et al., 2004).

Status in the wild

Due to the spraying of defoliants during the war, excessive logging and the conversion of forests into agricultural land, forests in Vietnam are rapidly declining (THANH, 1996, NADLER et al., 2004). Vietnam has lost much of its original forest cover and in 1993 only about 30% of the country’s land area was forest covered. Only about 10% of the remaining forests are rich closed-canopy forests, the rest are plantations, poor and regenerating forests (FOREST INVENTORY AND PLANNING INSTITUTE/ MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT, 2001). Slash and burn cultivation destroys pygmy loris habitats and the animals are completely eradicated from large areas (RATAJSZCZAK, 1998). In the absence of baseline data MacKINNON et al. (1987) tried a rough estimation based on the species' distribution range, habitat loss within this range and an assumed density of the animals and estimated a total number of about 72,720 *N. pygmaeus* in Vietnam. The fact, that HUYNH (1998), at that time a leading conservationist in Vietnam, estimated Vietnam's total pygmy loris population to be about 600-700 individuals reflects the impossibility of assessing the numbers without field data.

The species is heavily exploited for traditional medicines and the pet trade and the degree of exploitation is certainly not sustainable (RATAJSZCZAK, 1998, NOOREN et al., 2001, THANH, 2002). It has been concluded from the reduced numbers of pygmy lorises in the Vietnamese markets that the wild populations are declining (NADLER, pers. comm.). In the field pygmy lorises are more and more difficult to observe (MINISTRY OF SCIENCE, TECHNOLOGY AND ENVIRONMENT, 2000, THANH, 2002, NGUYEN, 2004).

Protection status

Vietnamese law protects the pygmy loris at the highest possible level (COUNCIL OF MINISTERS, 1992, THE GOVERNMENT OF VIETNAM, 1996) and prohibits any exploitation. The IUCN Red List of Endangered Species (HILTON-TAYLOR, 2002) lists the species within the category 'Vulnerable' and the Red Data Book of Vietnam places the species in the same category (MINISTRY OF SCIENCE, TECHNOLOGY AND ENVIRONMENT, 2000). In 1994 Vietnam became a member of CITES and pygmy lorises are listed in Appendix II.

Traditional beliefs

Pygmy lorises are not only reported to make nice toys, alive or mounted (MINISTRY OF SCIENCE, TECHNOLOGY AND ENVIRONMENT, 2000), their hair is also believed to have haemostatic qualities (HUYNH, 1998). Local people believe that the pygmy loris' bite is toxic and potentially lethal. A more anecdotic belief tells that pygmy lorises use the wind to move from branch to branch and in some areas the loris is called the 'monkey that moves with the wind "khi gio" (HUYNH, 1998, NGUYEN, 2004). Sightings of the animal are said to announce imminent misfortune and the animals are used for black magic (FITCH-SNYDER, pers. com.).

The Endangered Primate Rescue Center

The Endangered Primate Rescue Center was established in 1993 at Cuc Phuong National Park. Cuc Phuong National Park is the oldest National Park in the country, located at 20°14'-20°24'N and 105°29'-105°44'E and comprising an area of 22.000 ha of tropical evergreen forest-covered limestone hills (VO et al., 1996, BIRDLIFE INTERNATIONAL, 2000). The rescue centre was established with the goal of caring for endangered primates confiscated by Vietnamese authorities from the illegal wildlife trade. The foundation of captive breeding populations of rare primate taxa and the eventual release of the captive bred offspring is also part of the task appointed to the centre in fulfilment of the National Biodiversity Action Plan for Vietnam (GOVERNMENT OF VIETNAM & GLOBAL ENVIRONMENTAL FACILITY PROJECT, 1994). Within the past years the centre has worked on the confiscation and rescue of endangered primates and has successfully kept and bred a number of rare primate species. At the moment the centre has a unique primate population of more than 120 animals of 15 Indochinese primate species. Unfortunately hunting still continues and the numbers of the primates in the wild are still rapidly decreasing; the centre's work has become a crucial component of conservation for some species. Located at the headquarters of Cuc Phuong National Park, the centre comprises 20 cage complexes, a quarantine station and two semi-wild enclosures. The centre is funded by zoos, zoological societies (FZS, ZGAP), various foundations (ARCUS Foundation, Deutsches Tierhilfswerk, Andreas Stihl Stiftung) and private donations. It is run by a team of three foreigners (director, veterinarian, head animal keeper) and 18 Vietnamese staff members.

Pygmy lorises at the Endangered Primate Rescue Center

Pygmy lorises at the EPRC originate from many different sources; they are confiscated by Forest Protection authorities from hunters, traders and animal transports or they are brought by tourists, who "rescued" them by buying them in markets or from traders, or they are donated former pets. On arrival at the EPRC the animals receive a health check, are marked with a transponder, samples are taken for genetic screening and the animals undergo six weeks quarantine (STREICHER, 2004). After quarantine they are housed in large outdoor cages with open soil, natural vegetation and a furnishing of bamboo and branches. Sleeping boxes are provided as refuges. The enclosure fencing consists of small mesh wire to prevent rodents and snakes from entering the cage. Snakes are a potential threat to the animals and rodents are not only efficient food competitors, but might also spread disease. Animals are kept either in breeding groups with one male and several females, as single individuals or in non-breeding groups consisting only of several females and their offspring below two years of age.

References

Alterman, L., Hale, M. E. 1991. Comparison of toxins from brachial gland exudates from *Nycticebus coucang* and *N. pygmaeus*. American Journal of Physical Anthropology, Sup. 12: 43.

Alterman, L., Freed, B. Z. 1997. Description and survey of three *Nycticebus* species in Bolikhamxay Province, Laos. Primate Eye **63**: 16.

Bonhote, **J. L.** 1907. On a collection of mammals made by Dr. Vassal in Annam. Proceedings of the Zoological Society of London, **4**.

Birdlife International Vietnam Programme. 2000 Sourcebook of Protected Areas. www.birdlifevietnam.com

Byrd, K. E., Swindler, D. R. 1982. The dentition of the Lorisoidae. Pp. 27-37. In : Haines, D. E. (ed.) : The lesser bushbaby (*Galago senegalensis*) as an animal model : selected topic. CRC Press, Florida.

Corbet, G. B., Hill, J. E. 1992. The Mammals of the Indomalayan Region : A systematic review. Oxford University Press. Oxford.

Council of Ministers. 1992. Decree No. 18/HDBT of January 17 prescribing the list of precious and rare forest plants and animals and the regime of management and protection thereof.

Dao, V. T. 1960. Sur une nouvelle espèce de *Nycticebus* au Vietnam. Zool. Anz. **164**: 240-243.

Duckworth, J. W. 1994. Field sightings of the pygmy loris (Nycticebus pygmaeus) in Laos. Folia Primatol **63**: 99-101.

Fauna & Flora International. 1999. Primate Field Guide Vietnam. Fauna & Flora International Indochina Programme. Lotus Press, Hanoi.

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., Li, C. 1994. Progress of studies on intermediate slow loris in captivity. Zhongguo Lingzhanglei Yanjiu Tongxun / Chinese Primate Research and Conservation News **3** (1): 11-12.

Fisher, H. S., Swaisgood, R. R., Fitch-Snyder, H. 2003 a. Odor familiarity and female preferences for males in a threatened primate, the pygmy lorises (*Nycticebus pygmaeus*): applications for genetic management of small populations. Naturwissenschaften **90**: 509-512.

Fisher, H. S., Swaisgood, R. R., Fitch-Snyder, H. 2003 b. Countermarking by male pygmy lorises (*Nycticebus pygmaeus*): do females use odor cues to select mates with high competitive abilities? Behav Ecol Sociobiol **53**: 123-130.

Fitch-Snyder, H. 1998. Asian prosimians North American regional studbook. Vol. IV. Zoological Society of San Diego. San Diego

Fitch-Snyder, H. 2000. Reproductive patterns in a breeding colony of pygmy lorises (*Nyctivebus pygmaeus*) measured by behavioral and physiological correlates of gonadal activity. Masters thesis. San Diego State University. San Diego.

Fitch-Snyder, H. 2002. Pygmy loris (*Nycticebus pygmaeus*) international studbook. March 2002. Center for breeding of endangered species, Zoological Society of San Diego.

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

Fitch-Snyder, H., Ehrlich, A. 2003. Mother-infant interactions in slow lorises (*Nycticebus bengalensis*) and pygmy lorises (*Nycticebus pygmaeus*). Folia Primatol **74**: 259-271.

Fitch-Snyder, H., Jurke, M. 2003. Reproductive patterns in Pygmy Lorises (*Nycticebus pygmaeus*): Behavioral and Physiological Correlates of Gonadal Activitiy. Zoo Biology **22**: 15-32.

Fitch-Snyder, H., Vu, N. T. 2002. A preliminary survey of lorises (*Nycticebus spp*.) in Northern Vietnam. Asian Primates – A Newsletter of the IUCN/SSC Primate Specialist Group Vol. **8**, No.2: 1-6.

Fleagle, J. G. 1978. Primate adaptation in Evolution. Academic Press. New York.

Fooden, J. 1996. Zoogeographie of Vietnamese Primates. Int J Primatol Vol. **17**(5): 845-899.

Forest Inventory and Planning Institute/ Ministry of Agriculture and Rural Development. 2002. Data on the Situation of Forests in Vietnam. Vietnam Environment Monitor 2002: 9-10.

Government of Vietnam & Global Environmental Facility Project VIE/ 91/G31. 1994. National Biodiversity Action Plan for Vietnam, Hanoi.

Groves, C. P. 1971. Systematics of the Genus *Nycticebus*. Pp. 44 – 53. In: Proc. 3rd Int. Congr. Primat., Zürich 1970, Vol. 1.

Groves, C. P. 2001. Primate Taxonomy. Smithsonian Institution Press, Washington.

Groves, C. P. 2004. Taxonomy and biogeography of primates in Vietnam and neighbouring regions. Pp. 15-22. In: Nadler, T., Streicher, U., Ha, T. L.(eds.): Conservation of Primates in Vietnam. Haki press, Hanoi.

Groves, C., Maryanto, I. Craniometry of slow lorises (Genus *Nycticebus*) of insular Southeast Asia. In: Shekelle, M. (ed.): Primates of the Oriental Night. Treubia. Special issue. In print.

Hill, W. C. O. 1953. Primates: Comparative anatomy and taxonomy. Vol. I, Strepsirrhini. Edinburgh University Press, Edinburgh.

Hill, W. C. O. 1956. Body odour in lorises. Proc Zool Soc London **127:** 580.

Hill, W. C. O. 1972. Evolutionary Biology of the Primates. Academic Press, London, New York.

Hilton-Taylor, C. (comp.) 2002. IUCN Red List of Threatened Species. IUCN, Gland and Cambridge.

Huynh, D. H. 1998. Ecology, Biology and Conservation status of Prosimian Species in Vietnam. Folia Primatol **69** (suppl 1): 101-108.

International code of zoological nomenclature executive secretary. 2002. Opinion 1995: Lorisidae Gray, 1821, Galagidae Gray, 1825 and Indriidae Burnett, 1828 (Mammalia: Primates): conserved as the correct original spellings. Bulletin of Zoological Nomenclature **59** (1), March 2002: 65-67.

Jurke, M. H., Czekala, N. M., Fitch-Snyder, H. 1997. Non-invasive detection and monitoring of estrus, pregnancy and the postpartum period in pygmy loris (*Nycticebus pygmaeus*) using fecal estrogen metabolites. Am J Primatol **41**: 103-115.

Jurke, M. H., Czekala, N. M., Jurke, S., Hagey, L. R., Lance, V. A., Conley, A. J., Fitch-Snyder, H. 1998. Monitoring Pregnancy in Twinning Pygmy Loris (*Nycticebus pygmaeus*) Using Fecal Estrogen Metabolites. Am J Primatol **46**: 173-183.

Kappeler, P. M. 1991. Patterns in sexual dimorphism in bodyweight among primates. Folia Primatol **57**: 132-146.

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

Masopustova, R. 2001. The Quadruplets and Twins of Lesser Slow Loris in Prague Zoo. Gazella **28**: 63-71.

Ministry of Science, Technology and Environment (ed.) 2000. Red Data Book of Vietnam, Vol. 1. Animals. Hanoi.

Miyake, S., Ikedo, A., Ohta, S., Matsumoto, S. 1991. Three-dimensional analysis of the peculiar arterial pattern of the extremities in lorisidae: the rete mirabile. Pp. 569-570. In: Akiyoshi, E. et al. (eds.): Primatology today. Elsevier Science Publishers.

Nadler, T., Streicher, U. 2004. Primates in Vietnam – an Overview. Pp. 3-11. In: Nadler, T., Streicher, U., Ha, T. L. (eds.): Conservation of Primates in Vietnam. Haki Press. Hanoi.

Nguyen, T. N. 2004. The status of primates at Pu Mat National Park and suggestions for sustainable conservation approaches. Pp. 85-89. In: Nadler, T., Streicher, U., Ha, T. L. (eds.): Conservation of Primates in Vietnam. Haki Press. Hanoi.

Nisbett, R. A., Ciochon, R. L. 1993. Primates in North Vietnam: a review of the ecology and conservation status of extant species, with a note on Pleistocene localities. Int J Primatol **14** (5): 765-795.

Nooren, H., Claridge, G. 2001. Wildlife Trade in Laos: the End of the Game. A History of Wildlife Trade in Laos to 1995. Netherlands Committee for IUCN, Amsterdam.

Peng, Y. 1990. Distribution and taxonomy of Primates. Primatology in China, Primate Report **26**: 17-28.

Petter, J. J., Petter-Rousseaux, A. 1970. Classification of the prosimians. Pp. 281-286. In Doyle, G.A., Martin, R.D. (eds.): The study of Prosimian Behavior. Academic Press, New York.

Polet, G. Murphy, D. J., Becker, I., Phan D. T. 2004. Notes on the primates of Cat Tien National Park. Pp. 78-84. In: Nadler, T., Streicher, U., Ha, T. L. (eds.): Conservation of Primates in Vietnam. Haki Press, Hanoi.

Preuschoft, H. Witte, H., Fischer, M. 1995. Locomotion in Prosimians. Pp. 453-472. In: Alterman, L., Doyle, G. A., Izard, M. K. (eds.): Creatures of the Dark. The nocturnal prosimians. Plenum Press, New York.

Puschmann, W. 2004. Zootierhaltung. Tiere in menschlicher Obhut. Saeugetiere. Verlag Harri Deutsch, Frankfurt.

Ratajszczak, R. 1988. Notes on the current status and conservation of primates in Vietnam. Primate Conservation **9**: 134-136.

Ratajszczak, R. 1998. Taxonomy, distribution and status of the lesser slow loris *Nycticebus pygmaeus* and their implications for captive management. Folia Primatol **69** (suppl. 1): 171-174.

Roos, C. 2004. Molecular evolution and systematics of Vietnamese primates. Pp. 23-28. In: Nadler, T., Streicher, U., Ha, T. L.(eds.): Conservation of Primates in Vietnam. Haki press, Hanoi.

Streicher, U. 2003. Saisonale Veraenderungen in Fellzeichnung und Fellfaerbung beim Zwergplumplori *Nycticebus pygmaeus* und ihre taxonomische Bedeutung. Zoolog. Garten N. F. 73 (2003) 6, P: 368-373.

Streicher, U. 2004. Confiscated Primates- health problems and placement options. Pp. 154-160. In: Nadler, T., Streicher, U., Ha, T. L. (eds.): Conservation of Primates in Vietnam. Haki press, Hanoi.

Streicher, U. 2004. Seasonal changes in fur pattern and colouration in the pygmy loris *Nycticebus pygmaeus*. Pp. 29-32. In: Nadler, T., Streicher, U., Ha, T. L.(eds.): Conservation of Primates in Vietnam. Haki press, Hanoi.

Streicher, U., Schulze, H. 2002. Seasonal changes in fur pattern and colouration in the pygmy loris *Nycticebus pygmaeus*. P.398. In: Caring for Primates. Abstracts of the XIXth Congress of the International Primatological Society. Mammalogical Society of China, Beijing.

The Government of Vietnam. 1996. Instruction from the Prime Minister on Urgent Measures For Wildlife Protection and Development, No. 359/ Ttg, 29.05.96. Hanoi, Vietnam.

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 Exsudate Eating in Pygmy Slow Lorises (*Nycticebus pygmaeus*). Folia Primatol **72**: 37-39.

Thanh, V. N. 1996. Biodiversity and Biodiversity Loss. Presentation held at the Seminar on Environment and Development in Vietnam. Australian National University. Canberra.

Thanh, V. N. 2002. The status and conservation of the loris species, *Nycticebus coucang* and *N. pygmaeus* in Vietnam. P. 254. In: Caring for Primates. Abstracts of the XIXth Congress of the International Primatological Society. Mammalogical Society of China, Beijing.

Vo, Q., Nguyen, B. T., Ha, D. D., Le, V. T. 1996. Vuon Quoc Gia Cuc Phuong – Cuc Phuong National Park. Agricultural Publishing House, Hanoi.

Wang, W., Su, B., Lan, H., Liu, R., Zhu, C., Nie, W., Chen, Y., Zhang, Y. 1996. Interspecific differentiation of the slow lorises (Genus *Nycticebus*) inferred from ribosomal DNA restriction maps. Zoological Research **17**(1): 89-93.

Wolfheim, J. H. 1983. Primates of the World. Distribution, Abundance and Conservation. University of Chicago Press, Oxford.

Zhang, Y., Chen, Z., Shi, L., 1993. Phylogeny of the slow lorises (genus *Nycticebus*): an approach using mitochondrial DNA restriction enzyme analysis. Int J Primatol **14** (1): 167-175.

Zhang, Y., Chen, L., Qu,W., Coggins, C. 2002. Past, Present and Future. The Primates of China: Biography and Conservation Status. China Forestry Publishing House. Beijing.

Zimmermann, E. 1995. Acoustic communication in nocturnal prosimians. Pp. 311-330. In: Alterman, L., Doyle, G. A., Izard, M. K. (eds.): Creatures of the Dark. The nocturnal prosimians. Plenum Press, New York.

2. Seasonal changes in pelage in the Pygmy Loris

Streicher, U. 2003. Saisonale Veraenderungen in Fellzeichnung und Fellfaerbung beim Zwergplumplori *Nycticebus pygmaeus* und ihre taxonomische Bedeutung. Zoolog Garten N.F. **73**, 6: 368-373.

Introduction

The original description of the pygmy loris BONHOTE (1907) comprises characteristics of pelage, bodyweight and some morphological measurements. The fur was depicted as being reddish brown-grey with silvery tips and a trace of dark red fur along the spine. HILL (1953) considered the pygmy lorises merely a subspecies of the slow loris *Nycticebus coucang* and distinguished it from the latter by size and fur characteristics, namely a difference in the dorsal stripe. He pointed out that the type specimen of *N. pygmaeus* would largely lack a dark stripe, but considered this to be an individual anomaly. Observed colour variations he believed related to the age of the animals. Based on dentition, the forward production of the premaxilla and the sympatric occurrence with another subspecies *N. c. bengalensis,* he acknowledged the possibility that the pygmy loris might need to be acceded to specific rank. A few years later FIEDLER (1956) classified *N. pygmaeus* as a separate species, in respect to its small size and dental peculiarities. PETTER et al. (1970) still considered *N. pygmaeus* a subspecies of *N. coucang* but GROVES (1971) also suggested giving *N. pygmaeus* full species rank based on craniomorphological features and pelage characteristics. His pelage description was largely identical with the original one, but he considered the dark stripe along the spine to be related to age. CORBET et al. (1992) followed Groves' suggestion and considered *N. pygmaeus* a valid species.

All these different perspectives were based on gross morphological features. First chromosome studies on *N. pygmaeus* testified its close relation to *N. coucang* (CHU et al, 1962, DE BOER, 1973) based on identical chromosome numbers, not allowing an assessment of differences below chromosome level. First investigations on molecular genetics of *Nycticebus* were conducted by ZHANG et al. (1993) and WANG et al. (1996) who found the genetic difference between *N. pygmaeus* and *N. coucang* sufficiently large to justify their classification as different species. GROVES (1998) again emphasized the separate between *N. pygmaeus* and *N. coucang* based on morphometric studies of museum specimen. RATAJSZCZAK (1998) further supported the view that *N. coucang* and *N. pygmaeus* are separate species based on largely sympatric occurrence and differences in biology and reproduction. Ever since, the validity of *N. pygmaeus* as separate species has not been doubted and recent DNA investigations by ROOS (2004) further support their validity as species.

The relation to the slow loris was not the only point of discussion concerning the taxonomic status of *N. pygmaeus*. In 1960, DAO (1960) described a third species of *Nycticebus* - the intermediate or middle slow loris *Nycticebus intermedius*. His description was based on pelage characteristics and morphology. The fur was described as being uniform red-orange with a faint blackish-brown stripe and silvery frosted hair. The validity of this species has been doubted ever since its first description. GROVES (1971) pointed out that the type specimen of *N. intermedius* was an adult *N. pygmaeus* and that the type description of *N. pygmaeus* was based on an infant animal. Later, he consequently considered *N. intermedius* a synonym for *N. pygmaeus* (1998, 2001) and described the species with a fine textured reddish- buff fur and a broad but indistinct dorsal stripe. The opinion that *N. pygmaeus* and *N. intermedius* are just different aged individuals of the same species was supported by RATAJSZCZAK (1998) based on his observations of retarded growth in *N. pygmaeus* under unfavourable keeping conditions. ZHANG et al. (1993) reported that at the Kunming Institute of Zoology *N. intermedius* and *N. pygmaeus* were distinguished based on their differences in bodyweight and pelage. Accordingly, *N. intermedius* would be the larger species weighing about 450-800g and having a dorsal stripe, *N. pygmaeus* would be somewhat smaller weighing 300-450g and lacking a dorsal stripe. But in their molecular genetic studies (ZHANG et al., 1993, WANG et al., 1996) they found little difference between the two forms and suggested considering *N. intermedius* a junior synonym for *N. pygmaeus*. Despite all this seemingly obvious evidence, *N. intermedius* was still maintained as a species by a number of scientists. CORBET et al. (1992) claimed that *N. pygmaeus* and *N. intermedius*, though having indistinguishable skulls, would differ in weight, and pelage characters, without specifying the latter. Publications on *N. intermedius* kept occurring particularly from China (e.g. FENG et al., 1992, 1993, 1994). Further, based on craniomorphologic studies BEUTEL (1995) claimed the variation found in *N. pygmaeus* to exceed the values expected for a single species and postulated more rigorous investigation of the monotypie of this taxon. A recent overview on primates in China (ZHANG et al., 2002) again listed *N. pygmaeus* and *N. intermedius* as separate species with largely sympatric occurrence and *N. intermedius* being the more common species. However, the photographs in the same report featured two representatives of *N. pygmaeus*.

The report on a new loris species in Laos (ALTERMAN et al., 1997) again supported the assumption of a third species of loris differing from *N. pygmaeus* and *N. coucang* in size and colouration and potentially identical with the species previously described by DAO (1960).

Description of seasonal changes in fur pattern and colouration

Taxonomic considerations on lorises were often based on fur colouration and fur pattern and, therefore, a study on seasonal changes in these characteristics seemed to be an important contribution to clarify the taxonomy. Such a study has finally been conducted at the EPRC. According to the study, fur colouration and pattern do not justify the taxonomic distinction between *N. pygmaeus* and *N. intermedius.* The dark dorsal stripe and silvery frosting that had occasionally been used to distinguish *N. pygmaeus* from other species of lorises were found to be seasonal variations (Plate 2.1). The results of the study were first presented at the Conference of the International Primatological Society in Beijing in 2002 (STREICHER et al., 2002). *N. intermedius* had its strongest supporters in China and the study attracted much attention. It was finally published in German in 2003 and in English in 2004.

The study had a notable impact on further views of lorises' taxonomy. In a recent publication on taxonomy, GROVES (2004) acknowledged the findings of the study and emphasized again the doubts on the validity of *N. intermedius* based on the study's results. ROOS (2004) did largely neglect external characteristics for taxonomic considerations, but his DNA investigations showed little difference between *N. pygmaeus* and *N. intermedius*, and he expressed the accordance of his findings with the study. Since the publication of the study no further publications on *N. intermedius* appeared in China (BLEISCH, pers.com.).

Plate 2.1 Typical summer and typical winter colouration

Discussion

Taxonomical and ecological implications of a seasonal colouration change

Taxonomic considerations based predominantly on fur characteristics have to be viewed carefully. SUMNER (1927) long ago emphasized the difficulties encountered when assessing the colours of animals and suggested a standardized approach, whilst other authors boldly regarded specific and subspecific determination on coat colour to be “most unsound” (SANDERSON, 1938). Various reasons might account for alterations of the coat colour. In museum specimens drying and preservation might be as altering influences, but different colours might also be the results of plant juices dyes. Colour differences could also be just colour varieties within the species, a phenomenon common in mammals (SANDERSON, 1938), or they could be related to the region of origin (SUMNER, 1926). Certain regional variations are known from the pygmy lorises in Vietnam. Extreme frosting has been observed in some animals originating from the northern provinces of Vietnam and fairly yellowish brown animals had been collected in Dak Lak province in the south, but an assessment of these regional variations is still pending (STREICHER et al., 2002). It is also possible that variations in colour might be merely individual variations, which are known also from other loris species (HILL, 1932). Finally gland secretions are also known to be responsible for coat colour variations (VERON, in litt.).

However, seasonal influences have been largely neglected in the assessment of fur colouration. This might partly be due to the snapshot character of field surveys and museum collection expeditions. Due to their short duration they are unable to provide an overview over seasonal variations and other changing physiological parameters. However, the dark dorsal stripe and silvery frosting occasionally used to distinguish *N. pygmaeus* from other species of lorises appear to be exactly such seasonal variations. Consequently, it seems advisable to follow the recommendation of GROVES (2004) and revise the taxonomic classification of the genus by taking into account potential seasonal variations.

Considering the potential advantages of a seasonal pelage change for the pygmy lorises, it is important to look at it within the context of the pygmy loris’ ecology.

The winter pelage and colouration is most distinct between November and February. These are the coldest months of the year in northern Vietnam and temperatures during this time are close to freezing and often below 15°C for several days (NGUYEN et al., 2000). In combination with the low rainfall of this season the conditions are unfavourable for many tropical tree species (NGUYEN et al., 2000) and a large number of trees lose their foliage during this time of year.

During this season, captive pygmy lorises in outdoor enclosures show extensive resting periods and often remain in the same position without moving or feeding for a number of days. First observations on reintroduced, free-ranging lorises with radio transmitters seem to verify this observation for wild animals as well. Lorises do not rest in tree holes but rest either in dense scrub or more often on the fairly exposed, very high terminal branches of trees (STREICHER, 2003). Resting motionless in such an exposed position for longer periods of time requires a useful camouflage. It seems possible that the optically-dividing black stripe and the different colour provide a better camouflage in the partially bare trees.

Because most predators lack trichromatic vision and perceive only a limited range of colours (SUMNER, 2003), the pattern and light intensity of the fur's coloured surface play key roles for camouflage. Unable to detect the orange base colouration, a sleeping loris might appear to a predator as just a light grey shape, optically divided by a dark stripe.

It has been suggested that the bright colour influences mate selection processes. The animals achieve their bright summer colouration already some time prior to the actual mating season. There is no knowledge on the mating behaviour of pygmy lorises in the wild, if males and females pair up prior to mating, or which parameters influence mate selection. Bright orange colour could influence the mate choice. However, there is no notable dimorphism in the colouration of the animals and the latter point seems unlikely.

The fur of many animal species seasonally changes for the purpose of temperature regulation. Summer and winter pelages often have different insulation capacities. The pelage change coincides with the onset of the cold season and with other adaptations of the pygmy loris, which serve predominantly the purpose to overcome the cold season (see Chapter 5). It seems very likely that the winter pelage serves mainly for improved insulation.

References

Alterman, L., Freed, B. Z. 1997. Description and survey of three *Nycticebus* species in Bolikhamxay Province, Laos. Primate Eye **63**: 16.

Bonhote, **J. L.** 1907. On a collection of mammals made by Dr. Vassal in Annam. Proceedings of the Zoological Society of London **4**.

Chu, E. H. Y., Bender, M. A. 1962. Cytogenetics and evolution of primates. Ann N Y Acad Sci **102**: 253-266.

Corbet, G. B., Hill, J. E. 1992. The Mammals of the Indomalayan Region : A systematic review. Oxford University Press. Oxford.

Dao, V. T. 1960. Sur une nouvelle espèce de *Nycticebus* au Vietnam. Zool. Anz. **164**: 240-243.

De Boer, L. E. M. 1973. Cytotaxonomy of the Lorisoidae (Primates: Prosimii). II. Chromosome Studies in the *Lorisidae* and Karyological Relationships within the Superfamily. Genetica **44**: 330-367.

Fiedler, W. 1956. Übersicht über das System der Primaten. Pp. 1 – 266. In: Hofer, H., Schultz, A. H., Starck, D. (eds.): Primatologia 1, Basel.

Feng, Q., Wang, Y., Li, C. 1992. Mother-infants-interactions in captive middle slow loris (*Nycticebus intermedius*). Acta theriologica sinica **12** (3): 167-174.

Feng, Q., Wang, Y., Li, C. 1993. Reproduction of slow loris (*Nycticebus intermedius*) in captivity. Zoological Research **14** (1): 21-26.

Feng, Q., Wang, Y., Li, C. 1994. Progress of studies on intermediate slow loris in captivity. Zhongguo Lingzhanglei Yanjiu Tongxun / Chinese Primate Research and Conservation News **3** (1): 11-12.

Groves, C. P. 1971. Systematics of the Genus *Nycticebus*. Pp. 44 - 53 in: Proc. 3rd int. Congr. Primat., Zürich 1970, vol. 1.

Groves, C. P. 1998. Systematics of tarsiers and lorises. Primates **39** (1): 13-27.

Groves, C. P. 2001. Primate Taxonomy. Smithsonian Institution Press, Washington.

Groves, C. P. 2004. Taxonomy and biogeography of primates in Vietnam and neighbouring regions. Pp. 15-22. In: Nadler, T., Streicher, U., Ha, T. L.(eds.): Conservation of Primates in Vietnam. Haki press, Hanoi.

Hill, O. W. C. 1953. Primates: Comparative anatomy and taxonomy. Vol. I, Strepsirhini. Edinburgh University Press, Edinburgh.

Nguyen, K. V., Nguyen, T. H., Phan, K. L., Nguyen, T. H. 2000. Bioclimatic Diagrams of Vietnam. Vietnam National University Publishing House. Hanoi.

Petter, J. J., Petter-Rousseaux, A. 1970. Classification of the prosimians. Pp. 281-286. In Doyle, G.A., Martin, R.D. (eds.): The study of Prosimian Behavior. Academic Press, New York.

Ratajszczak, R. 1998. Taxonomy, distribution and status of the lesser slow loris *Nycticebus pygmaeus* and their implications for captive management. Folia Primatol. **69** (suppl. 1): 171-174.

Roos, C. 2004. Molecular evolution and systematics of Vietnamese primates. Pp. 23-28. In: Nadler, T., Streicher, U., Ha, T. L.(eds.): Conservation of Primates in Vietnam. Haki press, Hanoi.

Sanderson, I. T. 1940. The mammals of the north Cameroon forest area. Transactions of the Zoological Society of London **14**: 623-725.

Schwartz, J., Beutel, J. C. 1995. Species diversity in lorisids: a preliminary analysis of *Arcticebus*, *Perodicticus* and *Nycticebus*. Pp. 171-192. In: Alterman, L.; Doyle, G. A.; Izard, M. K. (eds.): Creatures of the Dark. The nocturnal prosimians. Plenum Press, New York.

Streicher, U. 2004. Seasonal changes in fur pattern and colouration in the pygmy loris *Nycticebus pygmaeus*. Pp. 29-32. In: Nadler, T., Streicher, U., Ha, T.L.(eds.): Conservation of Primates in Vietnam. Haki press, Hanoi.

Streicher, U., Schulze, H. 2002. Seasonal changes in fur pattern and colouration in the pygmy loris *Nycticebus pygmaeus*. P.398. In: Caring for Primates. Abstracts of the XIXth Congress of the International Primatological Society. Mammalogical Society of China, Beijing.

Streicher, U., Nadler, T., Zinner, D. 2003. Re-introduction study of Pygmy lorises in Vietnam, *Re-introduction News*. Newsletter of the IUCN/SSC Re-introduction Specialist Group. Abu Dhabi, UAE. No.23: 37-40.

Sumner, F. B. 1926. An analysis of geographic variation in mice of the *Peromyscus polionotus* group from Florida and Alabama. Journal of Mammalogy **7**: 149-184.

Sumner, F. B. 1927. Linear and colorimetric measurements of small mammals. Journal of Mammalogy **8**:177-206.

Sumner, P., Mollon, J. D. 2003. Colors of Primate Pelage and Skin: Objective Assesssment of Conspicousness. American Journal of Primatology **59**: 67-91.

Wang, W., Su, B., Lan, H., Liu, R., Zhu, C., Nie, W., Chen, Y., Zhang, Y. 1996. Interspecific differentiation of the slow lorises (Genus *Nycticebus*) inferred from ribosomal DNA restriction maps. Zoological Research **17**(1): 89-93.

Zhang, Y., Chen, Z., Shi, L., 1993. Phylogeny of the slow lorises (genus *Nycticebus*): an approach using mitochondrial DNA restriction enzyme analysis. Int. J. Primatol. **14** (1): 167-175.

Zhang, Y., Chen, L., Qu,W., Coggins, C. 2002. Past, Present and Future. The Primates of China: Biography and Conservation Status. China Forestry Publishing House. Beijing.

3. Pygmy Lorises in the trade

Streicher, U., Schulze, H., Fitch-Snyder, H. Confiscation, rehabilitation and placement of Slow Lorises. Recommendations to improve the handling of confiscated slow lorises *Nycticebus coucang*. In: Shekelle, M. (ed.): Primates of the Oriental Night. Treubia. Special issue. In print.

Introduction

Right in his original description of the species, BONHOTE (1907) mentioned the value of pygmy lorises for tourism, export and decoration (skin). Realizing the threats this might hold for the species, he suggested considering the species as vulnerable and recommended forbidding all hunting, trapping, capturing, and selling of pygmy lorises in markets, as well as the specific protection of pygmy lorises at all National Parks.

Despite the recent interest in primate fieldwork in Vietnam, there has been little focus on the situation of lorises in the trade. Paradoxically, the main source of information on the species has come predominantly from captive and traded animals. The information on the occurrence of the pygmy loris is often based less on sightings than on captive specimens and skins held at traders' and hunters' houses or on specimens confiscated from illegal trading (FITCH-SNYDER et al., 2002, THANH, 2002). Even new species have been described based on market animals (RICHARDSON et al., 1995).

Pygmy lorises are traded for their assumed medicinal values and for the pet trade and by ethnic minorities also for food (MacKINNON et al., 1987, HUYNH, 1998, THANH, 2002, SCHULZE et al., 2004, ROBERTON et al., in prep.). Amazingly, the Red Data Book of Vietnam lists, in addition to other characteristics of the species, its specific values; valuable for science in evolutionary studies, valuable to keep for display and export and the leather can be used to produce mounted specimens (MINISTRY OF TECHNOLOGY, SCIENCE AND ENVIRONMENT, 2000)! Dried lorises' skins can be found in most animal markets in Cambodia (STICH at al., 2002, WILD AID unpublished). Buddhist beliefs in Laos prevent the use of lorises for food or medicinal purposes to a certain degree, but still lorises are still traded for the pet market (NOOREN et al., 2001).

Pygmy lorises are common in the trade all over their distribution area. In the early nineties, hundreds of pygmy lorises could be seen in animal markets (HUYNH, 1998, RATAJSZCZAK, 1998, NADLER, pers. com.). In 1997 animal traders were officially banned from the main market building in Hanoi and the numbers of pygmy lorises in the markets heavily decreased (NADLER, pers. com.). Despite being much lower than in former times, however, the numbers of pygmy lorises in the main animal market in Hanoi are gradually increasing again (Table 3.1). This might reflect the recently increasing demand for wildlife products, which has been identified in Vietnam, particularly in the main cities (DO, 2003, SFNC, 2003).

Table 3.1 Pygmy lorises offered in Dong Xuan Market, Hanoi

Date	Number
4.8.2000	-
28.8.2000	2
6.9.2000	-
20.9.2000	2
5.10.2000	2
30.10.2000	-
11.11.2000	3
6.12.2000	-
3.2.2001	1
22.2.2001	2
23.3.2001	1
14.4.2001	3
9.5.2001	1
11.5.2001	2
23.7.2001	2
14.8.2001	6
23.8.2001	4
19.9.2001	1
26.11.2001	7
17.12.2001	7
26.4.2003	11

Lorises are protected nearly all over their distribution range (Table 3.2) and hunting, trading or keeping lorises is mostly illegal. Vietnamese forest protection law protects the pygmy loris on the highest possible level, and has done so since 1992 (COUNCIL OF MINISTERS, Decree No. 18/HDBT, Decree No. 48/2002/ND-CP, correction list No. 3399/VPCP-NN). Thus, all exploitation including hunting, catching, killing, purchasing, selling, storing, raising in cages and transporting of the animals or products thereof is prohibited. But the enforcement of the laws is low; lack of incentives, poor support from superior authorities, inadequate salaries, corruption and alcoholism have been identified as the main obstacles for correct enforcement (SFNC, 2003). The numbers of confiscations of lorises do not reflect the numbers in the trade but rather the lack of motivation in forest protection forces to confiscate the inconspicuous primate. For example, between 2000 and 2004 the Forest Protection Department in Ho Chi Minh City, a major trade point for southern Vietnam, reported only three official loris confiscations (WAR, unpublished). During the same period, however, sometimes more than ten pygmy lorises where counted by observers in the main animal market in a single day (pers.observ.). Improved law enforcement had be postulated as a crucial measure for loris conservation in Vietnam (HUYNH, 1998).

Table 3.2 Protection status of lorises

Country	Species	Legislation	Contents	Fine
Bangladesh	*Nycticebus coucang*	3rd Schedule of the Bangladesh Wildlife Preservation Act, 1974	Complete protection from hunting, killing or capture	
Buthan	Not mentioned	-		
Burma	No data available	-		
Cambodia	*Nycticebus tardigradus* *Nycticebus pygmaeus* *Nycticebus Coucang*	PRAKAS 359 Ministry of Forestry and Fisheries Species List prohibited to hunt from 1.8.1994	Prohibited to catch, hunt, poison or transport	10,000 to 1,000,000 Real (2.5 – 250 USD) 1 month to 1 year imprisonment
China	*Nycticebus coucang* *Nycticebus pygmaeus*	Class 1 protected	Illegal to capture, hold, trade, transport	Severe (death penalty theoretically possible for smuggling Class 1 protected animals e.g. pandas)
India	*Nycticebus coucang* *Nycticebus tardigradus*	Schedule I of Indian Wildlife Protection Act 1972 (1991)	Cannot be poached, kept, trophied or have derivatives extracted out of.	100,000 Indian Rupees (2150 USD) Up to 7 years imprisonment
Indonesia	*Nycticebus coucang*	Decree of Agriculture Ministry No.66 of 1973, Government Regulation No. 7 of 1999 concerning the Protection of Wild Flora and Fauna, Act No. 5 of 1999	Catching, killing, keeping, hurting, transporting and trading of live or dead lorises, parts of their bodies and derivates or products made of them is prohibited	Up to 100,000,000 Rupiah (10970 USD) Up to 5 years Imprisonment
Laos	Not mentioned	-		
Malaysia	*Nycticebus coucang*	Schedule 1 of Totally Protected Wild Animals	Hunting, killing or capturing Hunting immature animals Hunting females	Up to 5.000 Ringgit (1310 USD) Up to 3 years imprisonment Up to 6.000 Ringgit (1580 USD) Up to 6 years imprisonment Up to 10.000 Ringgit (2630 USD) Up to 10 years imprisonment
Sri Lanka	-	Fauna and Flora Protection Act 1937 (1993)	Forbidden to hunt, shoot, kill, wound or take any wild animal or have in personal possession or under personal control any wild animal, whether dead or alive or any part of such animal	10.000-20.000 Rupees (100-200 USD) or imprisonment from 2-5 years or both.
Thailand	*Nycticebus spp.*	Wildlife Preservation Act of 1992	Keeping, hunting or trading the species is illegal	Up to 40.000 Baht (1000 USD) Up to 4 years imprisonment
Vietnam	*Nycticebus Pygmaeus*	List IB, Art. 18 HBDT Ministerial Decision on the List of Rare and Endangered Wild Fauna and Flora from 1992 (2002)	Exploitation strictly forbidden (hunting, catching, killing, purchasing, selling, storing, raising in cages, transporting animals or products thereof)	Has to be prosecuted as a criminal case

A recent overview lists known occurrences of pygmy lorises in the trade (SCHULZE et al., 2004). Pygmy lorises do not only occur in the national but also in international trade and official confiscations and illegal purchases are known from Cambodia, Laos, Thailand, China, Taiwan, Hong Kong, Singapore, Japan, Russia, Poland, Germany and the Netherlands (LE

DIEN DUC, 1993, COMPTON et al., 1998, MASAPUSTOVA, 2001, SCHULZE et al., 2004). Lorises are listed in CITES appendix two, but despite the vivid trade only for two pygmy lorises official CITES documents have been issued at the Vietnamese CITES authority within the last years (CITES authority Hanoi, pers.com.).

Lorises are probably not a prime target for hunters but are rather collected during logging and slash and burn agricultural activities (RATAJSZCZAK, 1998). In addition to unsustainable hunting, widespread lack of knowledge on the species has worsened the situation. In southern China pygmy lorises have been eradicated locally since they were assumed to be a crop pests and were not considered primates (SHI, pers. com).

Due to their small size, lorises are easy to transport and are transported by land, sea and air. Lorises are transported by land in a variety of different containers including baskets, boxes and sacks are common (STREICHER, 2004). For short distances lorises are often merely tied to poles and sticks (NOOREN et al., 2001, WILD AID unpublished). All animal transport usually results in a certain mortality of the transported animals depending on species and transport conditions (JONES, 1974). Illegal trade pays particularly little respect to the transported animal’s health and transport mortalities are likely to exceed by far the rates known from legally traded species. Due to indifference and mere lack of knowledge, however, transport conditions do not often improve much after forest protection forces and animal rescue teams take over an animal (THANH, 1996, STREICHER, 2004). From a shipment of 102 pygmy lorises confiscated at a Taiwanese airport in 1993, more than 80% died between confiscation and arrival at their final destination at Saigon Zoo (EUDEY, 1995). Stress during transport has been identified as a main threat for animals’ health (FOWLER, 1974) but injuries, dehydration and mere exhaustion are also transport-associated health problems in pygmy lorises (MASOPUSTOVA, 2001, STREICHER, 2004).

The care given to an animal during and immediately after capture is known to play an important role for an animal’s survival, but the care after arrival at the final destination (be it a rescue centre, zoo or other long-term holding facility) is equally important. Mortality figures and quality of care during the first 30 days are strongly correlated (JONES, 1974).

There is little information on mortality rates in lorises after confiscation. SCHULZE (1998) reported high mortalities in *L. tardigradus* after translocation to a new facility and out of a large transport of slow lorises confiscated in Indonesia about 80% died within the first three months after confiscation (HAAS, in litt.). From seven confiscated lorises transferred to Saigon zoo, three died within the first six weeks (EUDEY, 1995). All pygmy lorises confiscated at Prague airport and brought into quarantine at Prague zoo between 1990 and 2000 died (MASOPUSTOVA, 2001). Death cases after arrival at a new facility might still be related to stress during transport and weeks might pass until the full results of transport related stress become apparent (FOWLER, 1974).

After confiscation lorises were in most cases released (WANG et al., 1996, THANH, 1996, STREICHER, 1998, SCHULZE et al., 2004, WAR, WFFT, WILD AID unpublished data). Introduction of disease, food competition and hybridisation with resident species are only some of the problems associated with such wild releases (KLEIMANN, 1996, CHIVERS, 1991, IUCN, 1998, IUCN, 2002, SOORAE et al., 2002). Such releases were nowhere monitored and it is unknown how many of the released animals survived at all.

Captivity also largely failed to provide a solution to the problem. Rescue centres and Asian zoos were confronted with the task of taking over confiscated lorises, which sometimes comprised as many as 100 individuals (SUN, in litt., PROFAUNA unpublished). Due to limited knowledge on correct handling and management of lorises, mortalities were exceedingly high. Despite their small size lorises required a lot of cage space and could not be successfully kept in large groups (HAAS, in litt.). The mere proximity of conspecifics might put considerable stress on the solitary lorises (PETTER, 1975, FITCH-SNYDER et al., 2001, SCHULZE et al., 2004) and death cases in lorises were related mainly to stress but also to trauma and disease (see Chapter 4.) Quiet, isolated housing in adequate numbers which would be required for the solitary and nocturnal animals could not be provided at zoos or rescue centres (HAAS, in litt., SUN, in litt.). To keep lorises for good at zoos was only possible in a few cases. Lorises have to be kept in nocturnal exhibits, which require a high degree of management (FITCH-SNYDER et al., in print) and where cage space is usually limited. Consequently, large numbers of animals have been returned to the country of origin (SUN, in litt.) where they then were released.

Though international guidelines on placement of confiscated animals in particularly primates are widely available, especially for primates, (IUCN, 1998, IUCN, 2002, SOORAE et al., 2002) they were not taken into account when dealing with confiscated lorises.

Recommendations to improve the handling of confiscated lorises

The need to develop standards and recommendations for the handling and placement of trade- confiscated lorises became obvious. On an International Workshop on Tarsier and Loris Taxonomy, Husbandry and Conservation in Jakarta in 2003, an effort was undertaken to develop such guidelines. The aim was to provide guidance for those involved in confiscation and handling of confiscated lorises and consequently to reduce mortalities, but also to avoid ill-managed releases of confiscated animals. The recommendations addressed in a concise form all aspects relating to confiscation, rehabilitation and placement in a way practicable for those involved in these processes. It gives guidance on correct handling, construction of transport containers, species identification, measuring, emergency health care, quarantine, short term-housing, feeding and placement options. .

Discussion

The need to improve the process of handling and confiscation of lorises

Improving the present process of loris handling and confiscation requires considerable efforts in capacity building and requires considerable financial and personal resources. Only then can confiscated lorises be integrated into comprehensive conservation programmes and contribute effectively to the species' conservation; otherwise, confiscation and rescue remains predominantly and merely an act of animal welfare (STREICHER, 2004). It can be argued if it makes sense to improve the present process of loris handling and confiscation at all. Regarding the difficulties, including financial and personal commitments related to successful rescue, captive management and reintroduction, would it not be wise to euthanize lorises at the moment confiscation and simply strive to further improve their protection in their habitats?

On the other hand the improvement, which can be achieved is impressive. At the Endangered Primate Rescue Centre, where the recommendations have been developed, the survival rate of newly arriving pygmy lorises is over 90%.

Field data on pygmy lorises are currently very rare (THANH, 2002) and market animals have always been a main source of scientific information (RICHARDSON et al. 1995, RATAJSZCZAK, 1998, FITCH-SNYDER et al., 2002).

As long as field data are missing, confiscated lorises must be considered an important source of information. Lacking a standard format for data collection, confiscating authorities do not collect any data besides species, animal numbers and total weight (SFNC, unpublished, NINH BINH FPD, unpublished). But detailed data collection on these animals would not only be of scientific interest, however, it would also help to develop adequate long-term solutions for the confiscated animals. Data on confiscation locality could provide information on local and regional variations, potentially even on habitat requirements. Data on morphometrics of each confiscated individual at the time of confiscation could help to identify target groups in the species and could help to document seasonal processes. Data collected on animals confiscated together could allow conclusions on their social structure (for example if females are confiscated together with their offspring in November). All these data are important sources of information in respect to later placement options for the animals.

Lorises seem to be rare in the wild (MacKINNON et al., 1987, THANH, 1996, 2002, HUYNH, 1998) and due to the unabated poaching in Vietnam the numbers are probably still decreasing. Captive breeding could become an important contribution to the species' conservation within the near future. Captive breeding populations could assure the availability of reintroduction stock, should reintroduction become a feasible option.

Captive populations would also be an important study possibility in order to further improve the understanding of the species (see Chapter 5).

Releasing radio-collared individuals provides an excellent opportunity to study the ecology of the species (see Chapter 6 and 7). Further, a full understanding of the species' ecology is an inevitable condition for successful captive management, efficient habitat protection, successful reintroduction and other conservation measures.

Public awareness of the pygmy loris is rudimentary or lacking completely. The fact that it has been considered a pest animal reflects the complete lack of understanding and demonstrates how a lack of understanding might lead not only to indifference but also to disastrous measures towards a species. Confiscated animals provide a good opportunity to explain relations between market demand, trade and species extinction. Well-presented examples of confiscation cases can be used to raise concerns about a species' status in the wild and to raise a feeling of commitment. Confiscated animals under captive conditions provide an excellent opportunity to prepare educational materials and films.

According to International Guidelines (IUCN, 1998), confiscated pygmy lorises in Vietnam meet all conditions for euthanasia. From a merely conservation based point of view it might be sensible to sacrifice individuals, which are already in the trade and lost to the wild populations, in order not to endanger the remaining animals in the wild (IUCN, 1998). The guidelines postulate accepting euthanasia as a valid alternative to captive breeding and return to the wild. But accepting these standards does require a broad view of conservation, which can't be taken for granted in a country like Vietnam just undertaking the first steps towards conservation. It is important to educate the public about the seriousness of the wildlife trade and the irreversibility of the damages done to the wild populations. There will always be confiscated animals, which can't be integrated in conservation programmes. It is important that the public realizes that even with confiscations and rescue programmes there is no way back for many animals and they consequently have to be euthanized. If euthanasia is the only solution offered, however, public acceptance for conservation and protection measures might be reduced and forest protection forces discouraged. In the worst case scenario, such a policy might reduce the rangers' readiness to confiscate lorises at all, if they assume that the animals are better off in illegal captivity as a pet than euthanized. The need to euthanize single animals too old or too sick for captive breeding or reintroduction might be more understandable if such an action is contrasted by rescues in a conservation oriented context, for example by integrating animals in a captive breeding programme.

Finally there is a strong aspect of animal welfare justifying all possible efforts to improve the present disastrous handling, confiscation and placement conditions.

The need for scientific investigations, the need to establish captive breeding populations, the need to raise public awareness, the need to offer a more positive conservation approach than euthanasia and finally the need for animal welfare are sufficient reasons to strive to improve current procedures of confiscating and managing confiscated pygmy lorises.

References

Compton, J., Le, H. Q. 1998. Borderline – An Assessment of Wildlife Trade in Vietnam. WWF Indochina Programme, Hanoi.

Chivers, D. J. 1991. Guidelines for re-introductions: procedures and problems. Symp. Zool. Soc. Lond. No **62**: 89-99.

Council of Ministers. 1992. Decree No. 18/HDBT of January 17 prescribing the list of precious and rare forest plants and animals and the regime of management and protection thereof.

Council of Ministers. 2002. Decree No. 48/2002/ND-CP of April 22.

Council of Ministers. 2002. Correction list No. 3399/VPCP-NN of June 21.

Do, K. C. 2003. A Thematic Research Group Report in support of the National Action Plan on Strengthening Wildlife Trade Controls in Vietnam 2004-2010. Unpubl.

Eudey, A. A.1995. Southeast Asian Primate Trade Routes. Primate Report **41:** 33-42.

Fitch-Snyder, H., Schulze, H., Larson, L. (eds.) 2001. Management of Lorises in captivity. A husbandry manual for Asian Lorisines (*Nycticebus* & *Loris* spp.). Center for Reproduction of Endangered Species, Zoological Society of San Diego, San Diego.

Fitch-Snyder, H. Schulze, H., Streicher, U. Enclosure design for *Nycticebus spp.*In: Shekelle, M.(ed): Primates of the Oriental Night. Treubia. In print.

Fitch-Snyder, H., Vu N. T. 2002. A preliminary survey of lorises (*Nycticebus spp*.) in Northern Vietnam. Asian Primates – A Newsletter of the IUCN/SSC Primate Specialist Group. Vol.**8**, No.1,2: 1-6.

Fowler, M. E. 1974. Veterinary aspects of restraint and transport of wild animals. Int Zoo Yearb Vol **14**: 28-33.

Huynh, D. H. 1998. Ecology, Biology and Conservation status of Prosimian Species in Vietnam. Folia Primatol **69** (suppl 1): 101-108.

IUCN. 1998. Guidelines for Re-introductions. Prepared by the IUCN/SSC Re-introduction Specialist Group. IUCN, Gland, Switzerland and Cambridge.

IUCN. 2002. Guidelines for the Placement of Confiscated Animals. Prepared by the IUCN/SSC Re-introduction Specialist Group. IUCN, Gland, Switzerland and Cambridge.

Jones, M. L. 1974. Mortality of wild-caught animals after arrival in the zoo. Int Zoo Yearb Vol **14**: 37-39.

Kleimann, D. G. 1996. Reintroduction Programs. In Kleimann, D.G., Allen, M.E., Thompson, K.V., Lumpkin, S., Holly, H. (eds.): Wild Mammals in Captivity. University of Chicago Press. Chicago and London.

Le, D. D. 1993. Final Report on the Vietnam Wildlife Trade Monitoring Project. Centre for Natural Resources and Environmental Studies (CRES), Hanoi.

Masopustova, R. 2001. The Quadruplets and Twins of Lesser Slow Loris in Prague Zoo. Gazella **28**: 63-71.

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

Ministry of Scienece, Technology and Environment (ed.) 2000. Red Data Book of Vietnam, Vol. 1. Animals. Hanoi.

Nooren, H., Claridge, G. 2001. Wildlife Trade in Laos: the End of the Game. A History of Wildlife Trade in Laos to 1995. Netherlands Committee for IUCN, Amsterdam.

Petter, J.-J. 1975. Breeding of Malagasy lemurs in captivity. Pp. 187-202. In: Martin, R.D. (ed.): Breeding endangered species in captivity. Academic Press, London.

Ratajszczak, R. 1998. Taxonomy, distribution and status of the lesser slow loris *Nycticebus pygmaeus* and their implications for captive management. Folia Primatol. **69** (suppl. 1): 171-174.

Richardson, D. M., Ratajszczak R. 1995. A possible new species of Nycticebus from Vietnam. Unknown source.

Roberton, S., Nguyen, T. T., Nguyen, T.V., Tran, V. P., Ngo, D. H., Hoang, M. L., Doan, D. V., Tran, Q. H., Cao, T. H., Phan, V. L., Tran, V. D. An Assessment of the Threats to the biodiversity of Phong Nha Ke Bang National Park, Quang Binh province, Vietnam. Repost No. 1: The Illegal Trade in Wildlife. Fauna & Flora International and Phong Nha National Park. Vietnam. In prep.

Schulze, H. 1998. Developing a husbandry manual to facilitate the distribution and presentation of information: with special reference to slender loris *Loris tardigradus nordicus* at Ruhr-University, Bochum. International Zoo Yearbook **36**: 34-48.

Schulze, H., Streicher, U. 2004. Threat for lorises and pottos. In: Conservation database for lorises and pottos. http://www.loris-conservation.org

Schulze, H., Groves, C. 2004. Taxonomic problems caused by illegal trade. Pp. 33-36. In: Nadler, T., Streicher, U., Ha, T. L. (eds.): Conservation of Primates in Vietnam. Haki press, Hanoi.

SFNC. 2003. Hunting and Trading Wildlife: An investigation into the wildlife trade in and around the Pu Mat National Park, Nghe An province, Vietnam. SFNC, Vinh.

Soorae, P. S., Baker, L. R. (eds.) 2002. Re-introduction News: Special Primate Issue, Newsletter of the IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, UAE. No. **21**: 60pp.

Stich, I., Krüger, K.-O. 2002. Artenschutz in Kambodscha. ZGAP Mitteilungen, 18. Jahrgang, **2**: 7-9.

Streicher, U. 1998.Vietnams Tierhandel- Gibt es einen Ausweg? Mitteilungen der ZGAP. 14.Jahrgang, Heft **2:** 4-8.

Streicher, U. 2004. Confiscated Primates- health problems and placement options. Pp. 154-160. In: Nadler, T., Streicher, U., Ha, T. L. (eds.): Conservation of Primates in Vietnam. Haki press, Hanoi.

Thanh, V. N. 1996. Biodiversity and Biodiversity Loss. Presentation held at the Seminar on Environment and Development in Vietnam. Australian National University. Canberra.

Thanh, V. N. 2002. The status and conservation of the loris species, *Nycticebus coucang* and *N. pygmaeus* in Vietnam. P. 254. In: Caring for Primates. Abstracts of the XIXth Congress of the International Primatological Society. Mammalogical Society of China, Beijing.

Wang, Z., Wu, D., Chen, H. 1996. Preliminary Survey on Transfrontier Wildlife Trade in Yunnan. Pp. 188-196. In: Schei, P. J., Wang, S., Xie, Y. (eds.): Conserving China's Biodiversity (II). China Environmental Science Press, Beijing.

4. Health problems in trade confiscated Pygmy Lorises

Introduction

Nothing is known on diseases of pygmy lorises in the wild and little about diseases in captivity. There are a number of overviews on diseases in prosimians (BENIRSCHKE et al. 1985, JUNGE, 1999, JUNGE, 2003), but they mostly focus on lemurs. SUTHERLAND-SMITH et al. (2001) provided an overview about diseases in lorises from several holding facilities in the United States, but it mostly refers to *L. tardigradus* and *N. coucang* and information on *N .pygmaeus* is scarce. The lack of reports on diseases, however, must not be mistaken for a lack of disease cases. By way of contrast, whilst the slow loris has been successfully kept and bred in zoos since 1899, the pygmy loris was not kept very successfully (JONES, 1986) and was not bred in captivity until later than 1988 (FITCH-SNYDER et al., 2001). To keep and breed pygmy lorises seemed more difficult than keeping the larger relatives. In 1998 the reproduction in captivity did still not cover mortality and the world's captive population was maintained predominantly with wild caught animals (RATAJSZCZAK, 1998).

Pygmy lorises show only a limited range of reactions to discomfort. Signs of disease lack nearly completely and are probably often overlooked. In Asian rescue centres lorises are, because of financial constraints and the possibility of later reintroduction, kept under natural lighting conditions. Consequently, the main activity period of the animals does not coincide with the working hours of the staff. Health problems are therefore often recognized too late (FITCH-SNYDER et al., in print) so that cases of disease are insufficiently known and remain undocumented.

Materials and Methods

Reviewed were health problems, which occurred in the pygmy loris population at the Endangered Primate Rescue Center between January 1997 and May 2004. A total number of 51 pygmy lorises had been registered at the EPRC during that time. Reviewed was also the available literature on health problems in pygmy lorises.

On arrival, all pygmy lorises received a health check and undergo a six weeks quarantine, which is described in detail below.

Data on the animals was kept on simple medical sheets. If necropsies were performed separate section reports were prepared. However, necropsies could rarely be performed since in the large outdoor enclosures with natural soil and in the warm and humid climate, insects and microorganisms facilitated fast decay. Often until a carcass was found the following morning it was already partly devoured and it was impossible to perform necropsy.

If possible, data on the specific health problems were assessed quantitatively or semi-quantitatively to allow comparison with related species; in particular the other loris species. Each of the identified health problems is briefly discussed. Since anaesthesia was a routine practice for examination, the anaesthesia used is introduced at the beginning.

Results

A variety of health problems did occur within the study population but the majority seemed to be sporadic cases. Between 1997 and 2004, 17 pygmy lorises died. Eleven of these were juveniles of less than a year. Of the adults which died, two died within the first months after arrival and four were long-term residents.

Table. 4.1 Population demographics in the study population

Year	Number of new arrivals	Number of birth	Death cases	
			infants	adults
1997*	4	4	2	
1998	1	-	-	-
1999	5	3	2	-
2000	7	6	2	1
2001	5	8	3	1
2002	1	2	2	-
2003	2	-	-	1
2004	-	3	-	1
Total	**25**	**26**	**11**	**4**

* Pygmy lorises arriving prior to 1997 are included in here

Quarantine

On arrival pygmy lorises are weighed and undergo a brief health check and receive treatment if health problems are obvious. They are transferred into quarantine cages, which are located in a quiet area behind the main quarantine building. The cages measure 60cm x 80cm x 80cm and are furnished with branches with foliage, bamboo and a sleeping box. The animals are fed in the late afternoon, with the regular food, however, special attention is paid to find food items, what they will initially accept (see Chapter 7). After about a week the animals receive a thorough health check under anaesthesia. They are weighed, the dental formula is noted, a full set of morphometric measurements is taken, the animals are treated against parasites and receive an intradermal Tb test, a microchip is implanted and samples are taken for genetic identification. Quarantine duration is six weeks as recommended by IUCN (WOODFORD, 2001).

4.1 Anaesthesia

Ketamine and tiletamin/zolazepam in combination with various other agents have been recommended drugs for anaesthesia in prosimians (JUNGE, 2003). Tiletamine/zolazepam was not available at the EPRC and ketamine and xylazine were the only drugs available. Literature values of ketamine and ketamine combinations are given in Tab.4.2.

Table 4.2 Literature values of dosages of ketamine and ketamine combinations

Source	**Ketamine**	**Ketamine Medetomidine**	**Ketamine Medetomidine Butorphanol**	**Medetomidine Butorphanol Midazolam**	**Ketamine Xylazine**
JUNGE, 2003		5 0.05	3 0.04 0.4	0.04 0.4 0.3	
GOELTENBOTH et al., 1995	10-20				6-8 0.5-1
GASS, 1987	5-15				
WIESNER et al., 1989					2 2.5
RIETSCHEL, 1991					5 0.5
JALANKA et al., 1990		5-8 0.06-0.1			
BUSH, M., 1996	10				10 0.1-0.5

Anaesthesia was performed during the late afternoon hours taking into account the pygmy lorises' nocturnal activity pattern. Anaesthesia was not performed during the winter period when the animals seemed to rest because of unknown impacts to the already low metabolism.

Handling pygmy lorises has been reported to require two people, due to the lorises' habit to cling to the wiring or furnishings (PUSCHMANN, 2004). To avoid stressing the animals prior to anaesthesia they were injected in the cages without much handling either in their sleeping boxes or by being fixed in their present position. Animals were then left in the same position until a sufficient anaesthetic effect was achieved and the animals could be handled without problems. This proceeding assured that no second person was required for handling.

Table 4.3 Ketamine dosages used for anaesthesia in *N. pygmaeus* at the EPRC

Dosage in mg	Weight in g	Sex	$T_{effective}$ in minutes**	$T_{recovery}$ in minutes**	Heart rate in beats/minute	Respiration rate in breaths/minute	T_{body} in °C
8	380	F	3	28	160	126	36.5
8	360	F	7	49	148	160	35.5
10	440	M	6	26	200	160	35.2
8	380	F	4	28	160	126	36.5
8	480	F	7	42	140	126	36.5
7	400	M	5	26	172	60	-
10 + 7*	400	M	12*	-	-	-	-
7	320	F	4	14	204	100	-
10+10*	380	M	12*	-	192	60	35.4
7	420	M	6	30	142	96	35.1
10	300	F	3	36	144	74	36.2
10+10*	320	M	15*	30*	198	40	36.2
8	340	F	4	36	156	158	36.8
8	330	F	5	40	184	126	36.7
10	540	F	4	25	150	148	-
10+10*	420	M	4	-	210	168	-
10	420	F	4	-	-	-	-
5+4*	550	M	16*	40*	142	108	34.6
5+7*	580	F	13*	30*	100	76	35.3
10	360	F	6	39	160	124	34.5
10	560	F	5	-	142	106	36.1
6	300	M	5	53	92	52	<34.0
10	260	M	5	35	154	52	35.1
7	360	F	10	38	94	132	34.6
7+5*	360	F	13*	28*	76	92	34.9
7	240	M	9	34	92	104	<34.0
7	360	M	5	28	186	124	34.8
10	400	M	4	25	176	144	34.9
6+6+12*	400	M	27*	57*	92	140	34.0
10	400	M	8	25	84	130	34.5
6	320	F	5	20	180	146	34.3
8	400	F	5	-	70	148	<34.0
7+5*	420	M	12*	35*	192	136	-
10	480	M	2	-	144	102	36.3

* in these cases animals were not sufficiently anaesthetized after 10 minutes and required a second/third injection.
** Teffective and T recovery are measured from the first injection of anaesthetic until full anaesthesia respectively until the animal started to show coordinated movements again.

Ketamine has been successfully used in *N. pygmaeus* for routine checks and smaller painless procedures: for example to fix a radio collar or implant a transponder for identification. The anaesthetic effect was achieved after 5 (±2) minutes and lasted 32 (±9) minutes, which was sufficiently long for smaller procedures. The average dosage used was 27 mg/ kg bodyweight. The analgesic effect was moderate and for painful interventions like the removal of teeth general anaesthesia had to be supplemented with local anaesthesia.

4.2 Parasites

Endoparasites

Protozoan parasites, nematodes, trematodes and cestodes are known to occur in prosimians (TOFT, 1986), but most reports again relate to lemurs. Only a few protozoan parasites have been reported for the lorises; *Trichomonas, Cryptosporidia* and *Trypanomsoma* have been identified in slow lorises (KUNTZ et al., 1970, ZAMAN, 1972, SUTHERLAND-SMITH et al., 2001) and *Giardia* has been reported in the pygmy loris (SUTHERLAND-SMITH et al., 2001).

Nematodes have been reported by a number of authors and multiple taxa (*Trichuris, Strongyloides, Strongylus, Gongylonema, Oxyuris, Enterobius, Physaloptera, Filaria, Spirura, Pterygodermatides*) have been identified for the slow loris (MONNIG, 1920, QUENTIN et al., 1975, QUENTIN et al., 1979, GRINER, 1983, TUGGLE et al., 1984, BENIRSCHKE et al., 1985, JUNGE, 1999, SUTHERLAND-SMITH et al., 2001). Whereas most parasitic infections are reported to be asymptomatic, *Pterygodermatides nycticebi* caused significant even fatal anaemia (TUGGLE et al., 1984, SUTHERLAND-SMITH et al., 2001). There are fewer reports on nematodes in slender lorises and only some species have been identified (*Dipetalonema, Strongyloides, Subulura, Physaloptera, Breinlia*) (GUPTA et al., 1975, KRISHNAMOORTHY et al., 1978, BAIN et al., 1979, SUTHERLAND-SMITH et al., 2001). Cestodes, trematodes and acantocephala have rarely been reported in any loris species and only a few taxa have been identified (*Hymenolepis, Phaneropsulus, Echinorhynchus*) (SUTHERLAND-SMITH et al., HILL, 1937). Only very few parasites have that far been identified in the pygmy loris, namely *Enterobius, Trichuris, Microfilaria. Hymenolepis*-like eggs have been found in one animal at San Diego Zoo (SUTHERLAND-SMITH et al., 2001).

Within the study population pointed round worms, 1-2mm long were found around anus and in faeces of some animals on arrival, which were identified as *Enterobius* sp.. *Strongylus* sp. were found several times in fecal examinations. During necropsy parasites were found in the stomach of another individual, which were assumed to be *Physaloptera* sp..

Ectoparasites

TOFT (1986) had reported fleas in prosimians without specific reference to lorises. A cat flea has previously been found in a captive slender loris (PHILLIPS, 1984) and RIETSCHEL (pers. com) identified fleas in a captive slow loris. Lice have previously been reported in lorises (TOFT, 1986).

Within the study population *Mallophaga* sp. were observed in one animal. The animal arrived in a very bad general condition and had previously been in captivity for some time. Lice were mostly gathered around the eyes and forehead. The fur was in a good condition and the animal did not show excessive scratching. Lice were not observed in freshly caught animals or in animals of the captive population.

4.3 Infectious diseases

Though tuberculosis has not been reported from lorises, a few pygmy lorises at San Diego Zoo had previously responded to tuberculine testing. However additional testing remained negative (SUTHERLAND-SMITH et al., 2001). Herpesvirus infections have been reported in association with persisting dental problems and lymphosarcoma (STETTER et al., 1995, JUNGE, 2003), but also in lorises without any clinical symptoms (WORLEY et al., 1991).

In the study population tuberculine testing was part of the routine screening of new arrivals during quarantine. Intradermal (eyelid) testing was performed with avian and all mammal tuberculine. None of the tested animals showed a positive reaction. Testing for herpesvirus is currently not possible in Vietnam and logistic difficulties prevent including it in the routine screening.

4.4 Organic diseases

4.4.1 Respiratory organs

No problems with the respiratory organs were observed in any animal of the study population in vivo. However necropsy findings in an old pygmy loris included alterations of the lungs suggesting pneumonia.

4.4.2 Digestive organs

Teeth

Dental problems have been identified as one of the main health problems in captive lorises. In *N. pygmaeus* they included dental disease and recurrent facial abscessation (SUTHERLAND-SMITH et al., 2001). Dental problems have been associated with herpesvirus infection (JUNGE, 2003), but dietary has also been suggested to play a role (SUTHERLAND-SMITH et al., 2001). In confiscated slow lorises in Indonesia, severe dental problems were found to be common due to the traders' practice of pulling teeth in lorises destined for the pet market. Lorises subsequently developed severe gingivitis and osteomyelitis.

In the study population dental health was assessed every time an animal was under anaesthesia according to the following categories: 1- milk teeth, 2 - very good, no signs of usage, 3 – good, first signs of usage, 4 - worn, lacking teeth.

Confiscated wild pygmy lorises showed few teeth problems. The only alteration sometimes observed were chipped canine tips, potentially a result of biting into hard materials (metal, wire) during transport. The assessment of the teeth allowed a rough age estimate on the pygmy lorises and the majority of pygmy lorises confiscated were between 2 and 8 years old at confiscation. Teeth remained in very good health during the animals' life in captivity and even old animals showed no dental problems besides regular tooth wear. Major signs of usage only occurred in animals older than 10 years. One animal, which has previously been kept long-time in a facility in Europe, showed recurrent problems with tartar and gingivitis. The animal gradually lost the first upper premolars, the lower canines and eventually second upper premolars. It is possible that this animal had acquired this condition in an unsuitable captive environment, but underlying viral and metabolic causes cannot be excluded. This animal did not show any gouging on branches.

The food offered to the study population differs hardly from the food in facilities, which report dental problems to be common. However, the cages at the EPRC are furnished mainly with natural branches. Tree gouging and scraping for sap is part of the lorises' feeding behaviour in the wild (TAN et al., 2001, WIENS, 1995, NASH, 1986) and the dental comb (BYRD et al., 1982) plays an important role in food acquisition. Bite marks on branches proved that captive animals searched for possibilities to scrape for sap, even if they were offered sufficient other food (see Chapter 7, Plate 7.2).

The dental health of the study population provided evidence that the captive environment is a prime cause influencing dental condition. Access to fresh branches to encourage tree gouging and scraping is essential for dental health. It is unknown, however, if animals at other facilities, which are already several generations in captivity, still show this behaviour. Insufficient scraping and thus lacking stimulation of the gums, lack of natural abrasion and cleaning of teeth might be the prime cause for dental problems. This could either be caused by a lack of scraping possibilities or by the gradual loss of the behaviour in captivity.

Stomach

Trichobezoars have been a common finding in prosimians in captivity (BROCKMAN et al., 1988), but the problem is not known from wild individuals. It has been assumed that components in the natural diet prevent accumulation of hair in the stomach of wild animals (JUNGE, 1999). Within the lorises a trichobezoar had previously been described in *L. tardigradus* (SCHULZE et al., 2004).

One animal in the study population did show reduced appetite and weight loss, but clinical examination did not find any cause for this condition. The animal eventually died and a trichobezoar was found in the stomach at necropsy (Plate 4.1).

Plate 4.1 Trichobezoar found in a pygmy loris at necropsy

In another case multiple regular round red 1-2mm petechia in the stomach were found in an animal and an infectious gastritis was diagnosed. However, the cause of the gastric problem remained unclear.

Gastric ulcerations were found at necropsy in an animal that died two weeks after arrival and stress could have been the primary cause for this condition.

4.4.3 Urinary organs

Kidney

Age related renal degeneration is a common cause of mortality in older prosimians (BENIRSCHKE et al., 1985) and has been identified as one of the main death reasons in captive lorises (SUTHERLAND-SMITH et al., 2001).

A prolonged period of wet abdomen was observed in an old animal (>> 10 years). The animal also had a strong uraemic smell and the wet abdomen was supposed to be a sign of profuse urinating. The animal died and kidney problems were assumed to be the primary cause. Another animal showed no signs besides severe uraemic smell, kachexia, inappentence and weakness and died also of assumed kidney problems. However in both cases the carcasses were not available for necropsy and it was not possible to verify the assumptions.

Urine sucking

One animal arrived severely dehydrated and showed an inflamed praeputium and an inflamed and partly prolapsed penis (Plate 4.2). The animal frequently sucked on his own penis. It was assumed that this was rather an effort to equalize the lack of liquid than a behavioural aberration.

Plate 4.2 Enlarged, inflamed penis of a pygmy loris showing urine sucking

4.4.4 Nervous system

Meningitis

Viral encephalitis has been reported in prosimians (JUNGE, 2003), but not in lorises specifically.

One juvenile animal in the study population suddenly showed a severe head tilt and uncoordinated movements (Plate 4.3). The animal died several hours later. Bite marks were found in the neck and on the head and septic meningitis was diagnosed.

Plate 4.3 Pygmy loris showing symptoms of meningitis. The fur is dirty and wet since the animal, seemingly, had fallen to the ground.

Other neurological problems

A case of ataxia and tremor of unknown origin and two cases of neurological disorders in connection with late gestation in pygmy lorises have been reported by SUTHERLAND-SMITH et al. (2001).

Nothing comparable was observed in the study population.

4.4.5 Sense organs

Eyes

Conjunctivitis

Conjunctivitis was a frequent finding in lorises in some facilities (SUTHERLAND-SMITH et al., 2001).

In the study population, purulent conjunctivitis has been observed in four animals after transport. It usually resolved after some days without complication and was most probably caused by environmental conditions during transport in particular air-conditioned transport vehicles.

Keratitis, Uveitis

One animal received a corneal injury during a fight with cagemates, which resulted in keratitis, uveitis and the fibrous organisation of the uvea (Plate 4.4).

Plate 4.4 Pygmy lorises with severe traumatic keratitis and uveitis

Retinal alterations

SCHMELTING (2001) reported lens luxation, retinal atrophy and permanent mydriasis in a colony of grey mouse lemurs without identifying the underlying cause. A detached retina of probably traumatic origin has been diagnosed in a pygmy loris (SUTHERLAND-SMITH et al., 2001).

Within the study population one animal showed permanent bilateral mydriasis and retinal atrophy on arrival (Plate 4.5). The cause of this condition is unknown. Bilateral trauma seems unlikely and a congenital anomaly has been assumed.

Plate 4.5 Bilateral retinal atrophy

Ears

Otitis externa and media has been reported from a North American facility (SUTHERLAND-SMITH et al., 2001).

No ear problems occurred in the study population.

4.4.6 Skin

Dermatitis

Ulcerative dermatitis of the tarsus had previously been described in lorises (SUTHERLAND-SMITH et al., 2001).

Comparable cases of ulcerative dermatitis of the carpus were observed in two animals on arrival (Plate 4.6). The pathogenesis of this condition was unknown. Due to little subcutaneous tissue on the distal extremities, infections had a bad healing tendency and wounds required months to fully close. It has been suspected that the specific structure of the blood vessels in this area (MIYAKE et al., 1991) prevents rapid healing.

Plate 4.6 Dermatitis of the carpus at healing stage

Dermatomycosis

Cutaneous mycoses have been reported to be rare in prosimians and have been associated with excessive scent marking processes (JUNGE, 2003). Cases of dermatomycosis have been reported from a captive population of slender lorises (SCHULZE et al., 2004).

Several cases of dermatomycosis did occur in the study population. The infected areas were mostly the abdomen and the inner sides of the legs (Plate 4.7). Complete hair loss, redness, white flaking and mild dark pigmentation were observed. In some cases dermatomycosis was preceded by a period of wet skin on the abdomen.

Plate 4.7 Dermatomycosis on an individual with radiocollar (the animal was consequently excluded from the reintroduction study until the condition had fully cleared up)

Wet abdomen

SUTHERLAND-SMITH et al. (2001) described idiopathic wet abdomen in *N. pygmaeus* and ruled out renal disease as a primary cause.

Wet abdomen did occur several times in the study population (Plate 4.8). Wet abdomen during times of extreme heat was obviously caused by the pygmy lorises wetting themselves with saliva. This behaviour is known from *N. coucang* and seems to be a strategy to prevent overheating (MUELLER, 1979) and a similar behaviour has also been reported from *L. tardigradus* (SCHULZE, in litt.). In these cases wet abdomen was observed only for a short period or only for single days. Extended periods of wet abdomen in conjunction with uraemic smell were obviously signs of severe renal disease. At least three times wet abdomens obviously facilitated the development of dermatomycosis.

Plate 4.8 Typical picture of idiopathic wet abdomen

Irregular moulting, hair-loss

Irregularities in moulting occured in one animal of the study population, with a moderate overall condition. The winter pelage persisted on the hind parts of the animal, whereas the front parts already showed the summer pelage (Plate 4.9). Another animal lost all hair on the throat, sides of the neck and the arms. The condition was not clearly connected to a primary skin disease. Both animals recovered spontaneously.

Plate 4.9 Irregular moulting. The front parts of the animals already show summer pelage, whereas the hind parts still show the winter pelage

4.5 Metabolism

Dehydration had been observed in animals on arrival. Lorises drink very little and usually cover their fluid need via the food (FITCH-SNYDER et al., 2001), but prolonged periods of starvation and thirst particularly in traded animals might lead to dehydration. Symptoms are drowsiness, reduced coordination, sunken eyes, reduced skin turgor (Plate 4.10).

Plate 4.10 Dehydrated pygmy loris with sunken eyes and dry skin. Typical is the disability to pull the hind legs up to the body and the hanging of the limbs.

4.6 Trauma

Injuries were separated into two groups. Part of the injuries resulted from hunting and transport and the other part were injuries resulting from intraspecific aggression.

The first group of injuries did not play a major role in pygmy lorises. Only 4 of the 25 arriving animals had injuries resulting from hunting and transport. Pygmy lorises mostly are opportunistically collected during logging and firewood cutting in daytime and thus get hardly injured. For sale and transport hands and feet of the lorises are often tied together with strings, which are then fixed to poles (NOOREN et al., 2001). Necrosis and severe skin infections can be the result. Injured toes occurred in one animal and another animal was lacking one finger on the left hand. Lorises have a very firm grip and grasp for edges of objects where their hands and feet can easily get traumatized.

SUTHERLAND-SMITH et al. (2001) reported bite wounds to be a common problem in *N. pygmaeus*. Bite wounds were often severe leading to abscessation or even septicaemia and death. It has been discussed that the severe reactions following lorises' bites are related to the toxicity of the excretions of their brachial glands mixed with saliva (WILDE, 1972, ALTERMAN et al., 1991, ALTERMAN, 1995).

In the study population injuries resulting from intraspecific aggression mostly occurred during the mating season and in females. They occurred in groups and between animals, which had previously lived together for years without problems. Observations suggested that it was one female attacking another. Bite wounds were mostly located on the hind legs and the tail area or the head and neck area. Injuries could be severe and lead to abscesses and extended skin necrosis (Plate 4.11). In one case an animal died with symptoms of acute meningitis as the result of severe bite wounds on the neck. Females never got pregnant during the respective mating season, when they had been attacked. The only injuries in a male were connected to efforts of integrating this male into a new group.

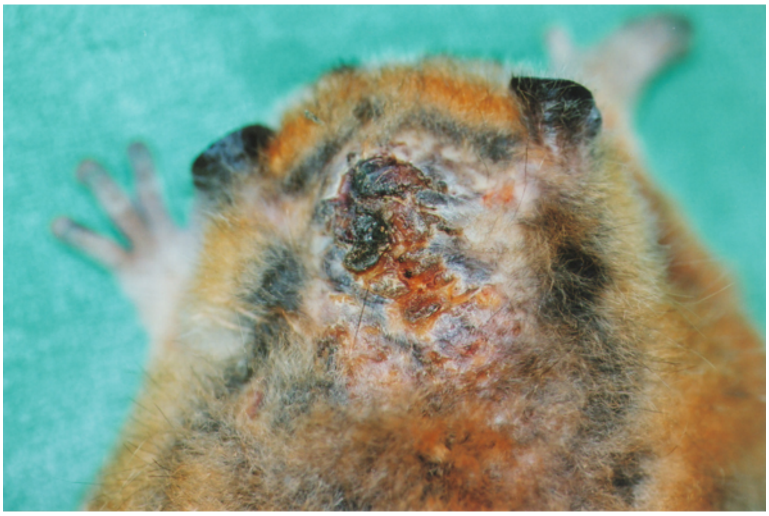


Plate 4.11 Typical bite wounds in the neck after conflict with a conspecific.

4.7 Neoplasia

A variety of neoplasia has been reported in prosimians. Diagnosed tumours included hepatocellular carcinoma, adenocarcinoma, lymphosarcoma, fibrosarcoma and carcinoma of thyroid, ovary and bile duct (GRINER, 1983, BENIRSCHKE et al., 1985, LOWENSTINE, 1986, JUNGE, 2003). Tumours of the skin and subcutis are also common among prosimians (incidence > 15%) but only few tumours are reported in lorises (PLESKER et al., 2002) and an older overview mentions only a single case of a skin tumour in a slow loris (LOWENSTINE, 1986). Lymphoma has been associated with a herpesvirus infection in a slow loris (STETTER et al., 1995). Only one case of neoplasia had been reported in *N. pygmaeus* (SUTHERLAND-SMITH et al., 2001), where an animal died due to a lymphosarcoma.

In one animal of the study population a lens-sized, shafted papilloma on the right side of the neck was found on arrival. Within 7 months the tumour reached the size of a bean (Plate 4.12). The tumour was still shafted, firm-elastic, circumscript, and showed a hairless, red to brown mixed coloration on the smooth surface. It was removed under general anaesthesia. Histological the tumour was diagnosed as a trabecular trichoblastoma. These tumours are classified as basal cell tumours and their biological behaviour is benign (PLESKER et al., 2002). The prime cause of the development of the tumour in the animal was unknown. The same individual also showed an irregularity in the pigmentation of the face, what has not been reported on any other lorises.

Plate 4.12 Trichoblastoma on the neck

4.8 Feeding problems

Obesity has been reported as the major feeding problem in lorises (RATAJSZCZAK, 1998, FITCH-SNYDER et al., 2001, SUTHERLAND-SMITH et al., 2001, PUSCHMANN, 2004).

Though most individuals of the study population temporarily showed a significant increase in bodyweight, this always spontaneously disappeared: seasonal changes in bodyweight are assumed to be a physiological adaptation to periods of food shortage and seasonal changes in the environment and have no pathological significance (see Chapter 5).

4.9 Breeding problems

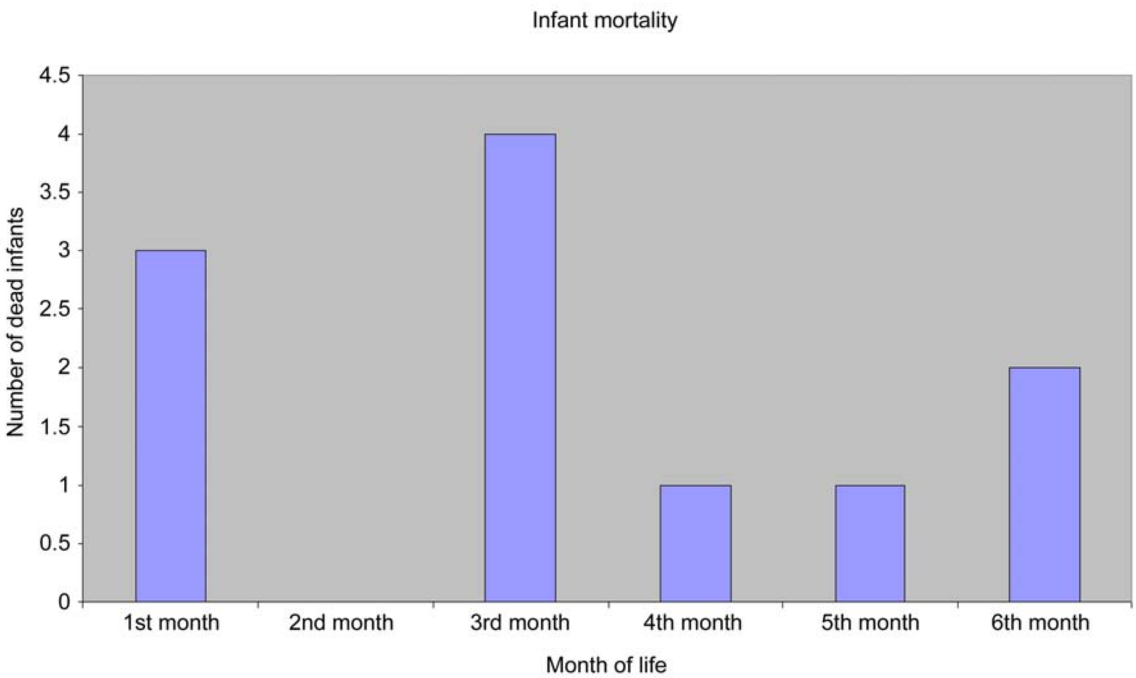
Juvenile mortality

The juvenile period is the period from birth to weaning. Death reasons during that period can be abortion, premature mortality, stillbirth and death of unweaned young. Amongst the prosimians lorises have particularly low juvenile survival rates (DEBYSER, 1995). LINDBURG et al. (1984) found infant mortality in *N. coucang* to be as high as 48% and FITCH-SNYDER et al. (2001) found juvenile mortalities in *N. pygmaeus* to be 27% during the first month and 36% during the first year. Juvenile mortality is usually concentrated during the first days (DEBYSER, 1995) and prosimians surviving these days are believed to have a high chance to survive the first year (POLLOCK, 1986). Stress, maternal neglect and traumatic insults commonly linked to each other are the causes for death of the infants (DEBYSER, 1995).

In the study population a total number of 26 (n=26) infants were born in 14 litters. Juvenile mortality is assessed in cumulative mortality incidence (CMI), which describes the number of animals that died during the juvenile period as a percentage of the total number of animals born (n). The CMI in the first month was 11.5% and in the first year it was 42.3 %.
34.6% of the animals born were males 46.2% were females and 9.2% were of unknown sex. The M/F ratio at birth was 0.75. The majority of the infants born were twins (92.3 %) and only two infants (7.7 %) were born as singletons.

Mortalities were highest in the first, third and sixth month of life.

Table 4.4 Timing of juvenile mortality



The mortality during the first month in the study population was low (11.5%), but by the end of the first year it was equal to values mentioned in literature (LINDBURG et al., 1984, FITCH-SNYDER et al., 2003). Mortality thus was not concentrated in the first days of life, but occurred at different stages of juvenile development.

Several of the dead infants showed signs of cannibalism. Cannibalism of infants has been frequently associated with stress (PETTER, 1975, TARTABINI, 1991). Stress might also lead to maternal neglect, which can either be fatal itself or can give way to aggression towards the infants by cage-mates (DEBYSER, 1995). Traumatic, even fatal insults may be inflicted by parents or cage-mates (PRESCOTT, 1980, BROCKMAN et al., 1987). In the study population, the history suggested furnishing of a neighbouring cage as a potential cause of stress and subsequent cannibalism in one case. However, in the majority of the cases, there was no obvious impact within the environment of the breeding group. But social stress must be considered as well. Lorises are assumed to have a solitary social pattern (FITCH-SNYDER et al., 2003) and even the mere proximity of conspecifics might stress solitary species (PETTER, 1975, LINDBURG et al., 1984, JURKE et al., 1997, SCHULZE, 1993). This corresponds with findings of POLLOCK (1986), who found infant mortality to be lower in females that were isolated before parturition. However in the study population, loss of infants due to cannibalism did occur likewise in females that raised their infants within the group and in females that were kept separate.

But the cause for maternal neglect cannot only be the mother but also the infant. A hypothermic, low birth weight, congenitally deformed or weak infant might not produce enough stimuli to arouse maternal behaviour (BROCKMAN et al., 1987). In the study population, infants of twin litters often notably differed in size and the smaller one in most cases was neglected and subsequently died.

Maternal neglect has also been associated to large litter size (BROCKMAN et al., 1987). A female pygmy loris in Prague, which gave birth to quadruplets, neglected the smaller two of the litter (MASOPUSTOVA, 2001). In the study population females gave birth, almost exclusively, to twins. A slight emphasis on twin litters has previously been observed (FITCH-SNYDER et al., 2003), but in the study population it seemed to be rather exceptional that a female gave birth to a singleton, and the majority of infants were born as twins (92.3%). Whereas successful rearing of both infants did occur, rearing of only one infant was more common.

Social structure of the group might as well be a cause of death and males have been found to interfere with infant feeding, withholding the females from nursing, so that infants die due to starvation (PRESCOTT, 1980). Pygmy lorises are strictly seasonal (FENG et al., 1994, FITCH-SNYDER et al., 2001, FITCH-SNYDER et al., 2003) and outside the mating season there is little interaction between males and females (FITCH-SNYDER et al., 2003).

The majority of the infants in the studied population died well prior to the onset of the mating season and interference of the male seems unlikely. But in two cases mortality occurred at a fairly late age and coincide with the oestrous of the females and the mating season (FENG et al., 1994, FITCH-SNYDER et al., 2001). There was evidence (e.g. location of the bite marks), that these death cases were the results of typical intraspecific attacks. Competitive and aggressive behaviour is part of the lorises' mating behaviour (MASOPUSTOVA, 2001, FITCH-SNYDER et al., 2003) and it is likely that the infants were subject of these attacks.

Finally sex of the infant might also play a role in determining the mortality. The M/F ratio at birth in most prosimians exceeds 1.0 and is commonly 1.4 (DEBYSER, 1995). The low number of males born in the study population is very unusual for primates (POLLOCK, 1986) and needs to be verified by larger numbers of cases. However, the high mortality rate for males is common in prosimians, which, in this way, equals the male biased sex ratio at birth (POLLOCK, 1986).

The death cases in the first year were separated in two groups. Deaths occurring during the first 12 weeks were most probably a result of maternal neglect. Pygmy lorises are reportedly weaned at about 24 weeks of age (WEISENSEEL et al., 1998) and during the first 12 weeks mother-infant interactions are very close (FITCH-SNYDER et al., 2003) and pygmy lorises have been reported to depend on their mothers longer than other prosimian species (EHRLICH, 1974). Limiting the considerations on juvenile mortality on the first ten days as suggested (DEBYSER, 1995), does leave out a considerable number of death cases.

Within the study population, the rate of twins was much higher than known from any other facility (FITCH-SNYDER et al., 2003), suggesting that breeding rates in most facilities are suppressed. But the pygmy lorises mostly raised only one infant of the twin litter and the neglecting of the other infant was not notably related to stress or external impacts. It seems possible that juvenile mortality in pygmy lorises serves a selective purpose. It is possibly more efficient for the species to give birth to two infants and rear only the stronger one.

The other group of infant death cases occurred during the mating season and were most likely a result of intraspecific aggression, which was directed less towards the infant than towards a conspecifics, potentially interfering with mating.

Retarded growth

RATAJSZCZAK (1998) reported *N. pygmaeus* to retard growth under unfavourable conditions. Little is known about consequences of poor early nutrition and compensatory potential of the organism (METCALFE et al., 2001).

At least two animals arriving at the rescue centre were less developed and had a bodyweight much lower than would be expected by the dental formula (Plate 4.13). It is unclear if organic or genetic reasons are underlying causes or if it were actually results of malnutrition at an early stage of development.

Plate 4.13 Growth retarded animal with full adult dentition and a bodyweight of only 170g.

4.10 Stress

Proximity to conspecifics, crowded conditions and unsuitable group composition might cause severe stress in prosimians (PETTER, 1975, PERRET, 1982). Stress has been reported as a major health problem in lorises (FITCH-SNYDER et al., 2001, SCHULZE, 1993, SCHULZE et al., 2004) and typically occurred with a certain delay to the actual stressful event. Stress was assumed to be a major death reason in trade confiscated slow and pygmy lorises (see Chapter 3.).

At least one death case in the study population seemed to be related to stress. The main necropsy findings in this animal were gastric ulcerations. Stress reduction is an important measure when handling new arrivals at the EPRC. During quarantine pygmy lorises are solitary housed in densely furnished cages in a remote area of the rescue centre with no public access and without conspecifics in the immediate surrounding. The high survival rate in newly arriving pygmy lorises might be a result of the stress reducing management.

4.11 Hypothermia

Cases of assumed hypothermia have been reported from San Diego (SUTHERLAND-SMITH et al., 2001).

Pygmy lorises in the study population show extensive resting period during the cold winter season. They do not feed and do not change position for several consequent days. The animals are cold to the touch and unable to move. They might still growl if being touched, but sometimes they even seize to vocalize. In a warm environment they reach normal body temperature and mobility within about twenty minutes. However this is not a pathological condition, but seems to be a not fully described torpor in pygmy lorises (WANG et al., 1998, RATASZCZAK, 1998).

Discussion

Main health problems in captive pygmy lorises, and ways to address them

Health problems in the study population were scarce. The main problems were related to the social system of the animals. Particularly the group management during the mating season requires attention. Intraspecific aggression during this time might case serious injuries, which might even be fatal.

Infant mortality was an ongoing problem: however, compared to other facilities it was not exceedingly high. If mortality of infants during the first three months is also a result of stress or a natural selective strategy of the species could not be fully clarified; but the latter seems possible. Separation of infants does not in all cases prevent maternal neglect, cannibalism and death of the infants, but it might reduce it.

Dental problems, which were known to be a major problem in captive lorises, did not occur in the study population and this was assumed to be a result of adequate cage furnishing with fresh branches. Dental disease might have serious complications and the provision of sufficient fresh branches in order to stimulate natural scraping behaviour is vital for a healthy population. Besides the function for dental health, this is also valuable contribution to environmental enrichment for the pygmy lorises.

Age related kidney problems have frequently been reported in pygmy lorises as a cause of death and did occur in the study population as well.

Obesity and hypothermia, both reported as pathological conditions from other facilities did occur in the study population but are supposed to be physiological processes.

Though stress did not notably play a major role as a reason for mortality, it might have been an underlying cause for other health problems. Based on experiences in other facilities, stress reduction in particular in newly arriving pygmy lorises, is an important measure of maintaining a healthy population.

References

Alterman, L., Hale, M. E. 1991. Comparison of toxins from brachial gland exudates from *Nycticebus coucang* and *N. pygmaeus*. American Journal of Physical Anthropology, Sup. **12**: 43.

Alterman, L. 1995. Toxins and toothcombs: potential allospecific chemical defence in *Nycticebus* and *Perodicticus*. Pp. 413-424. In: Alterman, L., Doyle, G., Izard, M. K. (eds.): Creatures of the Dark. Plenum Press, New York.

Benirschke, K., Miller, C., Ippen, R., Heldstab, A. 1985. The pathology of prosimians, especially lemurs. Pp. 167-208. In: Advances in Veterinary Science and Comparative Medicine, Vol. 30. Academic Press, New York.

Bain, O., Tibayrenc, M., Mak, J. W. 1979. 2 species of *Breinlia*, filarioidea from a squirrel in Malaysia. Bulletin du Museum National d´Histoire Naturelle, Section A, zoologie, biologie et écologie animales, 1 (1): 191-198.

Brockman, D. K., Willis, M. S., Karesh, W. B. 1987. Management and husbandry of ruffed lemurs *Varieca variegata* at the San Diego Zoo. II. Reproduction, pregnancy, parturition, litter size, infant care and reintroduction of hand raised infants. Zoo Biol **6**: 349-363.

Brockman, D. K., Willis, M. S., Karesh, W. B. 1988. Management and husbandry of ruffed lemurs, varieca variegata at the San Diego Zoo. III. Medical considerations and population management. Zoo Biol **7**: 253-262.

Bush, M. 1996. Methods of Capture, Handling and Anaesthesia. Pp. 25-40. In: Kleiman, D. G., Allen, M. E., Thompson, K. V., Lumpkin, S., Holly, H. (eds.): Wild mammals in captivity: principles and techniques. University of Chicago Press, Chicago and London.

Byrd, K. E., Swindler, D. R. 1982. The dentition of the Lorisoidae. Pp. 27-37. In : Haines, D. E. (ed.) : The lesser bushbaby (*Galago senegalensis*) as an animal model : selected topic. CRC Press, Florida.

Debyser, I. W. J. 1995. Prosimian Juvenile Mortality in Zoos and Primate Centers. Int J Primatol Vol **16**, No. 6: 889-907.

Ehrlich, A. 1974. Infant Development in Two Prosimian Species: Greater Galago and Slow Loris. Developmental Psychology, **7**(5): 439-454.

Feng, Q., Wang, Y., Li, C. 1994. Progress of studies on intermediate slow loris in captivity. Zhongguo Lingzhanglei Yanjiu Tongxun / Chinese Primate Research and Conservation News **3** (1): 11-12.

Fitch-Snyder, H., Jurke, M. 2003. Reproductive patterns in Pygmy Lorises (*Nycticebus pygmaeus*): Behavioral and Physiological Correlates of Gonadal Activitiy. Zoo Biol **22**: 15-32.

Fitch-Snyder, H., Schulze, H., Larson, L. (eds.) 2001. Management of Lorises in captivity. A husbandry manual for Asian Lorisines (*Nycticebus* & *Loris* spp.). Center for Reproduction of Endangered Species, Zoological Society of San Diego, San Diego.

Fitch-Snyder, H., Schulze, H., Streicher, U. Enclosure design for *Nycticebus spp.*. In: Shekelle, M. (ed.): Primates of the Oriental Night. Treubia. Special Issue. In print.

Gass, H. 1987. Affen. In: K. Grabisch & P. Zwart (eds.): Krankheiten der Wildtiere. Schluetersche Verlagsanstalt, Hannover.

Goeltenboth, R., Kloes, H.-G. 1995. Krankheiten der Zoo-und Wildtiere. Blackwell Wissenschaftsverlag, Berlin.

Griner, L. 1983. Pathology of Zoo Animals : Suborder Prosimiae. Zoological Society of San Diego, San Diego. Pp. 319-325.

Gupta, N. K., Dutt, K. 1975. On 3 nematode parasites of the genus *Subulura* from India. Rivista di parasitologia **36** (2-3): 185-188.

Hill, O. W. C. 1937. Treatment of the slender loris in captivity. Loris, June 1937: 85-88.

Jalanka, H. H., Roeken, B. O. 1990. The use of medetomidine, medetomidine-ketamine combinations and atipamezol in non-domestic mammals: a review. J Zoo Wildl Med **21**: 259-282.

Jones, M. L. 1986. Success and Failures of Captive Breeding . Pp. 251-260. In: Benirschke, K. (ed.): Primates. The road to self-sustaining populations. Springer, New York.

Junge, R. 1999. Diseases of prosimians. Pp. 365-368. In: Fowler, M. E., Miller, R. E. (eds.): Zoo and Wild Animal Medicine. Current therapy, ed 4. Saunders, Philadelphia.

Junge, R. E. 2003. Prosimians. Pp. 334-345. In: Fowler, M. E., Miller, R. E. (eds.): Zoo and Wild Animal Medicine. Saunders, St. Louis.

Jurke, M. H., Czekala, N. M., Fitch-Snyder, H. 1997. Non-invasive detection and monitoring of estrus, pregnancy and the postpartum period in pygmy loris (*Nycticebus pygmaeus*) using fecal estrogen metabolites. Am J Primatol **41**: 103-115.

Krishnamoorthy, R. V., Srihari, K., Rahaman, H., Rajasekharaiah, G. L. 1978. Nematode parasites of the slender loris *Loris tardigradus*. Proceedings of the Indian Academy of Sciences Section B, 87 (3): 17-22.

Kuntze, R. E., Myers, B. J., McMurray, T. S. 1970. Trypanomsoma cruzi-like parasites in the slow loris (*Nycticebus coucang)* from Malysia. Trans Amer Microsc Soc 89(2): 304-307.

Lindburg, D. G., Berkson, J. M., Nightenhelser, L. K. 1984. Primate Breeding in zoos : A ten year summary. Pp. 163-170. In : Ryder, O. A. , Byrd, M. L. (eds.) : One Medicine. Springer Verlag, Berlin.

Lowenstine, L. J. 1986. Neoplasms and Proloferative Disorders in Nonhuman Primates. Pp. 781-814. In: Benirschke, K. (ed.): Primates. The road to self-sustaining populations. Springer, New York.

Masopustova, R. 2001. The Quadruplets and Twins of Lesser Slow Loris in Prague Zoo. Gazella **28**: 63-71.

Metcalfe, N. B., Monaghan, P. 2001. Compensation for a bad start: grow now, pay later? Trends in Ecology & Evolution Vol.**16** No.5: 254-260.

Monnig, H. O. 1920. *Filaria nycticebi* eine neue Filaria aus dem *Nycticebus*. Centralb Bakterial **85**: 216-221.

Miyake, S., Ikedo, A., Ohta, S., Matsumoto, S. 1991. Three-dimensional analysis of the peculiar arterial pattern of the extremities in lorisidae: the rete mirabile. Pp. 569-570. In: Akiyoshi, E. et al. (eds.): Primatology today. Elsevier Science Publishers.

Mueller, E. 1979. Energy metabolism, thermoregulation and water budget in the slow loris *Nycticebus coucang* (Boddaert 1785). Comp Biochem Physiol 64A: 109-199.

Nash, L. T. 1986. Dietary, behavioral, and morphological aspects of gummivory in primates. Yearbk Physical Anthropol **29**: 113-137.

Nooren, H., Claridge, G. 2001. Wildlife Trade in Laos: the End of the Game. A History of Wildlife Trade in Laos to 1995. Netherlands Committee for IUCN, Amsterdam.

Perret, M. 1982. Stress-effects in *Microcebus murinus*. Folia primatologica **39**: 63-114.

Petter, J.-J. 1975. Breeding of Malagasy lemurs in captivity. Pp. 187-202. In: Martin, R.D. (ed.): Breeding endangered species in captivity. Academic Press, London.

Phillips, W. W. A. 1984. Manual of the mammals of Ceylon. Second revised edition. Part Part 2. Primates, pangolins, lagomorphs, rodents. Wildlife and Nature Protection Society of Sri Lanka.

Plesker, R., Streicher, U. 2002. A spontaenous trichoblastoma in a pygmy slow loris (*Nycticebus pygmaeus*). 46. Tagung der Fachgruppe Pathologie der Deutschen Veterinaermedizinischen Gesellschaft in Bamberg. Zusammenfassung der Wissenschaftlichen Vortraege. S. 18.

Pollock, J. I. 1986. The management of prosimians in captivity for conservation and research. Pp. 269-288. In: Benirschke, K. (ed.): Primates. The road to self-sustaining populations. Springer, New York.

Prescott, J. 1980. Breeding the brown lemur *Lemur macaco fulvus* at the Quebec Zoo. Int Zoo Yb **20**: 215-218.

Puschmann, W. 2004. Zootierhaltung. Tiere in menschlicher Obhut. Saeugetiere. Verlag Harri Deutsch, Frankfurt.

Quentin, J. C., Krishnasamy, M. 1975. Nematodes of the genus *Spirura*: parasites of *Tupaia* and *Nycticebus* in Malaysia. Annales de Parasitologie humaine et comparée **50** (6): 795-812.

Quentin, J. C., Krishnasami, M. 1979. Morphology of the ricularid *Pterygodermatites nycticebi*, Nematoda, Riculariidae, of the slow loris. Annales de Parasitologie humaine et comparée **54** (5): 527-532.

Ratajszczak, R. 1998. Taxonomy, distribution and status of the lesser slow loris *Nycticebus pygmaeus* and their implications for captive management. Folia Primatol **69** (suppl. 1): 171-174.

Rietschel, W. 1991. Erfahrungen bei der Immobilisation von Primaten. VAZ **11**: 142-144.

Schmelting, B., Kik, M. J. L., Boeve, M. H. 2001. Nocturnal Primates in Captivity: Screening for ophthalmic disorders in a breeding colony of grey-mouse lemurs (*Microcebus murinus*). Ver ber Erkrg Zootiere **40**: 321-322.

Schulze, H. 1993. Stress bei Schlankloris in Gefangenschaft. Pp. 11-22. In: W. Schmiedeberg (ed.): Arbeitsplatz Zoo Extra: Primaten. Zoo Köln.

Schulze, H. 1998. Developing a husbandry manual to facilitate the distribution and presentation of information: with special reference to slender loris *Loris tardigradus nordicus* at Ruhr-University, Bochum. International Zoo Yearbook **36**: 34-48.

Schulze, H., Fitch-Snyder, H., Perera, V., Petry, K., Plesker, R., Streicher, U. 2004. Health database of lorises and pottos. In: Conservation database for lorises and pottos. http://www.loris-conservation.org

Stetter, M. Worley, M., Ruiz, B. 1995. Herpesvirus associated malignant lymphoma in a slow loris (*Nycticebus pygmaeus*) J Zoo Wildl Med **26** (1): 155-160.

Sutherland-Smith, M., Stalis, I. 2001. Review of Loris Clinical information and Pathological Data From The San Diego Zoo 1982-1995. In: Fitch-Snyder, H., Schulze, H. (eds.): Management of Lorises in captivity. A husbandry manual for Asian Lorisines (*Nycticebus* & *Loris* spp.). Center for Reproduction of Endangered Species, Zoological Society of San Diego, San Diego.

Tan, C. L., Drake, J. H. 2001. Evidence of Tree Gouging and Exsudate Eating in Pygmy Slow Lorises (*Nycticebus Pygmaeus*). Folia Primatol **72**: 37-39.

Tartabini, A. 1991. Mother infant cannibalism in thick-tailed bushbabies (*Galago crassicaudatus umbrosus*). Primates **32**(3): 379-383.

Toft, J. D. 1986. The Pathoparasitology of Nonhuman Primates. Pp. 570-679. In: Benirschke, K. (ed.): Primates. The road to self-sustaining populations. Springer, New York.

Tuggle, B. N., Behlert, O. A. 1984. The occurence of *Pterygodermatites nycticebi* in a captive slow loris *Nycticebus coucang*. Proc Helminthol Soc Washington. **52**: 162-163.

Wang, Z.-K., Sun, R.-Y., Li, Q.-F., Wu, J.-Y. 1998. characteristics of the Resting Metabolism and Temperature Regulation in Lesser Slow Loris (Nycticebus intermedius). Abstract. Acta Zool Sinica **41**(2): 157.

Wiens, F. 1995. Verhaltensbeobachtungen am Plumplori, *Nycticebus coucang* (Primates: Lorisidae), im Freiland. Diplomarbeit im Fachbereich Biologie der Johann Wolfgang Goethe-Universität Frankfurt am Main.

Weisenseel, W. Izard, M. K., Nash, L. T., Ange, R. L., Poorman-Allen, P. 1998. A comparison of reproduction in two species of Nycticebus. Folia Primatol **69** (suppl. 1): 321-324.

Wiesner, H., v. Hegel, G. 1989. Praktische Hinweise zur Immobilisation von Wild-und Zootieren. Tieraerztl. Praxis **13**: 113-127.

Wilde, H. 1972. Anaphylactic shock following bite by a 'slow loris', *Nycticebus coucang*. Am J Trop Med Hyg, Sep. **21** (2): 592-594.

Woodford, M. H. 2001. Quarantine and health screening protocols for wildlife prior to transolcation and release into the wild. Office International des Epizooties, IUCN/SSC Veterinary Specialist Group, Care for the Wild and European Association for Zoo and Wildlife Veterinarians.

Worley, M. B., Shima, A. 1991. Isolation of a herpesvirus from short term lymphocyte cultures of the slow loris. Proc Am Ass Zoo Vet: 173-174.

Zaman, V. 1972. A Trypanomsoma of the slow loris (*Nycticebus coucang*). Southeast Asian Journal of Tropical Medicine Vol **3**: 22-24.

5. Seasonal bodyweight changes in Pygmy Lorises

Introduction

Pygmy lorises kept at the EPRC show remarkable variations in bodyweight. Alterations in bodyweight in captive pygmy lorises have often been considered pathological and weight gain has usually been interpreted as a tendency to become obese (RATAJSZCZAK, 1998, SUTHERLAND-SMITH et al., 2001). On the other hand keeping pygmy lorises at lower temperatures during the winter at a European facility caused reduced food intake and a decrease in bodyweight (RATAJSZCZAK, 1998, MASOPUSTOVA, 2001).

Seasonal changes in bodyweight have been reported from several prosimian species (FIETZ, 1998, PEREIRA et al., 1999). For endothermic animals that regularly experience periods of food scarcity energy storage is a survival strategy (MUELLER, 1995) and seasonal weight gain accumulating thick layers of fat is common to endure times of low food availability. Weight gain is mostly achieved simply by an increased food intake (PETTER-ROUSSEAUX, 1980, PEREIRA et al., 1999) but fat deposits can also be accumulated through a different selection of food items. Preference for energy rich food items during pre-hibernation fattening might enable for example the fat-tailed dwarf lemur *Cheirogaleus medius* to increase its bodyweight by nearly 90% within a few weeks (FIETZ et al., 1999, 2001). Changes in feeding behaviour are mostly triggered by changes in photoperiod (PETTER-ROUSSEAUX, 1980) and animals maintain the changed feeding behaviour in captivity despite regular food supply if the lightening imitates natural conditions (PEREIRA et al., 1991).

Besides being correlated to the seasons alterations in bodyweight could also be related to sexual processes. FOERG (1982) observed a decrease in bodyweight in the fat-tailed dwarf lemur *Cheirogaleus medius* and assumed a relation to increased sexual activity. However these were animals, which were kept under artificial lightening conditions, did not exhibit the natural seasonal resting behaviour and were relatively fat to start with. In the grey mouse lemur *Microcebus murinus* males increase bodyweight over the dry period. In this species bodyweight is positively correlated with rank and heavier males have priority of access to females (FIETZ, 1998).

Finally, weight considerations have taxonomic implications because lorises' species have been distinguished mainly based on bodyweight differences (DAO, 1960, CORBET et al., 1992, ZHANG et al., 1993). RAVOSA (1998) found size and weight of pygmy lorises not to be uniform and considered the observed weight differences to be geographical variations from northern and southern parts of the distribution range.

The aim of this study was to clarify if weight variations found in adult *N. pygmaeus* are related to the season and to evaluate these variations within the species' ecology.

Materials and Methods

Keeping conditions

At the EPRC pygmy lorises were kept in outdoor enclosures and were subjected to natural lightening conditions and climatic influences. Animals were kept in various group compositions (see Chapter 1).

Animals

Pygmy lorises at the rescue centre were weighed at irregular intervals, whenever they had to be handled.

Data that were obtained from subadult animals less than a year old were excluded. The age of confiscated pygmy lorises was usually not known exactly. Based on the fact that pygmy lorises have a distinct breeding season with birth occurring mostly in February and March (FENG et al., 1992, RATAJSZCZAK, 1998, FITCH-SNYDER et al., 2001), confiscated subadult animals were regarded to be adult after February of the year following their arrival at the EPRC.

Weight data obtained during the first three months after an animal's arrival at the rescue centre were also excluded. After hunting, and during trade and transport, the animals do not receive adequate food and care. The animals arrive in moderate to bad condition and their bodyweight is likely to differ from healthy animals.

Data from pregnant females were few. Pygmy lorises are strictly seasonal and their mating season is restricted to the months of August and September (RATAJSZCZAK, 1998, FITCH-SNYDER et al., 2001). After a six-months gestation time birth subsequently occurs in February or March.

Data from September 1999 until March 2003 were evaluated and the available data available from each month were pooled over all years.

Food

Pygmy lorises at the EPRC received the same food all year around. Feeding personnel changed on a daily basis and minor variations in the food composition therefore occurred. The food was weighed randomly to provide an overview of the average amount of food and to assure that there were no major variations. A total of 71g food was fed to each animal per day and the diet consisted of a mixture of fruit, vegetable and boiled eggs (Table 5.1). Stick insects, grasshoppers and crickets were fed additionally, but not regularly and only between May and October, when these insects were abundant. In addition the outdoor cages with natural vegetation and natural soil allowed for a certain degree of independent capturing of insects, which cannot be measured. The animals had permanently free access to water.

Food intake was not quantitatively measured. However the overall tendencies (eating all, eating well, eating little, not eating) are observed and regularly reported by the animal keepers.

Table 5.1 Food - items and amounts per day and individual

Food item	Banana	Pine-apple	Dragon-fruit	Papaya/ Mango	Carrot	Grapes	Apple/ Pear	Orange	Bolied egg	Milk-Powder
Amount	18g	6.4g	7.2g	8.3g	5.8g	6.5g	6.2g	5.7g	6g	1g

Climate

Northern Vietnam has a monsoon tropical climate with cold dry winters and hot wet summers. Cuc Phuong National Park experiences a dry season from December to February and this is also the time with the lowest temperatures. From December until February the daily mean minimum temperature during the month is usually below 15 °C and the daily absolute minimum is recorded below five degree. Water shortage (dry season) and low temperatures characterize the climate during the winter months and many tropical plants show little growth under these conditions (NGUYEN et al., 2000) (Table 5.2).

Table 5.2 Bioclimatic Table of Nho Quan District Weather Station, Vietnam (modified after NGUYEN et al., 2004)

	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Year Ø**
T	16.2	17.2	20.0	23.7	27.2	28.5	28.9	28.1	26.8	24.3	21.0	17.8	23.3
R	21.4	28.3	42.8	97.6	169.2	253.9	248.2	352.0	358.7	233.5	77.2	25.8	159.7
ΔT	6.2	4.6	5.2	6.3	7.9	7.5	7.5	6.7	6.5	7.0	5.9	7.3	6.6
U	84	86	89	87	82	83	81	86	86	83	82	81	84
S	2.4	1.7	1.6	3.3	6.2	5.9	6.6	5.2	5.9	5.6	4.6	4.1	4.4

T monthly mean temperature in °C
R total monthly precipitation in mm
ΔT monthly mean of night/ day fluctuation of temperature
U monthly mean relative humidity in %
S monthly mean of daily sunshine hours

Statistical analysis

For statistical analysis we used SPSS 11.5.

Results

A total number of 172 bodyweight values could finally be evaluated. 70 values were available from males and 97 values from non-pregnant females and 5 values from pregnant females.

The annual mean bodyweight of healthy adult pygmy lorises over the year was 418(±98) g for males (n=70) and 423(±97) g for females (n=102). To examine these differences a t-test had been conducted which revealed no sexual dimorphism in bodyweight ($t < 1$, $df = 170$ $p < .05$) (Table 5.3).

Around the year there were clear variations in the bodyweight. In male pygmy lorises the maximum values of the monthly mean bodyweight were up to 57 % higher than the minimum values. In female pygmy lorises the maximum values of the monthly mean bodyweight were up to 50% higher than the minimum values (Table 5.3). Referring to the annual mean bodyweight the maximum values were 38% higher in males and 29% higher in females; the minimum values were 12% lower in males and 14% lower in females.

Table 5.3 Monthly mean bodyweight values (g) of males and females and as a percentage difference from the minimum values for the monthly mean bodyweight and as percentage difference from the annual mean bodyweight (pregnant females are not included)

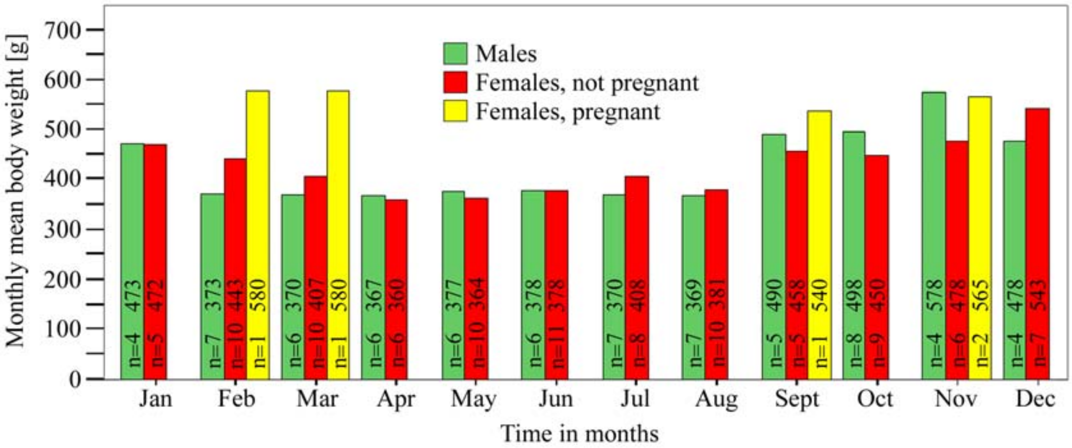
	Males				Females			
	Weight in g	Percentage		*n*	Weight in g	Percentage		*n*
Jan	472 (±59)	+29	+13	4	472 (±50)	+31	+12	5
Feb	373 (±88)	+2	-11	7	443 (±79)	+23	+5	10
Mar	370 (±48)	+1	-11	6	407 (±58)	+13	-4	10
Apr	367 (±26)	0	-12	6	360 (±25)	0	-15	6
May	377 (±78)	+3	-10	6	364 (±61)	+1	-14	10
Jun	378 (±50)	+3	-10	6	378 (±44)	+5	-10	11
Jul	370 (±70)	+1	-11	7	408 (±78)	+13	-3	8
Aug	368 (±57)	0	-12	7	381 (±61)	+6	-10	10
Sep	490 (±56)	+34	+17	5	458 (±86)	+27	+9	6
Oct	498 (±118)	+36	+19	8	450 (±90)	+25	+7	9
Nov	578 (±84)	+57	+38	4	478 (±88)	+33	+13	6
Dec	478 (±58)	+30	+14	4	543 (±111)	+50	+29	7
Mean	418 (±98)			70	422 (±88)			97

The bodyweight of pygmy lorises appeared to be related to the season (Fig. 5.1). From April until August the animals had the lowest bodyweight. Between August and September the animals rapidly gained weight and by November and December they had reached their maximum weight. In December the animals' bodyweight values started to decrease, they decreased continuously through January, February and March until they reached their minimum values by April, just after the end of the cold period.

The gross development of bodyweight was identical in males and females (Fig. 5.1). However, both weight gain and weight loss were more distinct in males. The males gained weight more rapidly than the females in autumn and the peak values were reached already in November, a month before the females reached their peak values. Then the weight values started to decrease and rapidly dropped to their minimum level, which they already reached in February and March, whereas females lost weight gradually until April. The peak values reached were nearly equal for both sexes.

The number of values of pregnant females was very low and it could not be assessed how the variations are influenced by pregnancy.

Fig 5.1 Bodyweight of *N. pygmaeus* around the year



In order to verify the hypothesis of a significant seasonal bodyweight change bodyweights in fall and winter were tested versus the bodyweights in spring and summer using a t-test. (fallwin = October through March, sprisum = April through September). There was a significant difference in body weight among all categories of lorises. Pygmy lorises were significantly heavier during fall and winter than during spring and summer irrespective of sex or pregnancy.

Table 5.4 All pygmy lorises

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Fallwin	84	240.00	770.00	462.0482	102.34756	10475.022
Sprisum	88	210.00	570.00	388.7500	71.06436	5050.144
Valid N	84					

n = 172, t = 5.478, df = 170, $p < .05$

Table 5.5 Female pygmy lorises

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Fallwin	51	290.00	770.00	468.0392	94.57314	8944.078
Sprisum	51	250.00	550.00	389.4118	70.66574	4993.647
Valid N	51					

n = 102, t = 4.756 , df = 100, $p < .05$

Table 5.6 Female pygmy lorises excluding pregnant females

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Fallwin	47	290.00	770.00	459.1489	93.05982	8660.130
Sprisum	50	250.00	550.00	386.4000	67.99640	4623.510
Valid N	47					

n = 97, t = 4.415, df = 95, $p < .05$

Table 5.7 Male pygmy lorises

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Fallwin	33	240.00	670.00	452.5000	114.58199	13129.032
Sprisum	37	210.00	570.00	387.8378	72.57698	5267.417
Valid N	33					

$n = 70$, $t = 2.866$, $df = 68$, $p < .05$

Correlations of bodyweight and several climatic parameters were tested. The analysis revealed a significant ($p < .05$) negative relationship between bodyweight and ambient temperatures ($r = -.30$) and humidity ($r = -.16$).

Qualitative assessment of food intake

During the summer months pygmy lorises showed strong preferences for several food items and usually left part of their food. In September, October and November the pygmy lorises completely finished all food offered and there were no leftovers. Even non-favourite food items were eaten. During the colder months they ate very little and sometimes did not feed at all for up to four consequent days. The food intake seemed related to the weather conditions. When the daily mean temperature was less than about 15 °C pygmy lorises ate very little or nothing. It seems that the critical value is the daily mean minimal temperature and not the daily absolute minimum temperature. On a day with a very low night temperature and a warm afternoon the animals were rather likely to eat, whereas on a day with a constantly low temperature the animals did usually to not eat any food.

Discussion

Ecological implications of the seasonal bodyweight change

Variations in bodyweight in pygmy lorises appear to be not a pathological sign but a physiological seasonal process. Seasonal weight changes in prosimians have been studied in detail in Malagasy prosimians, which display different forms of hibernating behaviour as daily or seasonal torpor (FIETZ, 1998, 1999, 2001). Although there are behavioural similarities between the species, prosimians in Madagascar and in Vietnam face different climatic challenges. The winter in Madagascar is characterized predominantly by low rainfalls, whereas the winter months in northern Vietnam are characterized not only by low rainfalls, but also by low temperatures, which get as low as 5 degree Celsius and can get close to the freezing point (Table 5.2). During the cold season, vegetation growth in the forest is low (NGUYEN et al., 2000), there are only a few insects and thus food resources are scarce. In addition to low temperatures and reduced food availability the cold season coincides with gestation, birth and the onset of lactation in the pygmy loris (FITCH-SNYDER et al., 2001). In prosimians, metabolic requirements during pregnancy may be up to 75% higher than general metabolic requirements (YOUNG et al., 1990, JENKINS et al., 1991). In order to compensate for the various adverse influences of low temperatures, food shortages and pregnancy primates exhibit a variety of strategies.

In order to still find sufficient food despite the diminished food availability pygmy lorises could increase their daily travel path length as other prosimians do (GURSKY, 2000). However, this is not an energetically feasible option for the quadrupedal pygmy loris which is unable to run, jump or leap and thus to rapidly cover long distances.

Switching to alternative food sources (HLADIK, 1979) could also be an option to overcome food scarcity. However alternative food sources are often of lower quality and cannot necessarily provide the same level of energy (see Chapter 7).

If the energy supply is uncertain, the pygmy lorises could alternatively reduce their energetic expenses to survive a period of food scarcity. This can be achieved through improved insulation through a thick cover of fur (MUELLER, 1995). A seasonal fur change has been found for the pygmy loris (see Chapter 2). The actual insulation capacity has not been measured, but the coincidence with the cold season suggests that it probably does improve insulation and thus plays a role as an over-wintering strategy.

Energy is also saved through an effective counter-currency heat exchange system along the vascular bundles (‘rete mirabile’) in the limbs and the extremities of lorises can be much colder than the body core (MUELLER, 1979).

Other prosimians inhabiting seasonal environments, such as the fat-tailed dwarf lemur *Cheirogaleus medius*, reduce locomotor activity as an option for reducing energy expenditure (FIETZ et al., 1999, FIETZ et al., 2001). Activity in *N. pygmaeus* is remarkably reduced during the cold months (MASOPUSTOVA, 2001). At the EPRC the animals show periods of complete inactivity during the cold season and often do not move for several days. Observations on reintroduced pygmy lorises suggest that free ranging individuals show the same behaviour.

Energetic expenses can also be reduced by lowering the metabolic rate (MUELLER, 1979, 1995). The energetic needs to maintain homoeostasis under thermoneutral conditions are defined as the basal metabolic rate; lorises have a priori a low basal metabolic rate (MUELLER, 1979, 1995, WHITTOW et al., 1977) as a result of their feeding on invertebrates, fruit and plant components with a low digestibility (McNAB, 1986). If ambient temperatures fall below the species-specific thermoneutral zone the energetic costs for thermoregulatory reaction usually increase. But in contrary, if ambient temperatures fall below the thermoneutral zone for slow lorises, the animals reduce their metabolic rate by an additional 16 % (MUELLER, 1995); and pygmy lorises have been suggested to do so as well (WANG et al., 1998). The thermoneutral zone for *N. coucang* is 27,5-33 °C and the value for *N. pygmaeus* is seemingly just slightly lower (WANG et al., 1998). The temperatures during the winter months in northern Vietnam consequently are far below the thermoneutral zone of the species. If small mammals as the pygmy loris strive to maintain their body temperature with thermoregulatory processes they can easily get in a negative energy balance. In this case leaving homoeostasis and lowering the metabolism are means to save energy. If temperatures reach very low levels pygmy lorises have been assumed even to be able to enter a torpid state (RATAJSZCZAK, 1998) and observations at the EPRC also suggest this, but this is not proved yet (see also Chapter 4.11).

Another common strategy for animals that regularly experience periods of food scarcity is the storage of energy (MUELLER, 1995). Without detailed observations RATAJSZCZAK (1998) has already claimed that pygmy lorises survive the Vietnamese winter living on fat reserves. Indeed the remarkable weight gain in *N. pygmaeus* after August seems to serve to accumulate energy reserves to overcome the period of food scarcity and the difficult climatic conditions during the winter months (Plate 5.1). Changes in food preferences might play a role in free ranging pygmy lorises, however, in captive individuals the main cause of the weight gain is an increased food intake.

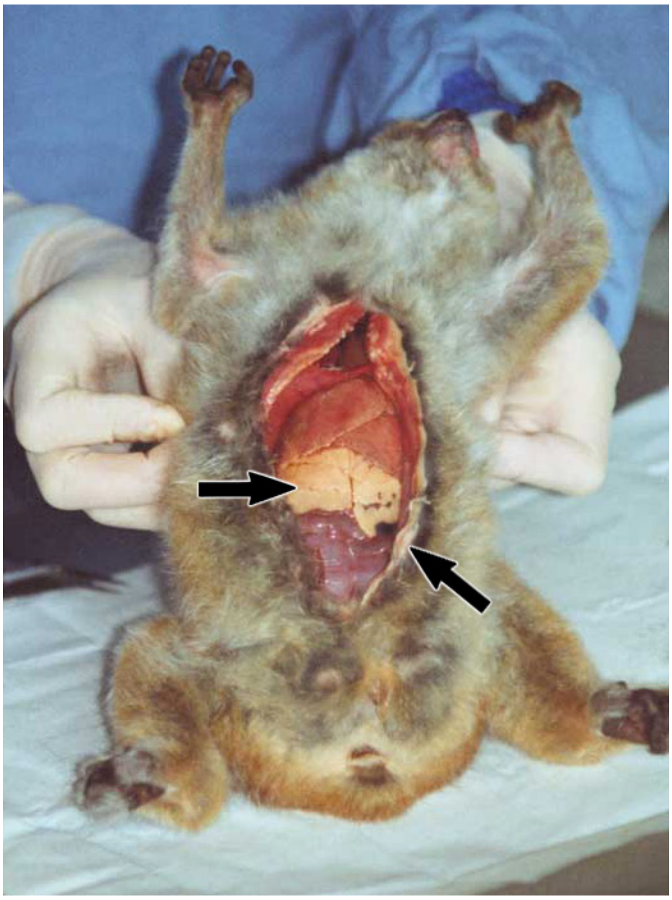


Plate 5.1 A wild caught female pygmy loris, which died in December only three weeks after arrival at the EPRC, illustrates the finding of seasonal weight gain. The arrows mark the thick layers of subcutaneous fat and fat stored in the mesenterium. The animal had a bodyweight of 530g.

Though the total weight gain is similar in both sexes, the weight gain in autumn is slower and in spring the weight decreases later in females than in males. This difference between males and females occurs in all females, whether they are pregnant or not. But the number of pregnant females included is too low to actually assess the influences of pregnancy on the bodyweight variations.

There is no obvious relation between bodyweight alterations and sexual processes. The lowest bodyweight is achieved several months before the actual onset of the mating season and cannot be attributed to sexual activities. The weight gain, on the other hand, starts in the late mating season and therefore is unlikely to have any influence on mate choice. However, observations on pygmy lorises in the wild would be necessary to prove this.

The seasonal change in bodyweight has implications for the species' taxonomy and shows that differences in bodyweight do not allow the distinction between different loris taxa for example *N. pygmaeus* and *N. intermedius* (vgl. ZHANG et al., 1993).

The combination of a number of different strategies to survive difficult environmental conditions is a common principle in mammals (BARTNESS et al., 1989). Besides reducing activity, metabolic rate and body temperature, accumulating energy reserves and seasonally gaining weight is an important strategy for *N. pygmaeus* to facilitate survival in a seasonally hostile environment.

References

Bartness, B. M. Elliott, J. A., Goldmann, B. D. 1989. Control of torpor and bodyweight patterns by a seasonal timer in Siberian hamsters. Am J Physiol 257:142-149.

Corbet, G. B., Hill, J. E. 1992. The mammals of the Indomalayan region: a systematic revision. Oxford University Press, Oxford.

Dao, V. T. 1960. Sur une nouvelle espèce de *Nycticebus* au Vietnam. Zool. Anz. **164**: 240-243.

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

Fietz, J. 1998. Body Mass in Wild *Microcebus murinus* over the Dry Season. Folia Primatol **69** (suppl 1): 183-190.

Fietz, J., Ganzhorn, J. U. 1999. Feeding ecology of the hibernating *Cheirogaleus medius*: how does it get so fat? Oecologica **121**:157-164.

Fietz, J., Dausmann, K. H., Tataruch, F. 2001. Fat Accumulation and Composition in a Tropical Hibernator *Cheirogaleus medius.*Folia Primatol **72**: 153-194.

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

Foerg, R., Hoffmann, R. 1982. Seasonal and daily activity changes in captive *Cheirogaleus medius*. Folia Primatol **38**: 259-268.

Gursky, S. 2000. Effect of Seasonality on the behavior of an insectivorous Primate *Tarsius spectrum*. Int J Primatol, Vol. 21, No **3**: 477-495.

Hladik, C. M. 1979. Diet and Ecology of Prosimians. In: Doyle, G.A. and Martin, R.D. (eds.): The Study of Prosimian Behaviour. Academic Press, New York.

Jenkins, P. D., Albrecht, G. H. 1991. Sexual dimorphism and sex ratios in Madagascan prosimians. Am J Primatol **24**: 1-14.

Masopustova, R. 2001. The Quadruplets and Twins of Lesser Slow Loris in Prague Zoo. Gazella **28**: 63-71.

McNab, B. K. 1986. The influence of food habits on the energetic of eutherian mammals. Ecological Monographs, 56(1) 1986:1-19.

Mueller, E. 1979. Energy metabolism, thermoregulation and water budget in the slow loris *Nycticebus coucang* (Boddaert 1785). Comp Biochem Physiol 64A:109-199.

Mueller, 1983. Waerme- und Energiehaushalt bei Halbaffen (Prosimiae). Bonn Zool Beitraeg, **34**, Heft 1-3: 29-71.

Mueller, E. 1995. Role of Energetics and Thermoregulation in Captive Breeding of Mammals and Birds. In Ganslosser, U., Hodges, J.K., Kaumanns, W.(eds): Research and Captive Propagation. Filander. Fuerth.

Nguyen, K. V., Nguyen,T. H., Phan, K. L., Nguyen, T. H. 2000. Bioclimatic Diagrams of Vietnam. Vietnam National University Publishing House. Hanoi.

Pereira, M. E., Strohecker, R. A., Cavigelli, S. A., Hughes, C. L., Pearson, D. D. 1999. Metabolic strategy and social behaviour in lemuridae. In Rakotosamimanana, B., Rasamimanana, H., Ganzhorn, J.U., Goodman, S.M. (eds.): New directions in lemur studies.Kluwer Academic/Plenum Publishers. New York.

Petter-Rousseaux, A. 1980. Seasonal activity rhythms, reproduction and body weight variations in five sympatric nocturnal prosimians, in simulated light and climate conditions. In Charles-Dominique, P. Cooper, H.M., Hladik, C.M., Pages, E. Pariente, G.F., Petter- Rousseaux, A., Petter, J.J., Schilling, A. (eds): Nocturnal Malagasy Primates: Ecology, Physiology and Behaviour. New York Academic Press, New York.

Ratajszczak, R. 1998. Taxonomy, distribution and status of the lesser slow loris *Nycticebus pygmaeus* and their implications for captive management. Folia Primatol. **69** (suppl. 1): 171-174.

Ravosa, M. J. 1998. Cranial allometry and geographic variation in slow lorises (*Nycticebus*). Sixty-sixth Annual Meeting of the American Association of Physical Anthropologists, St. Louis, Missouri, USA, April 1-5, 1997. American Journal of Physical Anthropology, **0** (suppl. 24): 193.

Sutherland-Smith, M. Stalis, I. 2001. Review of Loris Clinical Information and Pathology Data From The San Diego Zoo: 1982-1995. In Fitch-Snyder, H., Schulze, H.(eds.). 2001. Management of Lorises in Captivity. A Husbandry Manual for Asian Lorisines (*Nycticebus & Loris ssp.*) Center for Reproduction in Endangered Species, Zoological Society of San Diego. San Diego.

Wang, Z.-K., Sun, R.-Y., Li, Q.-F., Wu, J.-Y. 1998. Characteristics of the Resting Metabolism and Temperature Regulation in Lesser Slow Loris (*Nycticebus intermedius*). Abstract. Acta Zool Sinica **41**(2): 157.

Waterman, P. G. 1984. Food acquisition and processing as a function of plant chemistry. In: Chivers, D.J. Wood, B. A., Bilsborough, A. (eds.). Food Acquisition and processing in Primates. Plenum Press. New York.

Whittow, G. C., Lim, B. L., Rand, D. 1977. Body temperature and oxygen consumption of two Malaysian prosimians. Primates **18** (2): 471-474.

Young, A. L., Richard, A. L., Aiello, L. C. 1990. Female dominance and maternal investment in strepsirrhine primates. Am Nat 1990.

Zhang, Y., Chen, Z., Shi, L. 1993. Phylogeny of the slow lorises (genus *Nycticebus*): an approach using mitochondrial DNA restriction enzyme analysis. Int J Primatol, Vol 14 No 1: 167-175.

6. Reintroduction of Pygmy Lorises

Streicher, U., Nadler, T., Zinner, D. 2003. Re-introduction study of Pygmy lorises in Vietnam, Reintroduction News. Newsletter of the IUCN/SSC Reintroduction Specialist Group. Abu Dhabi, UAE. No: 37-40.

Introduction

Reintroductions are increasingly being used in conservation (STANLEY-PRICE, 1991, STUART, 1991) and primates have been subject of a number of reintroduction projects (SOORAE et al., 2002). The reasons, goals and strategies of these projects are as diverse as the range of species they cover. Though lessons are learned from each reintroduction it is still an experimental approach. Eventually a programme is likely to be judged a success if the status of the species is significantly improved by the reintroduction (KLEIMAN, 1996). But even unsuccessful reintroduction may have some value if monitoring of the released animals sheds light on the causes of failure and if the information gained is adequately recorded and accessible (OUNSTED, 1991).

Many concerns have been raised against reintroduction (IUCN, 1998, SOORAE et al., 2002) and each effort has to be very carefully evaluated, in particular for its need. Reintroduction must always have a powerful justification and the benefits must justify the risks. There is always the risk that reintroduction distracts attention and funds away from more necessary measures (MacKINNON et al., 1991). Wildlife protection, habitat preservation and conservation education may be more cost effective conservation measures than reintroduction (BORNER, 1985) and reintroduction can never be the sole solution (CHIVERS, 1991, STUART, 1991, KLEIMAN, 1996).

Enhancement of the long-term survival of a species is only one of the objectives of reintroduction. Another one is to promote local awareness (STUART, 1991, IUCN, 1998). Reintroductions can gain an enormous publicity and might help to attract attention also for the less glamorous aspects of conservation (STUART, 1991, KLEIMAN, 1989). But on the other hand the publicity of a reintroduction effort might foster the dangerous myth, that a problem faced by a species has been solved (OUNSTED, 1991).

Probably the most critical aspect of reintroduction is the health risk for resident wild animals. The concerns related to the potential spreading of diseases are multiple (WOODFORD et al., 1991, CHIVERS, 1991, WOODFORD et al., 1995, IUCN 1998, 2002, SOORAE et al., 2002). Animals held in captivity or transported have been exposed to a variety of pathogens and are potential carriers of infections. The impact such diseases can have on wild populations is unknown, in particular the introduction of diseases exotic to the wild populations might be disastrous (WOODFORD et al., 1991, IUCN, 2002, SOORAE et al., 2002). In many cases the knowledge on the disease situation at the reintroduction site is poor or completely lacking. Besides the risk of introducing disease, reintroducing animals into an unknown disease situation jeopardizes the life of the reintroduced individuals (WOODFORD et al, 1991, IUCN, 2002). A precautionary principle should guide reintroduction efforts; reintroduction must not constitute a physical or health hazard to local human or animal populations and the risk of inadvertently introducing disease should only be taken if there is a clear conservation value to the reintroduction (INTERNATIONAL ACADEMY OF ANIMAL WELFARE SCIENCES, 1992, SOORAE et al., 2002). Consequently health screening and quarantine must invariably be included as components of any reintroduction effort (WOODFORD et al., 1991, JOGER, 1998, WOODFORD, 2001).

Besides health risks there are potentially risks to the ecological integrity of resident species. Individuals, which are genetically identical with the resident species but originate from a different population, might introduce inadequate behaviours or lack regionally necessary survival skills (SOORAE et al., 2002).

In order to plan for reintroduction detailed ecological data are required. Ideally a reintroduction is based on a thorough knowledge of the species' biology, distribution and ecological requirements (BOX, 1991, KLEIMAN, 1996, IUCN, 1998, SOORAE et al., 2002). But often these data are not available in particularly if species have become rare and are difficult to observe in the wild.

Considering all these aspects, a reintroduction of pygmy lorises seems at first sight not to be feasible. But viewed within the national context of Vietnam the situation looks different.

The Vietnamese law protects the pygmy loris at the highest level (THE GOVERNMENT OF VIETNAM, 1996). The same law also postulates the release of confiscated animals back into their habitats. In practice this means that confiscated lorises are released into the nearest patch of forest, without health checks and without any consideration of their requirements for survival (THANH, 1996, STREICHER, 1998). Whether such released individuals survive, whether they spread disease, and whether they are able to adjust to wild food sources all remain unknown. Undocumented releases in Vietnam are known from several areas. In Cuc Phuong National Park up to 30 pygmy lorises confiscated from the wildlife trade have been released simultaneously. Reports of single released animals have been obtained from in Tuyen Quang Province, Thanh Hoa Province, Nghe An Province, Quang Binh Province and Dong Nai Province and there are probably many more. Monitoring of wildlife confiscations is fragmentary and post release monitoring completely lacking. Pygmy lorises are not considered a valuable animal and little attention is paid to their placement. Indifference towards the placement of confiscated lorises does not seem to be a problem limited to Vietnam, however, and there have been numerous releases of confiscated lorises all over their distribution range (DAIM in litt, PERERA, in litt., PROFAUNA unpublished, SUN in litt.).

Little attention has been paid to the orderly implementation of such reintroductions: there is likely to be a high failure rate and the risks for wild populations can't be assessed.

Prosimians have rarely been the focus of reintroduction projects, despite the increasing number of reintroductions projects. A release of captive bred black and white ruffed lemurs (BRITT et al., 2002) and a translocation of brown ruffed-collared lemurs in Madagascar (ANDRIAMANDRANTO, 2003) are at present the only monitored incidents.

Although there have been numerous releases of pygmy lorises in Vietnam there is still a lack of basic knowledge of the ecology and behaviour of the species in the wild. Information on the pygmy lorises is restricted to a few field reports and these are mostly mere sightings without any information on ecology (TAN, 1994, DUCKWORTH, 1994, THANH, 2002, FITCH-SNYDER et al., 2002, POLET et al., 2004, NGUYEN, 2004, NADLER et al., 2004).

However, the related slow loris has been studied in detail in Malaysia. The latter species was found to be an omnivorous, have a home-range size of about 8,9 ha, live preferably in plantations and have a solitary group-living social system including stable social units with overlapping home-ranges (WIENS, 1995, 2002, WIENS et al., 2003). Studies on another Asian loris species, the slender loris *L. tardigradus* from India, have been conducted by NEKARIS (2000, 2001, 2002, 2003). The latter species was found to be largely insectivorous, have a home-range size between 1.59 and 3.6 ha, inhabit dry acacia scrub forests and have a multimale social system with likewise overlapping home-ranges (NEKARIS, 2003).

Re-introduction of pygmy lorises in Vietnam

To resolve the dilemma of knowing very little on the species, but being obliged by law to release animals into the wild a study was conducted to assess the potential of pygmy lorises to re-establish themselves in the wild and to collect data on the species' ecology. The main objective of the study was to make adequate recommendations to the governmental forest protection authorities on further reintroductions of pygmy lorises. The study was conducted at the Endangered Primate Rescue Center and Cuc Phuong National Park between November 2000 and November 2002. In order to minimize the disease risk for resident wild populations the animals were quarantined for six weeks prior to release, tested for tuberculosis and treated for parasites. The reintroduction was conducted as 'soft release' as stated by IUCN (1998, 2002) and in accordance to the main guidelines (KLEIMAN et al., 1994, IUCN, 1998, 2002). Animals were equipped with radiocollars and observed by methods of telemetry and direct observation. Data was collected on feeding, sleeping site selection, movements, social behaviour and mortality. Pygmy lorises were found to be omnivorous and feed equally on plant and insect items (see Chapter 7). Animals grew rapidly independent of supplementary feeding, only one animal, which was released late in the year, kept using supplementary food as its main food source. The sleeping sites used by individual animals covered a range between 0.1 and 3.1 ha and the animals preferred familiar sleeping sites. Each animal established an individual range. The distance covered between two subsequent nights measured an average of 97,2 m, though in single cases it could be as much as 289,6 m. Pygmy lorises were found to use steady trails through the vegetation and also to travel on the ground, but only if adequate climbing substrates were missing and only after frequently checking the surrounding. Data on social behaviour were scarce, but suggested that pygmy lorises are largely solitary and live in a social system defined by scent marking cues and vocalization. Mortality occurred due to predator kills and probably due to adverse climatic conditions during the cold season.

The study provided valuable data on the ecology of pygmy lorises in the wild. However it also demonstrated the difficulties in designing a reintroduction programme, where there is insufficient knowledge of the species to be reintroduced.

Discussion

Towards a successful reintroduction of pygmy lorises

As stated above, reintroduction needs to be based on exact knowledge on ecology of the species in the wild (IUCN, 1998, SOORAE et al., 2002). For the pygmy loris no such data were available. However forestry legislation and animal trade realities made a monitored reintroduction an urgent requirement. In the absence of data on the species, data from other loris taxa were used with the assumption that the pygmy loris is in general similar to its close relatives. However, the results of the study showed that the pygmy loris in fact differs in some respects from the other loris species. Differences were found in feeding behaviour, range size and habitat requirements.

All animals were able to identify wild food sources from the first day after release. The pygmy loris proved to be omnivorous and differs in that respect from the slow loris, which predominantly feeds on plant exudates (WIENS, 1995, 2002), and the insectivorous slender loris (NEKARIS, 2003) (see Chapter 7). It seems plausible that the pygmy loris and the slow loris, with a largely sympatric distribution, occupy different ecological niches.

The recorded range size found of *N. pygmaeus* does fit the expectations for omnivorous prosimians and comparable ranges were found for prosimians with a similar ecology in Madagascar and central Africa (HLADIK, 1979). But it has to be emphasized that the sleeping site range is not exactly identical with the home-range and the centre of activity does not always coincide with the sleeping site (WIENS, 1995). Thus the home-range found in our study data have to be considered with care and might be subject to revision if more studies on the pygmy loris are conducted.

Suitable habitat has been stated the main determinant for a successful reintroduction (OUNSTED, 1991). The selected habitat was safe from hunting and based on observations on other loris taxa, which seemingly preferred plantations (WIENS, 1995) or open scrubland (NEKARIS, 2003) as habitat, the site was considered suitable. But the number of predator kills seemed high and it seemed the plantation forests did not provide a suitable canopy structure for the pygmy lorises. Possibly the canopy was not dense enough to form continuous pathways and the animals were frequently forced to travel on the ground, where they were very exposed to predation by terrestrial carnivores common in the area. The pygmy lorises' repeated checking for potential dangers before crossing the ground supports the assumption of a high predation risk on the ground. Comparable behaviour in *L. tardigradus* had been reported in areas where small cats are a main predator (BEARDER et al., 2002)

Two animals died during the cold season. In one case climatic influences (cold, rain) were identified as the likely cause of death; in the other case the cause of death remained unclear. The climate in the north of Vietnam is a monsoon tropical climate with cold winters and summer rains, very different from the climate in the south. *N. pygmaeus* in the north show a number of adaptive strategies to cope with these climatic conditions (see Chapter 5). Animals living in the southern part of the distribution range do not need these adaptive behaviours and might not have developed them.

The animal, which was assumed to have died due to climatic influences, was also the animal that exploited the supplementary feeding at the release site for the longest time and which was released latest in the year. The majority of the food sources used by the pygmy lorises are seasonally variable and are scarce in certain times of the year. It has been shown recently that lorises acquire their knowledge of food sources during infanthood by learning from adult con-specifics (WIENS, 2002, WIENS et al., 2003). Thus infants would learn about specific food sources in an area and presumably also about seasonally changes in food sources. Pygmy lorises from a different area in Vietnam would be unfamiliar with food and seasonal food source variations at a site very different from their origin.

No subspecific differences are known in *N. pygmaeus* (ROOS, 2004) and animals from all over the distribution range are genetically and externally identical (RATAJSZCZAK, 1998, ROOS, 2004, STREICHER, 2003). Consequently animals from the northern and southern part of the distribution range can't be differentiated and there is a high risk of reintroducing animals with locally inadequate behaviours.

Though the reintroduction study has had little or no impact on the wild lorises population, it has been an important step towards the understanding of *N. pygmaeus.* Besides providing data on the feeding behaviour of pygmy lorises, it allowed the following conclusions to be made for any further reintroduction of pygmy lorises:

1. Even if species seem very similar morphologically, baseline data for reintroduction can't simply be transferred from one species to the other.

2. It is impossible to assess habitat suitability from a pygmy loris' perspective. The reintroduction site should therefore be undisturbed habitat and not a altered by human impacts, even if the species also is known to survive in the compromised habitat. The survivors in the compromised habitat might have gone through a selective or adaptive process and might have gained the necessary skills to survive in the altered habitat. They might not be "average" representatives of the species. Thus if a species like the pygmy loris occurs in bamboo, plantation and primary forests, primary forests would be the preferred release site.
3. The season of release is crucial and the time of the highest food abundance is most suitable.
4. A lot of emphasis is placed on the best way to prepare animals for reintroduction (e.g. KLEIMAN, 1989, BOX, 1991, CHIVERS, 1991, KLEIMAN, 1996, IUCN, 1998, 2002). Though the need to take into consideration seasonal changes in the environment has been mentioned (CHIVERS, 1991, KLEIMAN, 1996), seasonal physiological mechanisms in the animals have so far not played a role in reintroduction planning. But planning for reintroduction must include not only the changes in the environment but also the animals' abilities to react adequately to them.
5. Pygmy lorises should exclusively only be reintroduced close to their area of their individual origin and not at any suitable site within the distribution area.

Besides providing the first field data on pygmy lorises the study had a very positive impact on the conservation of pygmy lorises in Vietnam. Through the study pygmy lorises gained remarkably in profile. Informative talks, official presentations in Vietnam and at international meetings, papers in relevant publications of the National Park and the EPRC and the involvement of local students led to a greatly increased awareness of the pygmy loris.

If the legal, political or religious situation in a country demands the release of confiscated animals, despite an obvious lack of data on the species' ecology, it is important to proceed in a way that minimizes risk to the wild populations.

It is equally important to monitor releases wherever possible in order to learn as much from any release as possible. Where conducted with care and responsibility, reintroduction of pygmy lorises can be successful and not put wild populations at risk, and can avoid jeopardizing the released individuals unnecessarily. Additionally such programmes can be a helpful tool in the conservation of the species. But the reintroduction strategy must remain flexible and must continuously adapt to new findings.

Objective solutions are urgently needed for the reintroduction of confiscated pygmy lorises in Vietnam.

References

Andriamandranto, M. R. 2003. Post-release monitoring of brown ruffed collared lemurs after translocation in the southeastern forest of Madagascar. Re-introduction News. Newsletter of the IUCN/SSC Re-introduction Specialist Group. Abu Dhabi, UAE. No. **23**: 34-35.

Bearder, S. K., Nekaris, K. A. I., Buzzell, C. A. 2002. Dangers in the night: are some nocturnal primates afraid of the dark? Pp. 21-43. In: Miller, L. (ed.): Eat or be eaten: Primate predator sensitive foraging. Cambridge University Press, Cambridge.

Box, H. O. 1991. Training for life after release: simian primates as examples. Symp.zool. Soc. Lond. No. **62**: 111-123.

Borner, M. 1985. The rehabilitated chimpanzees of Rubondo Island. Oryx **19:** 151-154.

Britt, A., Welch, C., Katz, A. 2002. The release of captive-bred black and white ruffed lemurs into the Betampona Reserve, eastern Madagascar. Re-introduction News: Special Primate Issue, Newsletter of the IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, UAE. No. **21**: 18-20.

Chivers, D. J. 1991. Guidelines for re-introductions: procedures and problems. Symp. Zool. Soc. Lond. No **62**: 89-99.

Duckworth, J. W. 1994. Field sightings of the pygmy loris, *Nycticebus pygmaeus*, in Laos. Folia Primatol. **63**: 99-101.

Fitch-Snyder, H., Vu Ngoc Thanh. 2002. A preliminary survey of lorises (*Nycticebus spp*.) in Northern Vietnam. Asian Primates – A Newsletter of the IUCN/SSC Primate Specialist Group. Vol.**8**, No.2: 1-6.

Hladik, C. M. 1979. Diet and ecology in prosimians. Pp. 307-358. In: Doyle, G. A., Martin, R. D. (eds.): The Study of Prosimian Behavior. Academic Press, New York.

International Academy of Animal Welfare Sciences. 1992. Welfare Guidelines for the Re-introduction of captive bred mammals to the wild. Universal Federation for Animal Welfare UFAW. United Kingdom.

IUCN. 1998. Guidelines for Re-introductions. Prepared by the IUCN/SSC Re-introduction Specialist Group. IUCN, Gland, Switzerland and Cambridge.

IUCN. 2002. Guidelines for the Placement of Confiscated Animals. Prepared by the IUCN/SSC Re-introduction Specialist Group. IUCN, Gland, Switzerland and Cambridge.

Joger, U. 1998. Pro und Contra Rueckfuehrung beschlagnahmter Tiere in die Ursrungslaender aus der Sicht der Populationsbiologie, des Arten-und Tierschutzes. Metelener Schrifetnreihe fuer Naturschutz **8**: 131-136.

Kleiman, D. G. 1989. Reintroduction of captive mammals for conservation. Bioscience **39** (3): 152-161.

Kleiman, D. G., Stanley Price, M. M., Beck, B. B. 1994. Criteria for reintroductions. Pp. 287-303. In: Olney, P. j. S., Mace, G. M., Feistner, A. T. C. (eds.): Creative Conservation. Interactive management of wild and captive animals. Chapman and Hall, London.

Kleiman, D.G. 1996. Reintroduction Programs. In Kleimann, D.G., Allen, M.E., Thompson, K.V., Lumpkin, S., Holly, H. (eds.): Wild Mammals in Captivity. University of Chicago Press. Chicago and London.

MacKinnon K., MacKinnon, J. 1991. Habitat protection and re-introduction programmes. Symp.Zool. Soc. Lond. No. **62**: 173-198.

Nadler, T., Streicher, U. 2004. Primates in Vietnam – an Overview. Pp. 5-11. In: Nadler, T., Streicher, U., Ha, T. L. (eds.): Conservation of Primates in Vietnam. Haki Press. Hanoi.

Nekaris, K. A. I. 2000. The spacing system of the slender loris (*Loris tardigradus lydekkerianus*) and its implications for slender loris social organization. Am J Primatol Suppl. **51**: 77.

Nekaris, K. A. I. 2001. Activity budget and positional behaviour of the Mysore slender loris: implications for slow climbing locomotion. Folia Primatol **72**: 228-241.

Nekaris, K. A. I. 2003. Spacing System of the Mysore Slender Loris (*Loris tardigradus lydekkerianus*). Am J Physical Anthropol 121: 86-96

Nekaris, K. A. I. , Rasmussen, D. T. 2003. Diet and Feeding Behaviour of Mysore Slender Lorises. Int J Primatol. Vol. **24**, No.1: 33-46.

Nguyen, T. N. 2004. The status of primates at Pu Mat National Park and suggestions for sustainable conservation approaches. Pp. 85-89. In: Nadler, T., Streicher, U., Ha, T. L. (eds.): Conservation of Primates in Vietnam. Haki Press. Hanoi.

Ounsted, M.L. 1991. Re-introducing birds: lessons to be learned for mammals. Symp.Zool. Soc. Lond. No. **62**: 75-85.

Polet, G. Murphy, D. J., Becker, I., Phan D. T. 2004. Notes on the primates of Cat Tien National Park. In: Nadler, T., Streicher, U., Ha, T. L. (eds.): Conservation of Primates in Vietnam. Haki Press, Hanoi.

Ratajszczak, R. 1998. Taxonomy, distribution and status of the lesser slow loris *Nycticebus pygmaeus* and their implications for captive management. Folia Primatol. **69** (suppl. 1): 171-174.

Roos, C. 2004. Molecular evolution and systematics of Vietnamese primates. Pp. 23-28. In: Nadler, T., Streicher, U., Ha, T. L. (eds.): Conservation of Primates in Vietnam. Haki Press. Hanoi.

Soorae, P. S., Baker, L. R. (eds.) 2002. Re-introduction News: Special Primate Issue, Newsletter of the IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, UAE. No. **21**: 60pp.

Stanley-Price, M. R. 1991. A review of mammal re-introductions, and the role of the Re-introduction Specialist Group of IUCN/SSC. In: Gipps, J. H. W. (eds.): Beyond Captive Breeding. Re-introducing Endangered Mammals to the Wild. Zoological Society of London, Clarendon Press, Oxford. UK.

Streicher, U. 1998.Vietnams Tierhandel- Gibt es einen Ausweg? Mitteilungen der ZGAP. 14.Jahrgang, Heft **2**: 4-8.

Streicher, U. 2003. Saisonale Veraenderungen in Fellzeichnung und Fellfaerbung beim Zwergplumplori *Nycticebus pygmaeus* und ihre taxonomische Bedeutung. Zoolog. Garten N.F. **73** (2003) 6: 368-373.

Stuart, S. N. 1991. Re-introductions: to what extent are they needed? Symp.Zool. Soc. Lond. No. **62**: 27-37.

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

Thanh, V. N. 1996. Biodiversity and Biodiversity Loss. Presentation held at the Seminar on Environment and Development in Vietnam, 1996. Australian National University. Canberra.

Thanh, V. N. 2002. The status and conservation of the loris species, *Nycticebus coucang* and *N. pygmaeus* in Vietnam. P. 254. In: Caring for Primates. Abstracts of the XIXth Congress of the International Primatological Society. Mammalogical Society of China, Beijing.

The Government of Vietnam. 1996. Instruction from the Prime Minister on Urgent Measures For Wildlife Protection and Development, No. 359/ Ttg, 29.05.96. Hanoi, Vietnam.

Wiens, F. 1995. Verhaltensbeobachtungen am Plumplori, *Nycticebus coucang* (Primates: Lorisidae), im Freiland. Diplomarbeit im Fachbereich Biologie der Johann Wolfgang Goethe-Universität, Frankfurt am Main.

Wiens, F. 2002. Behaviour and ecology of wild slow lorises (*Nycticebus coucang*): social organisation, infant care system, and diet. Dissertation, Faculty of Biology, Chemistry and Geosciences, Bayreuth University.

Wiens, F., Zietzmann, A. 2003. Social structure of the solitary slow loris *Nycticebus coucang* (Lorisidae). J Zool Lond **261**: 35-46

Wiens, F., Zietzmann, A. 2003. Social Dependence of Infant Slow Lorises to Learn Diet. Int J Primatol Vol. **24**, No.5: 1008-1021.

Woodford, M. H. 2001. Quarantine and health screening protocols for wildlife prior to transolcation and release into the wild. Office International des Epizooties, IUCN/SSC Veterinary Specialist Group, Care for the Wild and European Association for Zoo and Wildlife Veterinarians.

Woodford, M. H., Kock, R. A. 1991. Veterinary considerations in re-introduction and translocation projects. Symp. zool. Soc. Lond. No. **62**: 101-110.

Woodford, M. H., Rossiter, P. B. 1994. Disease risks associated with wilflife translocation projects. Pp. 178-200. In: Olney, P. j. S., Mace, G. M., Feistner, A. T. C. (eds.): Creative Conservation. Interactive management of wild and captive animals. Chapman and Hall, London.

7. Diet and feeding behaviour of Pygmy Lorises

Introduction

Little is known about the diet and feeding behaviour of the pygmy loris. Within the lorises a variety of different feeding ecologies are represented. Usually the slow loris *Nycticebus coucang* is counted among the frugivorous and the slender loris *Loris tardigradus* among the insectivorous species. In a recent field study in Malaysia, the slow loris was found to feed preferably on plant exudates, gum and fruit (WIENS, 1995, 2002) and a field study in India proved that the slender loris is indeed almost exclusively faunivorous with termites and ants being an important component of the diet (NEKARIS et al., 2003). On this background it seems interesting to investigate the pygmy loris' dietary habits. Where does it range on the scale of faunivory, frugivory and gummivory?

Observations on wild pygmy lorises feeding are very rare and only two reports are available. On one occasion pygmy lorises were found in a tree (TAN, 1994), which showed typical gnaw marks ("gouges") and it was suggested that the animals had been feeding on gum there. On another occasion a pygmy loris was observed in a tree feeding on an unidentified fruit (DUCKWORTH, 1994).

For a long time the pygmy loris was considered a subspecies of *N. coucan*g (HILL, 1953, PETTER et al., 1979, see Chapter 2). Based on external similarities to the slow loris the pygmy loris was assumed to differ from the larger species only in size, but have similar dietary habits. Like *N. coucang N. pygmaeus* was assumed to be a species that inhabits the main canopy and lives on a frugivorous diet (FLEAGLE, 1978).

In captivity, pygmy lorises are usually maintained on a mixed diet, with the majority of the offered food items being fruit and vegetables and insects comprising the rest of the diet (FITCH-SNYDER et al., 2001). At the Endangered Primate Rescue Center, pygmy lorises are fed on a diet consisting of fruit, vegetable, boiled eggs, milk powder and seasonally varying insects (see Chapter 5).

Newly confiscated animals at the rescue centre show a strong preference for invertebrates. Insects are mostly the first food item accepted, whilst recently confiscated animals mostly reject fruit, boiled eggs or vegetables. Obviously, wild pygmy lorises are more familiar with insects than with the other food items offered in particular cultivated fruit. Another hint to potential wild feeding habits is the gouging on fresh branches, which nearly all the confiscated pygmy lorises exhibit (Plate 7.1).

Plate 7.1 Typical gauge hole in a piece of furnishing

Methods

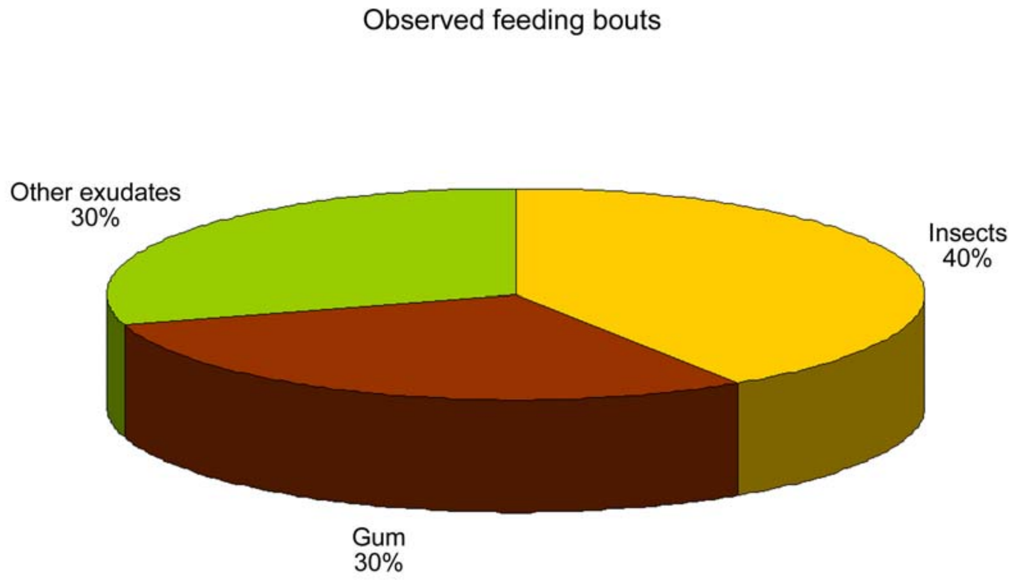
Data have been collected from four reintroduced individuals. The animals had all been captured as adults and had only been in captivity for several months. Thus all of them must have had previous experiences with wild food sources. The animals were genetically identical, with individuals originating from Cuc Phuong, but the exact locality of their origin and the habitat type they originated from was unknown.

The release site comprised forested limestone hills surrounded by old plantations and scrub and was located in the Cuc Phuong National Park in northern Vietnam (VO et al., 1996). The released animals had been equipped with transmitters and were located during the daytime in their sleeping sites by radio-telemetric methods (see Chapter 6). Before dusk, an observer returned to the loris' sleeping site and observed it during the beginning of its active period. Observations lasted from a few minutes to more than two hours. Head torches with redlight filters were used for observation and the animals could be fairly well-observed from a distance between 5 and 15 meters; only when the canopy was extremely dense visibility was sometimes limited. The animals showed different degrees of habituation. Whereas three animals got used to the observer's presence within a short time, one proved extremely reluctant to accept the presence of a researcher and was continuously hiding when an observer was around, exhibiting minimal activity. If the observer lost direct contact with the observed loris, observations were discontinued. In addition, the animals were not followed by telemetry at night due to the treacherous character of the terrain.

Each animal was observed for four to six weeks from the date of release onward. Data was collected ad libitum (ALTMAN, 1974) on prepared data sheets. Feeding trees were identified the following day by collecting a branch sample and having it identified at the scientific department of the National Park.

Results

Feeding could be observed from the first day after the release onwards.
A total number of 27 feeding bouts were observed. Several different types of feeding behaviour and food items were observed. In eleven cases, the food item was identified or suspected to be an insect, in eight cases it was gum, and in eight cases it was not exactly identified plant exudates.



Animal prey

Pygmy lorises searched for animal prey by moving slowly along branches with the nose close to the substrate. On nine occasions the pygmy lorises caught insects. Insects were caught either using one or using both hands and then put in the mouth. If both hands were used, the animals clung with both legs to a branch or stood bipedal. In one case the captured insect was a moth (Hymenoptera) attracted by the head torch of the observer. The most detailed observation of insect feeding was after one animal captured a very large cricket (Hemiptera). The cricket was held with both hands and slowly eaten starting from the head. The hard skin was broken using the molars and by pushing the prey into the mouth with the hands. The skin was partly bitten off and the loris frequently got rid of access parts of skin by fiercely shaking the head. The wings of the insects were bitten off and “disposed.” Towards the end of this feeding session, the animal changed the position two times, moving to another branch, whilst holding the remains of the insect in one hand. The seemingly very sticky inner contents of the insect finally covered the surrounding area of the mouth and the hands of the loris and the animal spent several minutes grooming, concentrating on the hands by licking them intensively. On one occasion the animal was observed licking on a branch of *Dracontomelum duperreamum* (Anacardiaceae). Whereas licking on branches in most cases was associated with feeding on plant items, this case was different because the animal frequently interrupted feeding to fiercely shake its head. Similar behaviour has been found to be associated with feeding on ants (NEKARIS, 2001) and therefore it was assumed that the animal was feeding on ants, which attacked the intruding loris. On another occasion the animal was observed feeding for an extended time in low scrub with climbing weeds. The food source was not identified, but later inspection of the scrub found all young shoots showed marks of an insect foraging. Feeding on insects was usually a short event. Only when the loris found a number of insects in the same location or if an insect was exceedingly large, it spent several minutes feeding. For example, the devouring of the large cricket required over twenty minutes. All feeding on insects occurred at heights less than ten meters.

Gum and other plant exudates

Feeding on gum or other plant exudates comprised the majority of observed feeding events. The common feature was intense licking on branches without locomotion. Feeding on plant substrates comprised short sessions only lasting one minute and extended sessions lasting up to twenty minutes in the same location (Plate 7.2). One of the tree species where the animals showed extensive licking behaviour was *Saraca dives* trees (Fabaceae). In full blossom these trees carried large bundles of big orange flowers that were inspected intensively on at least one occasion. However, it could not be ascertained if the animal actually found something to eat in the flowers. In this tree species the animals were licking intensively on the branches but this was not accompanied by audible scratching and bark-breaking sounds. The food sources must have been rather on the surface and easily accessible. The behaviour was not observed when the trees were not flourishing. Of the few observations of wild pygmy loris at Cuc Phuong National Park, two were made in the same tree species carrying blossoms (ROBERTON, pers.com.). Obviously these trees were particularly attractive, when flourishing.

Similar licking on branches was observed as well in a *Sapindus sp*. tree (Sapindaceae), a *Vernicia montana* tree (Euphorbiaceae) and at least two other non-identified tree species.

Another tree species exploited for its exudate were *Spondias axillaris* (Anacardiaceae). Here the food source could clearly be identified as gum: the tree had an old injury and was visibly shedding gum (Plate 7.3). The scraping for gum was accompanied in most cases by sounds of scratching and breaking bark. The animal fed with the body orthograde, clinging with all four legs to the bark (Plate 7.2). Feeding sessions on this tree were the most extended ones observed. A remarkable observation was that one animal returned to the same feeding site every time it had slept in the near vicinity. After it became active, it always first passed the “gum bar,” when it was nearby. Scratching and bark-breaking sounds were very intense.

All but one feeding event related to gum or other food exudates were observed at heights over eight metres.

Plate 7.2 Pygmy loris scraping for gum on the trunk of a *Spondias axillaris*

Plate 7.3 The same site in daytime. The shedding of gum is clearly visible.

Questionable food items

A possibly but not clearly feeding-related behaviour was observed in dense scrub areas where no plants were covering the soil and where the foliage was not very dense. From tree heights below one meter, the lorises frequently visited the ground for up to thirty seconds without actually covering any distance on the ground. Before going to the ground the animals always carefully observed the area where they intended to go. They usually went to the ground along the same tree, which they climbed up again after finishing the ground visit. It seems likely that these ground trips served a feeding purpose. But because these events were not clearly identified as feeding-related behaviour, they were not counted amongst the feeding bouts.

Feeding on fruit described by DUCKWORTH (1994) was never observed.

Solitary feeders

In our observations, pygmy lorises were never observed feeding together or even in close proximity, but the observations are too scarce to evaluate if pygmy lorises actually prefer solitary feeding. They did exploit the same food sources on the same tree but not simultaneously.

Seasonal variations in food exploitation

Animals released in spring fed preferably on different tree species than animals that were released later in the year. In spring, the animals preferred *Saraca dives* as a food tree. At that time of year the trees are in full blossom. Later on, when the tree does not have any flowers, lorises did not show any specific preference for this tree species. The animals released from September onward showed a strong feeding preference for *Spondias axillaris* trees.

Discussion

Omnivory as a strategy to overcome times of food shortage

Feeding behaviour of the pygmy loris has previously been assumed to be largely similar to the slow loris (FLEAGLE, 1978). Based on the large areas of sympatric occurrence, RATAJSZCZAK (1998) suspected different feeding preferences and suggested the pygmy loris to be the more insectivorous species. Indeed the pygmy loris shares many characteristics of feeding behaviour with the insectivorous slender loris. Details of the feeding behaviour are identical (NEKARIS et al., 2003) and both animals capture insects single-handedly or bimanually with stereotyped movements typical for prosimians and specifically adapted to catch small rapidly moving or flying insects (HLADIK, 1979). However, ants which make up a large percentage of the prey of the slender loris (NEKARIS et al., 2003), seem to play no important role for the pygmy loris' diet. The feeding on gregarious insects has been assumed to relate to the gregariousness amongst the slender lorises themselves (NEKARIS et al., 2003); slender lorises in captivity devote more time to social interactions than any other loris species (RASMUSSEN, 1986, SCHULZE et al., 1995). Correspondingly, the insects preferably devoured by the pygmy lorises would facilitate a solitary way of foraging not risking intraspecific competition.

The pygmy loris also shares feeding characteristics with its larger relative, the slow loris. Previously considered predominantly frugivorous (CHIVERS et al., 1980, BARRET, 1983), the slow loris was recently found to spend a large percentage of its foraging time feeding on plant exudates (WIENS, 1995, 2002). In pygmy lorises, gum and plant exudates also make up an important food source. Active stimulation of exudate flow by gouging trees has previously been documented for some callitrichids *Cebuella* and *Callithrix* (COIMBRA-FILHO et al., 1978) and the fork-marked lemur *Phaner furcifer* (PETTER et al., 1971) and a similar behaviour has been suggested for the pygmy loris as well (TAN et al., 2001). According to our observations, pygmy lorises indeed actively stimulate the exudate flow and possibly maintain a steady food source by scraping gum at the same location every night, thus inducing additional gum shedding. Licking plant exudates off the branches in flourishing trees is also a behaviour which the pygmy and the slow loris have in common, and both species show the behaviour in trees of the same family (Fabaceae). Nectarivory had been a suggested explanation (WIENS, 1995) and it is likely that the pygmy lorises were also feeding on nectar, since this behaviour was not observed when the trees were not carrying blossoms.

According to our observations, the pygmy loris is more of a generalist than the other Asian loris species and includes animal prey as well as gum and plant exudates in its diet. Being a generalist could be a mere result of physiological requirements. With a body size of around 350g, the pygmy loris is among the larger forms of prosimians. HLADIK (1979) postulated that prosimians of this size have to utilize a variety of different food sources, since they are too large to be able to maintain themselves merely on insects because they simply do not find enough prey in a given habitat in one night.

But being a generalist could also be a potential advantage to overcoming difficult environmental conditions.

The winter in northern Vietnam is characterized not only by water shortage (dry season), but also by low temperatures unfavourable for many tropical plants (NGUYEN et al., 2000) (see Chapter 5). The number of insects during these winter months is much lower than during the rest of the year. There are no flourishing trees for several months and plant growth rates are at their minimum. There appears to be a seasonal variation in the majority of the loris' food sources like insects and nectar. For several months these resources are extremely rare.

During periods of low resource availability, primates may switch to alternative, poorer quality food sources and incorporate them into the diet in greater than usual quantities (HLADIK, 1979, GURSKY 2000). The insectivorous spectral tarsier *Tarsius spectrum* reacts to seasonal fluctuations in food availability by including higher percentages of lower quality insects in its diet (GURSKY, 2000). However, the tarsier remains fully insectivorous even if this means depending on a diminished resource. But a tarsier is small, requires less insects for maintenance and can travel fast and cover a larger area in order to find sufficient food if necessary. Indeed, in times of food shortage tarsiers increase their travelling distances while foraging (GURSKY, 2000). Being limited to quadrupedal locomotion without the ability to leap, the pygmy loris can't greatly increase its daily travel path length and must use a different strategy to overcome times of food shortage.

Gum has been found to be part of the pygmy loris' diet and gum is available all year round and thus a reliable food source. Consequently, gum could be an ideal food source to overcome periodical food shortage. Gum contains high concentrations of carbohydrates (BEARDER et al., 1980) and some prosimians, such as the lesser bushbaby *Galago senegalensis* and thick-tailed bushbaby *Galago crassicaudatus* are able to persist on gum alone when other food sources are scarce (BEARDER, 1987). In the bushbabies, gum is digested in the enlarged caecum through the action of symbiotic bacteria (CHARLES-DOMINIQUE, 1977, HLADIK, 1979). In contrast, for mammals that lack microbial fermentation, gum is largely indigestible (WATERMAN, 1984) and the pygmy loris has no chambered site for microbial fermentation in its digestive tract (HILL, 1953). Moreover, gum has been suspected to be a self-limiting food source since detoxifying toxic components in gum might be energetically expensive and is considered responsible for a low metabolism and reduced pace of life (WIENS, 2002).

Reduced activity and extensive resting of the pygmy lorises during the winter period (see Chapter 5) thus are not only measures to reduce energetic expenses but also a way to respond to the available energy sources.

The pygmy loris feeding behaviour enables it to switch to other food sources in times when its main feeding sources are rare and exploit gum as a steady reliable food source. Gum is a low quality food source and only allows living at a low energy level with a reduced metabolism. However, it is an important part of the pygmy loris multifaceted strategy to survive times of hostile environmental conditions.

References

Altman, J. 1974. Observational study of behaviour: sampling methods. Behaviour **49**: 227-267.

Barret, E. 1983. Ecology of nocturnal lorisines: some interspecific comparisons. Primate Eye **21**: 8-9.

Bearder, S. K. 1987. Lorises, bushbabies and tarsiers: diverse societies in solitary foragers. Pp. 11-24. In: Smuts, B. B., Cheney, D. L., Seyfarth, R. M., Wrangham, R. W., Struhsaker, T. T. (eds.): Primate Societies. University of Chicago Press, Chicago.

Bearder, S., Martin, R., D. 1980. Acacia gum and its use by bush-babies, *Galago senegalensis* (Primates: Lorisidae). Int J Primatol 1:103-128.

Charles-Dominique, P. 1977. Ecology and Behaviour of the Nocturnal Primates. Prosimians of Equatorial West Africa. Duckworth, London.

Chivers, D. L., Hladik, C. M. 1980. Morphology of the gastrointestinal tracts in primates: comparisons with other animals in relation to diet. J Morph **166**: 337-386.

Coimbra-Filho, A. F., Mittermeier, R. A. 1978. Tree-gouging, exsudate-eating and the "short-tusked" condition in Callithrix and Cebuella. In: Kleimann, D.G. (ed.): The Behaviour and Conservation of the Callithrichidae. Smithonian Institution Press, Washington.

Duckworth, J. W. 1994. Field sightings of the pygmy loris (Nycticebus pygmaeus) in Laos. Folia Primato. **63**: 99-101.

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

Fleagle, J. G. 1978. Primate adaptation in Evolution. Academic Press. New York.

Gursky, S. 2000. Effect of Seasonality on the Behaviour of an Insectivorous Primate, *Tarsius spectrum*. Int J Primatol **21**(3): 477-495.

Hill, O. W. C. 1953. Primates: Comparative anatomy and taxonomy. Vol. I, Strepsirhini. Edinburgh University Press, Edinburgh.

Hladik, C. M. 1979. Diet and Ecology of Prosimians. Pp. 307-357. In: Doyle, G.A. and Martin, R.D. (eds.): The Study of Prosimian Behaviour. Academic Press, New York.

Nash, L. 1986. Dietary, Behavioral and Morphological Aspects of Gummivory in Primates. Yearb Physical Anthropol **29**: 113-137.

Nekaris, K. A. I. 2001. Some Aspects of Feeding Ecology of the slender loris (*Loris tardigradus lydekkerianus*) at Dindigul District, South India. In: Loris homepage, nutrition chapter from the in: *Loris* in the wild. www.nocturnalprimate.org/wilddiet.html. Seen: 15.07.01.

Nekaris, K. A. I., Rasmussen, D. T. 2003. Diet and Feeding Behaviour of the Mysore Slender Loris. Int J Primatol Vol. **24**, No.1: 33-46.

Nguyen, K. V., Nguyen,T. H., Phan, K. L., Nguyen, T. H. 2000. Bioclimatic Diagrams of Vietnam. Vietnam National University Publishing House, Hanoi.

Petter, J. J., Petter-Rousseaux, A. 1979. Classification of the prosimians. Pp. 281-286. In: Doyle, G.A., Martin, R.D. (eds.): The study of Prosimian Behavior. Academic Press, New York.

Petter, J. J., Schilling, A., Pariente, G. 1971. Observations eco-ethologiques sur deux lemuriens malgaches nocturnes: *Phaner furcifer* et *Microcebus coquereli*. Terre Vie. **118**: 287-327.

Rasmussen, D. T. 1986. Life history and behavior of slow lorises and slender lorises: implications for the lorisine-galagine divergence. Dissertation, Department of Anthropology, Duke University.

Ratajszczak, R. 1998. Taxonomy, distribution and status of the lesser slow loris *Nycticebus pygmaeus* and their implications for captive management. Folia Primatol **69** (suppl. 1): 171-174.

Schulze, H., Meier, B. 1995. Behavior of captive *Loris tardigradus nordicus*: a qualitative description, including some information about morphological bases of behavior. Pp. 221-249. In: Alterman, L., Doyle, G., Izard, M. K. (eds.): Creatures of the Dark, , Plenum Press, New York.

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 Exsudate Eating in Pygmy Slow Lorises (*Nycticebus pygmaeus*). Folia Primatol 72: 37-39.

Vo, Q., Nguyen, B. T., Ha, D. D., Le, V. T. 1996. Vuon Quoc Gia Cuc Phuong – Cuc Phuong National Park. Agricultural Publishing House, Hanoi.

Waterman, P.G. 1984. Food acquisition and processing as a function of plant chemistry. In: Chivers, D.,J. Wood, B., A., Bilsborough, A. (eds.). Food Acquisition and processing in Primates. Plenum Press. New York. USA..

Wiens, F. 1995. Verhaltensbeobachtungen am Plumplori *Nycticebus coucang* (Primates: Lorisidae) im Freiland. Diplomarbeit. Johann Wolfgang Goethe-Universitaet, Frankfurt a.M.

Wiens, F. 2002. Behaviour and ecology of wild slow lorises (*Nycticebus coucang*): social organisation, infant care system, and diet. Dissertation, Faculty of Biology, Chemistry and Geosciences, Bayreuth University, Bayreuth.

Wiens, F., Zietzmann, A. 2003. Social Dependence of Infant Slow Lorises to Learn Diet. Int J Primatol Vol. **24**, No.5: 1008-1021.

Summary

Initially, an important aspect of taxonomy of the pygmy loris is addressed. Pygmy lorises undergo a distinct seasonal pelage and colouration change. Whereas pygmy lorises in summer have a bright orange-brown fur, their winter pelage is dull orange-brown, shows extensive white frosting and the animals have a dark dorsal stripe. To verify a seasonal colouration change for pygmy lorises is a valuable contribution to the taxonomy of the genus. The pygmy loris has been distinguished from the intermediate loris *Nycticebus intermedius* mainly based on fur pattern and fur colouration. According to our data, fur characteristics do not allow the separation of two species and the existence of the intermediate loris can't be verified this way. In respect to the pygmy loris' ecology, the fur change might play a role for improved insulation and camouflage in the seasonally changed environment. **(Chapter 2.)**

Pygmy lorises are under severe threat through hunting and illegal trade. The law strictly protects the species, but the law enforcement is weak and, even if authorities interfere, the majority of the traded animals is lost. Ignorance and indifference lead to the death of the confiscated animals. Recommendations for the handling of confiscated lorises can help to improve the condition and reduce the number of losses. Improving the situation is particularly important in respect to the placement options for the lorises. Only careful monitoring on confiscation and adequate handling of the confiscated animals allow their later integration in captive breeding or reintroduction programmes. The IUCN recommends euthanizing animals, which can't be integrated in such programmes. Conservation awareness in Vietnam is still in its early stages and it is important to assure public support for conservation. Culling is inevitable in some cases, but to understand it as a measure of conservation requires a broad understanding of ecology, which the Vietnamese public is unlikely to have at present. Culling must remain an emergency measure and conservation should strive to find other solutions for confiscated lorises within the conservation framework. **(Chapter 3.)**

If trade-confiscated animals survive, they are brought to rescue centres, such as the Endangered Primate Rescue Center, which are established to care for primates confiscated from the illegal wildlife trade. Kept in a quiet natural environment under natural climatic conditions, pygmy lorises show few health problems. The most common incidents are injuries due to intraspecific aggression, particularly during the mating season. Correct housing of the predominantly solitary lorises and careful group composition is important for a healthy population. Another problem is infant mortality. But the rate of twins born within the study population is much higher than known from other captive populations (> 90%), and it is possible that rearing of only the stronger infant is a normal process. Dental problems, known to be a major health problem in captive lorises in zoos, hardly occur. This is probably a result of the cage furnishing, which allows regular use of the teeth by scraping of branches. Stress

has not been a main problem, but it is possible that the reduction of stress is cause for the high survival rate in the newly arriving pygmy lorises. (**Chapter 4.)**

Obesity has often also been considered a main health problem of captive pygmy lorises, but in fact it is not pathological but a wrongly interpreted aspect of physiology. Kept under natural lighting and climatic conditions, pygmy lorises show distinct weight changes independent from the food supply. These changes are correlated to the season and pygmy lorises have significantly higher bodyweights in the winter than in the summer months. Peak bodyweight values in winter are more than 50 % higher than the lowest values in summer. The variation in bodyweight occurs in both sexes and equally in pregnant and non-pregnant females. Food sources are scarce during the winter season and pygmy lorises seemingly increase their daily food intake in order to accumulate fat reserves prior to the time of food shortage. For pygmy lorises, energy storage in conjunction with reduced activity seem important means to allow survival during the winter months. Our observations also suggest that pygmy lorises temporarily reduce their metabolism, but the final proof for the latter is still pending. **(Chapter 5.)**

However worthwhile the study of pygmy lorises in rescue centres might be, for forest protection authorities the confiscated animals remain predominantly an unwanted burden. Uncontrolled releases of confiscated pygmy lorises are common practice in Vietnam. In order to give adequate recommendations for the present system of release and to find long-term placement options, possibilities a number of radiocollared pygmy lorises were reintroduced. Pygmy lorises establish individual ranges between 0.1 and 3.1 ha in size, cover distances between 90 and 290 metres per night and communicate by olfactory and acoustic cues. They are omnivorous and preferably use the edge areas with dense vegetation, avoiding the open space of tree plantations. Animals were killed by predators and succumbed to climatic influences. Besides yielding data on the pygmy lorises' ecology, the study showed that it is crucial to include seasonal adaptation processes into reintroduction planning. If a species' range covers a variety of different climates, animals from areas of the distribution range with an extreme climate might have developed specific adaptations to cope with these climatic hardships. Individuals originating from a different area within the distribution range do not need these specific skills and might not have developed them. Pygmy lorises can probably be reintroduced successfully, but they require good quality habitat and they should be reintroduced exclusively in areas close to the site of their origin. **(Chapter 6.)**

The reintroduction study proved that pygmy lorises are omnivorous. They feed on insect prey and plant matters at nearly equal parts, thus ranging between the faunivorous slender and the frugivorous and gummivorous slow loris. Gum is acquired by tree gouging and identified gum sources are regularly exploited. Nectarivory is likely. Most of the food sources exploited by the pygmy lorises are seasonally available and lacking during the winter months. Gum has been suggested to be a reliably food source, but gum can’t be digested well by pygmy lorises, and, due to its toxic components, it can only be used to a small degree. It can’t replace the food sources available in summer, but it does suffice to run a low metabolism and grant life at a reduced pace. **(Chapter 7.)**

The pygmy loris combines a number of strategies to survive in a seasonally hostile environment. The excellent adaptation to seasonal variations in its environment differentiate the pygmy loris among the lorises. Improved protection, combatting the illegal trade and a comprehensive conservation programme for the species are urgently required.

Aspekte von Ökologie und Schutz des Zwergplumploris *Nycticebus pygmaeus* **in Vietnam**

Zusammenfassung

Einleitend wird ein wichtiger Aspekt der Taxonomie des Zwergplumploris geklärt. Zwergplumporis durchlaufen einen saisonalen Fellfarbwechsel. Im Sommer ist ihr Fell kräftig orangerotbraun, im Winter ist es dumpfrotbraun, mit einer ausgeprägten silbernen Überreifung und einem dunklen Rückenstreifen. Der Nachweis dieses saisonalen Fellfarbwechsels ist ein wichtiger Beitrag zur Taxonomie der Gattung. Der Zwergplumplori wird vom Mittelplumplori *Nycticebus intermedius* vor allem aufgrund von Fellmuster und Farbe unterschieden. Unsere Daten zeigen, dass derartige Charakteristika keine Unterscheidung der beiden Arten erlauben und auf diese Weise kein Nachweis für die Existenz des Mittelplumploris geführt werden kann. Hinsichtlich der Ökologie des Zwergplumploris spielt der Fellwechsel möglicherweise eine Rolle für eine verbesserte Tarnung in der jahreszeitlich variablen Umgebung, höchstwahrscheinlich dient er aber der Verbesserung der Isolation während der Wintermonate. **(Kapitel 2.)**

Zwergplumploris sind in Vietnam stark bedroht durch Jagd und illegalen Tierhandel. Nach vietnamesischem Recht sind Zwergplumploris zwar strengstens geschützt, aber das Gesetz wir nur mangelhaft umgesetzt, und selbst wenn die Behörden einschreiten, bedeutet dies das Ende für die Mehrzahl der gehandelten Tiere. Mangelnde Sachkenntnis und Gleichgültigkeit führen zum Tod der meisten beschlagnahmten Loris. Empfehlungen zum Umgang mit beschlagnahmten Loris können zur Verbesserung der Situation beitragen und die Anzahl der Verluste verringern. Eine Verbesserung der Situation ist besonders wichtig hinsichtlich der Reintegrationsfähigkeit der beschlagnahmten Tiere. Nur sorgfältige Datenaufnahme bei der Beschlagnahme und sachgerechter Umgang mit den Tieren gewährleisten, dass zumindest ein Teil der beschlagnahmten Zwergplumploris in Erhaltungszuchtprogramme oder Auswilderungsprogramme integriert werden kann. Für Tiere, die nicht in derartige Programme integriert werden können, sieht die Weltnaturschutzorganisation die Tötung vor. Vietnam beginnt gerade erst, ein Artenschutzbewusstsein zu entwickeln und es ist wichtig, öffentliche Unterstützung fuer Artenschutzbelange zu gewinnen. Die Tötung von Tieren ist zwar in manchen Fällen unerlässlich, es erfordert aber ein gewisses Verständnis ökologischer Zusammenhänge, sie als Massnahme des Artenschutzes zu begreifen. Gerade dieses Verständnis kann in Vietnam derzeit nicht vorausgesetzt werden. Euthanasie sollte deshalb als Mittel für Ausnahmefälle betrachtet werden und Artenschutzarbeit sollte sich bemühen, andere im Sinne des Artenschutzes sinnvolle Lösungen für beschlagnahmte Tiere zu finden. **(Kapitel 3.)**

Wenn beschlagnahmte Zwergplumploris überleben, werden sie an Auffangstationen untergebracht, die mit der Versorgung von beschlagnahmten Tieren betraut sind, so zum Beispiel das Endangered Primate Rescue Center am Cuc Phuong National Park. Unter den dortigen Haltungsbedingungen zeigen Zwergplumploris nur wenig Gesundheitsprobleme. Am häufigsten sind Verletzungen aufgrund von Auseinandersetzungen mit Artgenossen insbesondere während der Paarungszeit. Richtige Unterbringung der vorwiegend einzelgängerischen Zwergplumploris und eine sorgfältige Gruppenzusammensetzung sind für eine gesunde Population unerlässlich. Ein weiteres Problem ist die Jungtiersterblichkeit. Die Zwillingsrate in der Untersuchungspopulation liegt weit über dem aus Gefangenschaftshaltung bekannten Prozentsatz (> 90%) und es scheint möglich, dass die Aufzucht nur des jeweils stärkeren Wurfgeschwisters ein normaler Vorgang ist. Zahnprobleme, die allgemein bei der Haltung von Plumploris ein Hauptproblem darstellen, treten in der Untersuchungspopulation kaum auf. Dies ist vermutlich auf die Käfigeinrichtung zurückzufuehren, die eine regelmässige Abnutzung der Zähne durch das Benagen von Zweigen erlaubt. Stress scheint als Krankheitsursache keine grosse Rolle zu spielen, aber die hohe Überlebensrate bei den neuankommenden Tieren ist vermutlich eine Folge der Stressminimierung für neuankommende Tiere. **(Kapitel 4.)**

Fettsucht wird oft als eine weiteres Gesundheitsproblem bei Zwergplumploris in Gefangenschaftshaltung angesehen. Tatsächlich ist dies aber keine krankhafte Erscheinung sondern ein falsch interpretierter physiologischer Mechanismus. Unter natürlichen Licht- und Klimaverhältnissen zeigen Zwergplumploris deutliche Gewichtsschwankungen unabhängig vom Futterangebot. Diese Schwankungen sind abhängig von der Jahreszeit und Zwergplumploris haben während der Wintermonate signifikant höhere Körpergewichte als während der Sommermonate. Höchstgewichte im Winter liegen mehr als 50% über den niedrigsten Gewichten im Sommer. Die Schwankungen treten bei beiden Geschlechtern auf und sowohl bei tragenden wie auch bei nichttragenden Weibchen. Im Freiland sind die Nahrungsquellen fuer den Zwergplumplori im Winter nur spärlich und es scheint, dass Zwergplumploris vor dieser Zeit der Nahrungsknappheit ihre Futteraufnahme erhöhen um Fettreserven aufzubauen. Für Zwergplumploris scheint die Speicherung von Energie in Verbindung mit verminderter Aktivität ein wichtiges Mittel zu sein, das Überleben während der Wintermonate zu sichern. Unsere Beobachtungen geben auch Hinweise darauf, dass Zwergplumploris zeitweise ihren Stoffwechsel reduzieren, aber hierfür steht ein letzter Nachweis noch aus. **(Kapitel 5.)**

Wie lohnend es auch immer sein mag, Zwergplumploris in Auffangstationen in Gefangenschaft zu studieren, für die Forstbehörden bleiben die beschlagnahmten Tiere in erster Linie eine unerwünschte Belastung. Unkontrollierte Freilassungen von beschlagnahmten Zwergplumploris sind in Vietnam allerorts üblich. Um angemessene

Empfehlungen zur Verbesserung des derzeitigen Freilassungssystems geben zu können und um langfristige Unterbringungsmöglichkeiten für beschlagnahmte Tiere zu finden, wurden eine Anzahl von Zwergplumploris mit Sendern versehen ausgewildert. Zwergplumploris besetzen jeweils einzeln ein Gebiet von 0.1 bis 3.1 ha Groesse, wandern pro Nacht zwischen 90 und 290 Metern und kommunizieren ueber olfaktorische oder akustische Signale. Sie sind Allesfresser und die dichten Waldrandgebiete sind ihr bevorzugtes Habitat, wogegen sie lichte Plantagen meiden. Todesursachen sind sowohl Beutegreifer als auch Klimaeinflüsse. Neben diesen Daten ueber die Ökologie der Tiere zeigt die Studie, dass es unerlässlich ist, saisonale Anpassungsprozesse in die Planung von Auswilderungen einzubeziehen. Wenn das Verbreitungsgebiet einer Art eine Vielzahl verschiedener Klimate einschliesst, haben Tiere in extremen Klimabereichen des Verbreitungsgebiets möglicherweisse spezielle Anpassungsmechanismen entwickelt, um diese extremen Bedingungen zu überleben. Individuen aus anderen Bereichen des Verbreitungsgebiets benötigen diese speziellen Fähigkeiten nicht und haben sie demzufolge möglicherweise auch nicht entwickelt. Eine erfolgreiche Auswilderung von Zwergplumploris erscheint also zwar möglich, aber die Tiere benötigen Habitat guter Qualität und sollten ausschliesslich nahe ihres Ursprungsgebietes ausgewildert werden. **(Kapitel 6.)**

Die Auswilderungsstudie zeigt, dass Zwergplumploris Allesfresser sind. Sie fressen zu nahezu gleichen Teilen Insekten und pflanzliche Bestandteile und stehen so zwischen dem insktenfressenden Schlanklori und dem frucht- und harzfressenden Plumplori. Harz wird durch das Anzapfen von Bäume gewonnen und einmal identifizierte Harzquellen werden regelmässig genutzt. Anscheinend wird auch Nektar gefressen. Die meisten Futterquellen der Zwergplumploris unterliegen starken jahreszeitlichen Schwankungen und sind während der Wintermonate nicht vorhanden. Es wurde vorgeschlagen dass Harz eine zuverlässige ganzjährig verfügbare Futterquelle wäre. Der Zwergplumplori kann Harz aber nur bedingt verdauuen und Harz kann aufgrund toxischer Bestandteile nur in kleinen Mengen genutzt werden. Es kann die Nahrungsquellen, die dem Zwergplumplori im Sommer zur Verfügung stehen, nicht ersetzen. Es genügt jedoch, den Stoffwechsel auf einem geringen Niveau und bei reduzierter Lebensgeschwindigkeit weiterzubetreiben. **(Kapitel 7.)**

Der Zwergplumplori kombiniert eine Anzahl verschiedener Strategien, um in einem saisonal feindlichen Lebensraum zu überleben. Seine hervorragende Anpassung an die starken jahreszeitlichen Schwankungen in seinem Lebensraum räumen dem Zwergplumplori eine Sonderstellung unter den Loris ein. Eine Verbesserung seines Schutzes und eine Bekämpfung des illegalen Handels sowie ein umfassendes Schutzprogramm sind dringend erforderlich.

Attachments

Streicher, U. 2003. Saisonale Veraenderungen in Fellzeichnung und Fellfaerbung beim Zwergplumplori *Nycticebus pygmaeus* und ihre taxonomische Bedeutung. Zoolog Garten N.F. **73**, 6: 368-373.

Streicher, U., Schulze, H., Fitch-Snyder, H. Confiscation, rehabilitation and placement of Slow Lorises. Recommendations to improve the handling of confiscated slow lorises *Nycticebus coucang.* In: Shekelle, M. (ed.): Primates of the Oriental Night. Treubia. Special issue. In print.

Streicher, U., Nadler, T., Zinner, D. 2003. Re-introduction study of Pygmy lorises in Vietnam, Reintroduction News. Newsletter of the IUCN/SSC Reintroduction Specialist Group. Abu Dhabi, UAE. No: 37-40.

Confiscation, rehabilitation and placement of Slow Lorises

Recommendations to improve the handling of confiscated slow lorises
Nycticebus coucang

Ulrike Streicher*
Helga Schulze**
Helena Fitch-Snyder***

*Endangered Primate Rescue Center, Vietnam
**Ruhr-University Bochum, Germany
***Loris Conservation International, USA

Keywords: Slow Loris, Wildlife Trade, Confiscations, Wildlife Rescue

Abstract
Lorises are common in the wildlife trade all over Indonesia. They are traded as pets but also used in traditional medicines and are destined for the national as well as the international market. Large numbers of lorises are exported to the Middle East and Asian countries and confiscations of up to one hundred of animals in a single shipment are known to occur. The care, rehabilitation and final placement of these animals seem currently not addressed in a satisfying way. Animals die due to lack of adequate facilities, diseases, or ill managed releases. Some recommendations to reduce these problems have been developed during the workshop on tarsier and loris taxonomy, husbandry and conservation in Jakarta, 15.-25. February 2003. Materials herein are only brief and it is strongly recommended to access the mentioned sources for more detailed information.

Note: The following recommendations address specifically the lorises confiscated in animal markets and in the trade (animals with unknown geographical origin). Animals, which are confiscated by rangers directly from hunters (animals with known geographical origin), require a different proceeding. These cases are not addressed here and recommendations for these cases can be obtained from the authors.

1. Legal background

Lorises occur from China west to India, and south to Indonesia. A number of different species and genera occur in ten different countries. Despite different political structures and economic situations in these countries there is agreement on the protection of lorises. In most countries hunting or capture of lorises is prohibited and the keeping of lorises illegal. Keeping lorises is subject to permits that can usually be issued only by high governmental authorities and these permits are often restricted to specific purposes (e.g. scientific). In some countries there are no specified exceptions and all keeping of lorises is illegal. Fines can be surprisingly high and imprisonment up to 6 years can in theory be imposed. In Indonesia lorises are protected under Decree of Agriculture Ministry No.66 of 1973, the Government Regulation No. 7 of 1999 concerning the Protection of Wild Flora and Fauna and Act No. 5 of 1999 concerning the Biodiversity Conservation. Consequently all catching, killing, keeping, hurting, transporting and trading of live or dead lorises, parts of their bodies and derivates or products made of them is prohibited. Imprisonment up to five years and a fine up to 100.000.000 rupiah can be implemented in case of violation. Lorises can only be kept with a permission from the Directorate of General

Forest Protection and Nature Conservation and only for the purpose of captive breeding.
The international trade with lorises is restricted by CITES and most loris species are listed in appendix II.
A major task of conservation must be to raise awareness on the legal status of lorises and to encourage strict law enforcement in order to prevent hunting and illegal keeping.

2. Handling of lorises after confiscation
Lorises are nocturnal primates and are very susceptible to stress. Direct handling of confiscated animals should be reduced to a minimum and reducing stress must be a main concern during all stages of confiscation and rehabilitation. The environment of the cages should always be quiet and cages should be at least partly covered and provide enough hiding possibilities (branches with foliage, sleeping boxes).
Lorises should be handled preferably with gloves for the safety of the people handling them. Little is known about the diseases carried by wild lorises but potentially dangerous viruses can never be excluded. In addition bites of lorises can be toxic and are known to occasionally cause anaphylactic reactions.
Transport containers for lorises should be dark, maybe with mesh wire on one of the sides to allow control of the animals. Two layers of mesh wire at a distance of at least one centimetre prevent injuries on the lorises' hands during transport. Cages should contain some branches with foliage for the animals to hide. Ideally containers should at least measure 300 mm x 300 mm x 300 mm so lorises can be kept in them for several days if necessary.
Lorises are fairly solitary animals and should be kept in separate transport containers if possible. However animals that have been together in a shipment or in one cage in a market can be kept in the same transport container. Separating them from a familiar cage mate might increase the stress for the animals, but the number of animals should not exceed four animals per cage/ transport unit.
Animals should be transported in a non air-conditioned vehicle. Exposing them for several hours to an air-conditioned environment where temperature and humidity are considerably lower than outside can cause severe health problems.

3. Emergency health care
After transport and confiscation, lorises should be given some time to recover before they are inspected or handled.
After the recovery period a careful inspection without direct handling of the animal should be conducted (see attachments).
Common health problems in confiscated lorises include stress, dehydration, injuries, parasites and dental problems. Consequently emergency treatment will comprise the following:

1. Rest and removal of possible stress factors
2. Rehydration, orally or subcutanously
3. Antibiotic treatment
4. Wound hygiene/ dental problems
5. Antiparasitic treatment

Details on treatment are included in the attachments.

4. Identification

4.1. Taxonomic Identification

At present knowledge of taxonomy of lorises is fragmentary. The number of species and possible subspecies of slow lorises in Indonesia is uncertain. A classification proposed in 1972 recognised three subspecies: Nycticebus coucang coucang (Sumatra, North Natuna), Nycticebus coucang menagenis (Borneo, Bangka, Belitong) and Nycticebus coucang javanicus (Java). But this arrangement may be too simple and needs to be checked by examination of larger samples of known origin and by molecular and karyotype work.

Intensified surveys for lorises are required and the data collection should be standardized in order to allow better comparison of the gathered data. A suggested standard data collection sheet is attached to these materials (see attachments). It is important to emphasize that the data collection on confiscated animals is particularly important in order to assess later placement possibilities but also to identify trade source areas.

A preliminary identification key for the different loris subspecies is shown in attachment 4 and a detailed version is currently in preparation. But a wide variety of colourations occur even within the subspecies level and exact taxonomic identification based on the outer appearance might be difficult.

A dry hair sample or faecal sample in 100% Ethanol should be taken for genetic identification. The hair sample should be taken with a pair of tweezers or an artery forceps. It is important to assure the hairs are collected with the roots and care must be taken not to touch the hairs in order not to contaminate the sample.

Hair samples are subject to CITES regulations and their export and import requires official permits.

4.2. Individual identification

Lorises might be confiscated in large numbers and it is important to mark the animals individually. Implanting a transponder (microchip) is the marking method of choice. If lorises are kept in large groups a visible marking method might additionally be required. Coloured plastic bird rings are widely available and have been used in several institutions successfully.

The number of the transponder respectively the colour of the arm ring must be noted on the measure sheet and track must be kept of every single individual from the moment of confiscation until its death or return to the wild.

5. Quarantine and health screening

In view of the high risk of primates carrying zoonotic diseases, quarantine requirements are stringent (Woodford 2001). As other primates lorises should be held in quarantine for at least 30 days after arrival.

Quarantine cages must be easy to clean and sufficiently large to keep the animal for several weeks.

Though hygiene plays an important role during the quarantine period, but in order to reduce stress, nest boxes must also be provided in quarantine cages and cages should be covered with drapes at least on three sides.

Animals of one shipment can be quarantined together, but in order to reduce social stress, it is recommended to keep only small groups of animals, which are familiar with each other in the same quarantine cage.

However it is difficult to confirm that each individual is eating normally. Animals that have been found in a poor state and/or animals with dental problems should be housed separately during quarantine in order to assure they feed normally.

At least one general health check under anaesthesia should be performed during the quarantine period. Health checks in trade confiscated lorises must include full dental checks, since removing teeth is a common procedure in animals destined for the pet trade. Suggestions on basic treatment and a recommended quarantine protocol are included in the attachments.

6. Long-term placement options
6.1 Re-introduction
6.2 Captivity
6.2.1 Keeping in semi-natural conditions
6.2.2 Captive breeding programme
6.3 Euthanasia

6.1 Re-introduction

Re-introduction is often considered a suitable placement option for confiscated lorises. However there are many concerns related to such a proceeding.

The provenance of animals confiscated from the trade and from transports is usually not known. Furthermore the taxonomy of Indonesian lorises is still insufficiently known. Releasing individuals from a different race or sub-species might be a threat to the local population. Little is known about lorises specific adaptations to the ecological requirements of their habitat and individuals released into the wrong habitat type might not have the necessary skills to survive.

Due to limited awareness and facilities animals hardly undergo a thorough health check and quarantine period before being returned to the wild. But animals that have been in the transport and trade might carry diseases and if they are returned to the wild they might spread these diseases to the wild populations. Thus the released animals can become a serious health threat to the wild populations.

In addition animals might not have the necessary skills to survive in the wild. In most cases the animals are not monitored after the release and nothing is known about their survival in the wild.

Returning animals to the wild in a responsible manner might be expensive and might limit the resources available for the conservation of the wild populations (IUCN, 2002).

Due to the lack of detailed taxonomic information and the lack of capacity for adequate health care (screening, quarantine) re-introduction into the wild is at present not considered a feasible option (see 2.A).

It might be possible in the future and in this respect it is important to assure the genetic resources (see 6.2).

6.2. Captivity

Captive options are described in detail in this volume in Fitch-Snyder, H., Schulze, H., Streicher, U.. 2003: Enclosure design. Indonesian Prosimian Workshop. Schmutzer Primate Center, Jakarta, Indonesia.

6.2.1. Keeping in semi-natural conditions

The establishment of semi-wild areas for the permanent keeping of larger groups of confiscated lorises (sanctuary) is an option worth pursuing for the immediate solution of the problem.

Animals could be kept in a large fenced area and supplementary fed. There is no experience yet with such a facility for lorises and in particular and optimal feeding management for the lorises has to be developed. Optimal group size and potential

social stress factors should be studied in such a facility in order to find suitable group sizes. Detailed recommendations on the establishment and management of such an enclosure can be found in the mentioned document. As long as there are no other placement solutions for confiscated lorises, breeding should be restricted for common lorises' taxa in a rescue centre situation. The least invasive way to do so is by separating the sexes and housing only all female or all male groups.
Though animals can't be reintroduced at present, they can still be a valuable resource for educational purposes. In addition they provide important study possibilities and they assure that genetic resources are not lost.

6.2.2. Captive breeding programme

At present some taxa of Indonesian lorises do not exist in captivity and little is know about their status in the wild. Confiscated individuals of such insufficiently known taxa should be used to establish a captive breeding population. Such a breeding population can be established and maintained with minimal cost and should not necessarily be used for exhibition.

6.3 Euthanasia

Euthanasia might become necessary in some cases. Aspects of animal health and conservational considerations as well as lacking financial and logistical capacity to cope with the number of confiscated lorises suggest euthanasia as feasible option. But it should always be considered the last option and should be only pursued if all other options have been thoroughly explored.
Public opinion and political aspects might well be contradictory and care must be taken to carefully justify any case of euthanasia, in order to maintain the credibility of conservation efforts.

7. Further information on lorises

First aid, taxonomy, husbandry, measuring standards, diseases:
http://www.ruhr_uni_bochum.de/neuroanatomie/people/helga_schulze/loris

Quarantine:

Woodford, M.H. .2001.Quarantine protocols and health screening protocols for wildlife prior to translocation and release in to the wild. Office International des Epizooties. Paris, France.

Diseases:

Goeltenboth, R. Kloes, H.-G. . 1995. Krankheiten der Zoo-und Wildtiere. Blackwell Wissenschaftsverlag, Berlin.

Husbandry:

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

Fitch-Snyder, H., Schulze, H., Streicher, U.. 2003. Enclosure design. Indonesian Prosimian Workshop. Schmutzer Primate Center, Jakarta, Indonesia. In prep.

Placement:

Baker, L. R. (ed.). 2002. Guidelines for Nonhuman Primate Re-introductions. In Soorae, P.S., Baker, L.R. (eds.). Re-introduction News: Special Primate Issue,

Newsletter of the IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, UAE. No. 21: 29-53
IUCN. 2002. Guidelines on the Placement of Confiscated Animals. IUCN/SSC Re -introduction Specialist Group, Abu Dhabi, UAE.
IUCN. 1998. IUCN Guidelines for Re-introductions. Prepared by the IUCN/SSC Re-introduction Specialist Group. Abu Dhabi, UAE.

8. Acknowledgements
Though three authors a signing responsible for this paper, it includes contributions from many participants of the Indonesian Prosimian Workshop in Jakarta in February 2003. Particularly Irene Arboleda, Colin Groves, Sharon Gursky, Alexandra Nietzsch and Myron Shekelle have provided valuable inputs to this paper. Staff of the Schmutzer Primate Center, Pro Fauna Indonesia and WWF Indonesia have contributed in many discussions.
Sincere thanks go to LIPI and the Schmutzer Primate Center, which financed and hosted this workshop. Very personal thanks go to Myron Shekelle for his efforts in organizing the workshop.

9. References
Baker, L. R. (ed.) 2002. Guidelines for Nonhuman Primate Re-introductions. In Soorae, P.S., Baker, L.R. (eds.). Re-introduction News: Special Primate Issue, Newsletter of the IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, UAE. No. 21: 29-53
Fitch-Snyder, H. et al. (eds.) 2001. Management of Lorises in Captivity. A Husbandry Manual for Asian Lorisines (*Nycticebus & Loris ssp.*) Center for Reproduction in Endangered Species (CRES), Zoological Society of San Diego, USA.
Gass, H. 1987. Affen. In: K. Grabisch & P. Zwart (eds.): Krankheiten der Wildtiere. Schluetersche Verlagsanstalt, Hannover, Germany.
Goeltenboth, R. et al. 1995. Krankheiten der Zoo-und Wildtiere. Blackwell Wissenschaftsverlag, Berlin, Germany.
IUCN. 2002. Guidelines on the Placement of Confiscated Animals. IUCN/SSC Re -introduction Specialist Group, Abu Dhabi, UAE.
IUCN. 1998. IUCN Guidelines for Re-introductions. Prepared by the IUCN/SSC Re-introduction Specialist Group. Abu Dhabi, UAE.
Schulze, H. et al. 2001. Conservation database for lorises and pottos. http://www.ruhr_uni_bochum.de/neuroanatomie/people/helga_schulze/loris
Sutherland-Smith, M.et al. 2001. Review of Loris Clinical information and Pathological Data From The San Diego Zoo:1982-1995. In: Management of Lorises in Captivity. A Husbandry Manual for Asian Lorisines (*Nycticebus & Loris ssp.*). Fitch-Snyder, H. and Schulze, H. (eds.). 2001. Center for Reproduction in Endangered Species (CRES), Zoological Society of San Diego, USA.
Wiens, F. 1995. Verhaltensbeobachtungen am Plumplori *Nycticebus coucang* (Primates: Lorisidae) im Freiland. Diplomarbeit. Johann Wolfgang Goethe-Universitaet, Frankfurt a.M., Germany.
Woodford, M. H. 2001.Quarantine protocols and health screening protocols for wildlife prior to translocation and release in to the wild. Office International des Epizooties. Paris, France.

Attachment 1- Performing a basic health check

Healthy animals should be alert, when disturbed.
Signs of diseases:
Animal seems very sleepy
Animals hold the head wobbly or not straight.
Note: Freezing to motionlessness may be normal camouflage behaviour, indicating stress

The eyes should be bright and look around actively, when disturbed.
Signs of diseases:
There is blood, pus or other secretion around the eye.
Animal is unable to open both eyes.
There is a swelling in the surrounding of the eye.
The eye seems dull, greyish or sunken.

The nostrils should be clean and the animal breathes normally.
Signs of diseases:
There is blood, pus or other secretion around the nostrils.
The animal is breathing very heavily.
The animal makes sounds while breathing.
Note: Feeling threatened lorises might utter growls, that must not be misinterpreted as raspy breathing and a sign of disease.

The muzzle should be symmetrical and the animal should feed normally.
Signs of diseases:
Swollen or enlarged muzzle.
Blood or pus on the visible gums.
Difficulties to bite and chew.

The ears should be symmetrical and clean.
Signs of diseases:
There is blood, pus or other secretion from one or both ears.
One ear or both ears hanging not normally
There are injuries or swellings around the ear.

They should have a healthy looking coat.
Signs of diseases:
There are injuries or wounds
There are bald patches
The animal shows excessive scratching.

They should have a normal body shape and move normally.
Signs of diseases:
There are swellings or lumps
The position of one or more limbs is abnormal.
There is lack of function of a limb

Note: During daytime lorises will present themselves mostly tightly curled up, holding on to the cage or the cage furnishing. Thus it might be difficult to correctly assess the reactions of the animal. Repeating the inspection of the animal at night with the help of a torch might be necessary.

Animal access sheet

Access data:

Taxon name: Identification number:

Date of birth (est.): Sex:

Weight: Source:

Arrival date:

External check on arrival (not under anaesthesia):

Nutrition state:

Care state:

Skin:

Eyes:

Nose:

Mouth:

Movements:

Digestive system:

Respiratory system:

Circulatory system:

Emergency measures:

Feeding instructions:

Duration of quarantine:

Attachment 2 – Emergency care of slow lorises

Emergency care

The below mentioned drugs are only some suggestions out of a variety of possibilities.

Rehydration:	Oral rehydration solution or Ringer's lactate orally or subcutaneous (at body temperature), up to 10 % of the bodyweight distributed over the day
Antibiotic treatment:	Antibiotic treatment is required in case of obvious (wounds, gingivitis, pneumonia) infections in order to prevent further spreading of bacteria. Enrofloxacin (Baytril®) has been used with good results at a dosage of 5mg/kg intramuscular.
Wound hygiene:	Wounds should be cleaned with clean water and iodine solution (Betadyne®). Application of antibiotic creams is not recommended, since lorises lick themselves thoroughly and will ingest the cream. Wound in trade animals will in most cases not be fresh and aggressive treatment (e.g. suturing) might be delayed for several days until the health check under anaesthesia.
Dental problems:	Dental problems occur mostly in animals from the pet trade, in which teeth have been removed. These animals might suffer from severe gingivitis and sinusitis. Antibiotic treatment is necessary in order to control the infection. In addition such animals might be reluctant to feed on hard or firm food items and might require specific food preparation (blander). In some cases removal of teeth or tooth fragments might be necessary but this can only be done under anaesthesia.
Antiparasitic treatment:	Ivermectin (Ivomec®) 0.2-0.4 mg/kg (Goeltenboth et al., 1990)

Attachment 3 – Quarantine and health screening in slow lorises

Quarantine

Based on international guidelines (Woodford, 2001) 30 days quarantine with the following protocol is recommended. During anaesthesia at least one full health check must be performed under anaesthesia.

1. Faecal examination (direct and flotation) for endoparasites, especially *Entamoeba sp*. which often infect primates, causing diarrhoea in animals subjected to stress. Since *Entamoeba sp.* are shed intermittently, several samples should be examined.

2. Check for ectoparasites.

3. Appropriate serology, based on history and origin. Health screening for lorises might include screening for Hepatitis B and C and Herpes simplex and Herpes B viruses.

4. Intracutaneous tests for tuberculosis (using avian, bovine or mammalian tuberculine). In most primates this test is routinely performed in the eyelid. However this location might in lorises be difficult to monitor and a shaved spot on the flank or abdomen might be preferable.

5. Complete blood chemistry

Note: False positive tuberculine reactions have been reported from lorises at San Diego Zoo. A new Herpes virus variety has been identified in lorises at the same facility.
Not all rescue facilities might be able to perform all these tests for several reasons.
Thus the quarantine period should be absolutely strictly kept.

Anaesthesia

Anaesthesia should only be performed by qualified veterinarians.

Ketamine is most commonly used for anaesthesia in lorises.

Recommended dosage: 23 mg/kg intramuscular

Literature:
5 mg/kg (Gass, 1978)
8-12 mg/kg (Sutherland-Smith et al., 2000)
20 mg/kg (Goeltenboth et al., 1990)
11.3-33.3 mg/kg (Wiens, 1995)

Note: females might require lower dosages than males

Health check in anaesthesia:

Taxon name: Identification number:

Date of birth (est.): Sex:

Weight: Origin:

Arrival date: Way of application:

Dose	Drug	T_{hit}	T_{out}	Effect	T_{up}

Heart rate: Respiration rate: Body temperature:

Testing:

Treatments:

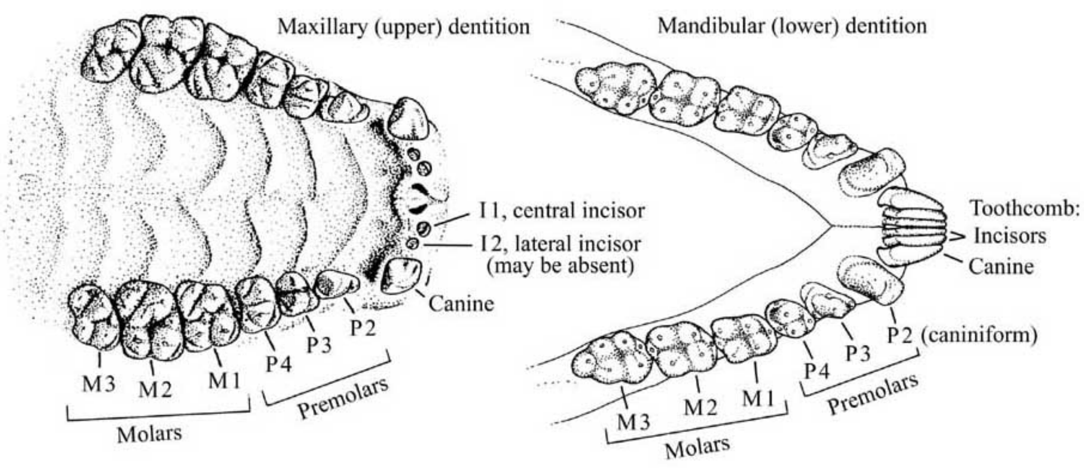
Samples taken:

Remarks:

Dental check (mark if absent, damaged or affected by health problems):

M3 M2 M1 P4 P3 P2 C I2 I1 I1 I2 C P2 P3 P4 M1 M2 M3
M3 M2 M1 P4 P3 P2 C I2 I1 I1 I2 C P2 P3 P4 M1 M2 M3

Note: In lorises P1 is missing, they only have P2 and P3. The incisors in the upper jaw are very small or missing. In the lower jaw the canine has been modified to incisor-like shape. Incisors and canines comprise the toothcomb, and the first premolar is functionally replacing the canine.



Attachment 4 – Taxonomic identification of lorises

Preliminary identification key of lorises found in Indonesian markets (preliminary)

Note: Considering the amount of trade with imported lorises and the fact that Vietnamese pygmy lorises have already been illegally exported from Java, all *Nycticebus* forms are considered here although occurrence of some is unlikely in Indonesia. The identification key is based on small samples from partly rather variable populations with overlapping features and more research will be necessary. Updates and a key with colour figures is supposed to be available in the future via http://www.ruhr-uni-bochum.de/neuroanatomie/people/helga_schulze/loris/identification_key/index.html

1 **a)** Nuchal region creamy or white; clear dark fork marks from the dorsal stripe to ears and eyes. White median facial stripe extending up to the dorsal stripe, pointed above* (see below: fig. f). General colour light yellowish-grey or ashy-grey, slightly tinged with rufous. Two, three or four upper incisors, according to age; in the permanent dentition I2 (lateral incisor) missing .... ***N. c. javanicus***

b) Nuchal area creamy, whitish or very light other colour, no dark stripes connecting the dorsal stripe with the circumocular patches and ears*[1] (see fig. a). Strong dorsal frosting .... ***N. bengalensis*** *[2]

c) Other. Nuchal area not creamy or white, although it may be lighter than general dorsal colour or more frosted with white, and a light-coloured zone bordering the dark dorsal stripe may be present **2**

2 **a)** Rather large ears (ear length 25-27 mm), ear tips naked or with few hairs, rim pigmented dark to blackish. Small animal; foot length 33-55 mm, head-body-length less than 287 mm, usually about 240 mm, sitting height less than about 260 mm, usually about 220 mm. Facial markings as in fig. d or e, sometimes with a little red median zone in the middle of the upper part of the median light facial stripe which is not known from any other form. I2 in the upper jaw present in about 93 % of adults .... ***N. pygmaeus*** *[3]

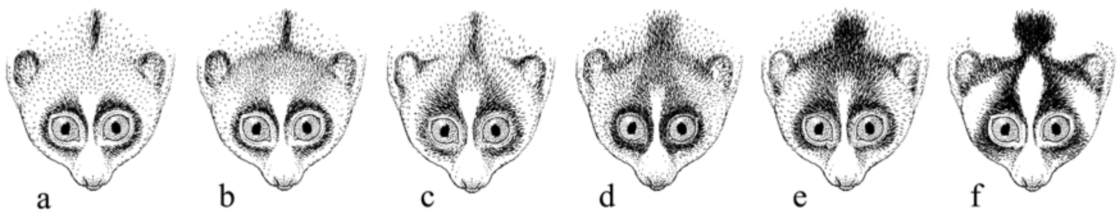
b) Foot length 48 mm or more, head-body-length about 240-251 mm (sitting height about 215-226 mm), ears small (ear length 14-20 mm) and somewhat hidden in the fur, more clothed with hair than in 2 a, pigmented, no evident naked black pinna. In adults lateral incisors in the upper jaw always missing *[4] .... **3 a**

c) Head-body-length about 251-330 mm (sitting height about 226-226 mm), ear length 11-24 mm, foot length 48-74 mm, head-body-length 240-330 mm (sitting height, calculated: approximately 215-267 mm) **3**

3 **a)** Lateral incisors in the upper jaw, I 2, always missing in adults, in Borneo even missing in young animals *[4]. Rather small, foot length 48-67 mm, head-body-length 240-300 mm (sitting height, calculated: approximately 215-270 mm)- Inconspicuous ear pinnae partly covered with hair. Facial markings often faint, but variable, as in figs. b, c or d. ....***N. c. menagensis***

b) Four incisors (I 1, I 2) present in the upper jaw in about 80% of adult animals *[4]. Foot length 51-74 mm, head-body-length 251-330 mm (sitting height, calculated: approximately 226-297 mm)- Ear small (ear length 11-24 mm), but on photos well visible (hair around ears shorter than in 3a?), looking naked.
Usually with four clear red-brown to dark brown fork marks from the dorsal stripe to ears and eyes ; in the Malayan form the dark forkmarks typically broaden and unite to form a rufous-brown crown patch which usually covers the forehead and almost extends from ear to ear, (fig. e) ....***N. c. coucang***

c) The insular form from Pulau Tioman (presently regarded as *N. c. coucang*, synonym *N. c. insularis*) is said to have indistinct facial markings, no dark dorsal stripe and temporal ridges resembling the ones of Bornean slow lorises, but otherwise resemble *c. coucang* (Osman Hill 1953). For this rare form data are lacking.



Annotations:

* Some photos show lorises of unknown origin with different facial markings, for instance a dark face, but with the whitish nuchal area. These animals at present are considered to be from Java; further research and surveys are necessary to confirm their origin.

*[1] The possibility that some lorises have been bleached or treated with dye before offering them for sale, for obtaining higher prizes for unusually coloured animals, must also be considered.

*[2] Form distributed from India and southern China to Thailand; unlikely to be found in Indonesia. Intermediate *bengalensis-coucang* forms (synonym: *N. c. tenasserimensis*, facial marking typically as in fig. c) are reported from peninsular Thailand, information about their external features are still lacking, it may be difficult to distinguish them from *N. c. coucang* or *N. c. menagensis*. But their occurrence on Indonesian markets also seems not too likely.

*[3] Form occurring in Laos, Vietnam and southern China; often exported as a pet, trade in / via Indonesia confirmed in at least one case.

*[4] Missing incisors cannot be used to distinguish forms if there is evidence for abnormal loss of teeth, for instance removal of teeth by traders to prevent the animals from biting.

Measurements of slow lorises for taxonomic purposes

Under anaesthesia a full set of measurements should be taken for taxonomic purposes. Information about measuring standards for lorises can be found at http://www.ruhr-uni-bochum.de/neuroanatomie/people/helga_schulze/loris/population_database/measure_index.html
or
http://www.ruhr-uni-bochum.de/neuroanatomie/people/helga_schulze/loris/population_database/Standards_for_Measurement/Measurements_short.pdf.

Identification:

Identification number:

Markings (number of transponder, colour of arm ring):

Sex:

Origin (country, locality):

Taxon name:

General colour description, facial markings, dorsal stripe, presence and location of frosting (white hair tips):

Photos (complete rear view and portrait, preferably in daylight):

Measurements (in mm):

Sitting height:		
Upper arm length:	right:	left:
Forearm length:	right:	left:
Thigh length:	right:	left:
Knee height:	right:	left:
Hand length:	right:	left:
Foot length:	right:	left:
Hand span:	right:	left:
Foot span:	right:	left:
Maximum head length:		
Muzzle length:		
Ear length	right:	left:
Tail length		

Attachment 5 – Recommendations on the feeding of slow lorises

Examples of a mixed diet for slow lorises *Nycticebus bengalensis* at a North American Zoo and an Asian primate rescue facility

Item	**Amount offered per animal per day** **San Diego Zoo**	 **Endangered Primate Rescue Center**
Banana	16 g	34g
Papaya/ Mango/ Dragonfruit	8 g	10g
Peeled orange	13 g	13g
Grapes	13 g	13g
Cooked carrot	3 g	11g
Cooked yam	7 g	-
Pinapple	-	13g
Apple	13 g	10g
Cucumber	9 g	-
Foliovore biscuit	3 g	-
Mealworms	2 g	-
Crickets or locusts	2 g	Seasonally, 1-2 pieces
High protein biscuits	13 g	-
Hard-boiled egg white	13 g	10g
Milk powder		2g

Fresh water must always be available.
The left column only lists food items, which are usually available locally.
If lorises do not eat during the first days after confiscation, this might be a result of stress and the fact that the animals are not familiar with the offered food sources. If the animal seems otherwise normal this should not be taken as a reason to interfere. However after some days the animal should accept at least some of the offered items. Offering some small moving prey may encourage prey-catching and feeding.
Dental problems might require a special food preparation (blander).
Detailed information on food requirements as well as manufacturer's addresses can be found in Fitch-Snyder et al. 2003. Enclosure design. Indonesian Prosimian Workshop. Schmutzer Primate Center, Jakarta, Indonesia.

Streicher, U., 2003: Saisonale Veränderungen in Fellzeichnung und Fellfärbung beim Zwergplumplori (*Nycticebus pygmaeus*) und ihre taxonomische Bedeutung. [Seasonal changes of fur patterns and colour in the pygmy slow loris (*Nycticebus pygmaeus*) and their taxonomic meaning]. Der Zoologische Garten, Jena **73** (6): 368-373. ISSN 0044-5169. (German)

Saisonale Veränderungen in Fellfärbung und Fellzeichnung beim Zwergplumplori (*Nycticebus pygmaeus*) und ihre taxonomische Bedeutung

Von Ulrike Streicher, Endangered Primate Rescue Center, Vietnam

Mit 3 Abbildungen Eingeg. 29. August 2003

Einleitung

Zur besseren Identifikation werden Zwergplumploris im Endangered Primate Rescue Center (EPRC) bei der Ankunft fotografiert. Von einigen Tieren wurden aus verschiedensten Gründen zu einem späteren Zeitpunkt erneut Aufnahmen gemacht. Der Vergleich der Bilder eines Tieres zu verschiedenen Zeitpunkten zeigte deutliche Unterschiede in Färbung und Zeichnung. Das war der erste eindeutige Hinweis darauf, daß Zwergplumploris einen deutlichen Farb- und Zeichnungswechsel durchlaufen.
Die Taxonomie der Loris ausschliesslich auf Fellfarbe und Fellzeichnung zu begründen, ist eine recht begrenzte Betrachtungsweise, doch bevor genetische, ökologische, ethologische und weitere biologische Untersuchungen zur Verfügung standen, war es die einzige verfügbare Möglichkeit.
Mit der Kenntnis über Fellfarbe, Fellzeichnung und deren saisonalen Veränderungen beim Zwergplumplori ist es jedoch möglich, einen entscheidenden Hinweis zur Revision der Systematik von *Nycticebus* zu geben.

Zur Systematik des Zwergplumploris

Der Zwergplumplori *Nycticebus pygmaeus* wurde 1907 von Bonhote beschrieben. Terra typica ist Nha Trang im südlichen Vietnam.
Die Erstbeschreibung beinhaltet im Wesentlichen Größe und Fellbeschaffenheit. Weiches rötlich-braun-gräuliches Fell mit etwas silbrigem Weiß durchsetzt, eine weiße Linie auf dem Nasenrücken, ein langer Streifen dunkelrötlichen Fells entlang der Wirbelsäule und eine silberweiße Unterseite werden als Hauptmerkmale des Tieres genannt (Bonhote 1907). Gemeinsam mit vielen andernen Autoren betrachtet von

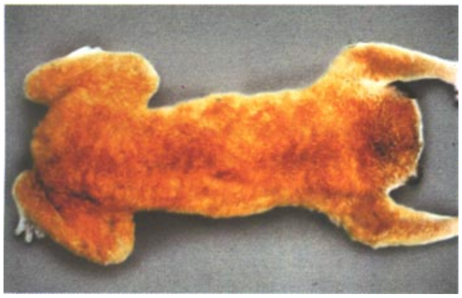


Abb. 1. Zwergplumplori
(*Nycticebus pygmaeus*)
in typischer Sommerfärbung (August 2001)

Abb. 2. Dasselbe Tier wie in Abb. 1 in typischer Winterfärbung mit ausgeprägter Überreifung und deutlichem Rückenstreifen (März 2002)
Aufn.: ULRIKE STREICHER

Abb. 3. Verschiedene Färbungen eines Zwergplumploris über einen Zeitraum von zwanzig Monaten (Juli 2000, November 2000, März 2001,
August 2001, November 2001, März 2002)
Aufn.: ULRIKE STREICHER

Boetticher (1958) den Zwergplumplori als eine Unterart des Plumplori *Nycticebus coucang*. Demzufolge ist Boetticher's Farbbeschreibung sehr allgemein gehalten und beschreibt die Art mit einem kastanienbraunen bis schwärzlichen Rückenstreifen. Groves (1971) dagegen läßt keinen Zweifel am Artstatus von *Nycticebus pygmaeus* und seine Farbbeschreibung ist der ursprünglichen Beschreibung von Bonhote sehr ähnlich: feines gewelltes Haarkleid, von rötlicher bis oranger Farbe, mit einem Hauch Grau "überreift" in jung erwachsenen Individuen, der dunkle Rückenstreifen nie sehr dunkel und in der Lendenregion endend. Eine neuere Beschreibung (Groves 2001) charakterisiert den Zwergplumplori mit einem Fell von feiner Struktur und rötlich- brauner Farbe und einem mittel- bis dunkelbraunen, breiten, aber undeutlichen Rückenstreifen, der sich auf dem Kopf gabelt.

Das Vorhandensein eines dunklen Rückenstreifens und silbrigweißer Haare gewann eine zentrale Bedeutung in der Diskussion um die Taxonomie der Art. Dao Van Tien (1960) beschrieb für Vietnam eine weitere Loriart, den Mittelplumplori *Nycticebus intermedius*, mit einem dunklen Rückenstreifen und viel silbrigweißen Haaren. Am Institut für Zoologie Kunming, China, der einzigen Institution, die sich ausdrücklich mit der Forschung am Mittelplumplori beschäftigte, galten das Vorhandensein eines dunklen Rückenstreifens, eines weniger gewellten Fells und Unterschiede im Körpergewicht als die Hauptmerkmale zur Unterscheidung des Mittelplumplori vom wesentlich besser bekannten Zwergplumplori (Zhang 1993).

Ratajszczak (1998) zweifelt aufgrund seiner Beobachtungen zu Fellfarbe und Körpergewicht an der Existenz von *Nycticebus intermedius*. In Übereinstimmung mit Groves (1971) hält er das Typenexemplar von *Nycticebus intermedius* für einen adulten *Nycticebus pygmaeus* und das früher beschriebene Typenexemplar von *pygmaeus* für ein subadultes Tier derselben Art.

Ratajszczak (1998) erwähnt auch die Einheitlichkeit der Art innerhalb ihres gesamten Verbreitungsgebietes, wogegen die Beobachtungen von Nadler (pers. Mitt.) bei im illegalen Handel auftauchenden Tieren, ein weites Spektrum verschiedener Farben und Zeichnungen zeigen.

Material und Methoden

Das Endangered Primate Rescue Center erhält regelmäßig Loris, die entweder von Forstschutzbeamten bei Jägern oder Tierhändlern beschlagnahmt wurden, oder von Touristen gebracht werden, die die Tiere durch Kauf von Tiermärkten "gerettet" haben.

Vor derartigen Mitleidskäufen sei jedoch ausdrücklich gewarnt. Sie tragen nur zum weiteren Handel mit der Art bei und damit zur Jagd und der Reduzierung der Wildbestände. Zudem verstößt ein Kauf der Tiere gegen die jeweiligen nationalen Schutzbestimmungen. Jagd, Handel und Haltung von Loris sind in ihrem gesamten Verbreitungsgebiet illegal und können mit hohen Geld- und Freiheitsstrafen belegt werden!

Gehandelt werden Loris vor allem als Haustiere und zur Verwendung in der "traditionellen Medizin", in geringem Maße auch zum Verzehr (Vu Ngoc Thang, per. Mitt., Fitch-Snyder, pers. Mitt.). In Vietnam ist die Zahl der auf den Tiermärkten angebotenen Loris mittlerweise stark rückläufig, ein Phänomen, das weniger auf

eine verbesserte Durchsetzung der Schutzbestimmungen, sondern auf die dezimierten Wildbestände zurückzuführen ist (Nadler, pers. Mitt.).
Bei Ankunft im EPRC wird von jedem Lori im Rahmen der Eingangsuntersuchung ein Foto gemacht. Seit 1999 werden Tiere zudem regelmäßig fotografiert, wenn eine medizinische Behandlung notwendig ist, wenn sie in ein anderes Gehege umgesetzt, oder mit Radiosendern für eien Auswilderung versehen werden.
Für die Untersuchungen zu Fellfärbung und Fellzeichnung werden nur Fotos von Rückenansichten verwendet. Von einigen Tieren liegen jeweils nur eine oder zwei solcher Aufnahmen vor, da die Tiere mittlerweile im Rahmen einer Auswilderungsstudie freigelassen worden sind oder verstarben. Von der Mehrzahl der Tiere existieren jedoch mindestens zwei und bis zu sieben verschiedene Aufnahmen.
Nach einem Zeitraum von drei Jahren liegen auswertbare Aufnahmen von insgesamt 27 Tieren vor. Die Aufnahmen stammen aus fast allen Monaten. vorwiegned jedoch aus den Monaten August, Oktober, März und November.
Die Lichtbedingungen aller Aufnahmen sind ähnlich, d.h. die Aufnahmen wurden entweder bei Tageslicht oder mit Blitzlicht gemacht. Sie sind jedoch an verschiedenen Plätzen und vor unterschiedlichen Hintergründen aufgenommen. Zum besseren Vergleich der Bilder wurden die Hintergründe später technisch durch einen einheitlich grauen Hintergrund ausgetauscht. Trotzdem kann die tatsächliche Fellfarbe noch durch den ursprünglichen Hintergrund beeinträchtigt erscheinen. Deshalb wird die Fellfärbung als solche nicht beurteilt.
Für die Aussagen zur saisonalen Veränderung werden nur zwei, im Wesentlichen farbunabhängige Merkmale beurteilt: das Vorhandensein oder Fehlen eines dunklen Rückenstreifens und das Vorhandensein oder Fehlen von silbrigweißen Haaren, die "Überreifung".
Zeigt das Fell einen dunklen Rückenstreifen und eine ausgedehnte Überreifung wird es als Winterfärbung klassifiziert. Ein mehr oder weniger einheitlich orangebraunes Fell ohne Rückenstreifen und ohne Überreifung wird als Sommerfärbung bezeichnet.
Alle dazwischenliegenden Formen mit blassem oder unklarem Rückenstreifen und unterschiedlichen Graden der Überreifung werden als Übergangsfärbungen eingeordenet.

Ergebnisse

Alle im Juli und 90% der im August fotografierten Tiere zeigten Sommerfärbung ohne Überreifung und ohne dunklen Streifen, lediglich eine Spur dunkelorgangeroten Fells ist gelegentlich entlang des oberen Teiles der Wirbelsäule erkennbar. Die Grundfarbe variierte von leuchtendorange bis stumpf gelborange. im September zeigten alle Tiere einen gewissen Grad von Überreifung, aber ein dunkler Rückenstreifen war bei keinem Tier deutlich ausgeprägt. Diese Färbungen werden als Übergangsfärbungen klassifiziert. Im Oktober hatten die meisten Tiere ihre Farbe verändert. 60% der Tiere hatten ihre Winterfärbung entwickelt und zeigten bereits einen deutlichen dunklen Streifen und eine ausgeprägte Überreifung. Im November hatten 83% und im Dezember 100% der Tiere Winterfärbung. Das Fell hatte in dieser Zeit einen vergleichsweise stumpfen braunorangenen Grundton. Eine Überrei-

fung war am ganzen Körper vorhanden, aber an Kopf, Schultern und Oberkörper besonders ausgeprägt. Der Rückenstreifen war schwarzbraun und endete bei der Mehrzahl der Tiere in der Lendengegend. Bei einigen Tieren reichte er jedoch bis zur Schwanzwurzel.
Es liegen keine Aufnahmen aus den Monaten Januar und Februar vor. Im März hatten 33% der Tiere noch immer Winterfärbung. Die übrigen Tiere zeigten einen verringerten Grad an Überreifung und der Rückenstreifen war undeutlich, kurz und schien eher braun als schwarz. All diese Farbungen werden ebenfalls als Übergangsfärbungen klassifiziert. Im April und Mai zeigten alle Tiere Übergangsfärbungen mit geringgradiger Überreifung und der Rückenstreifen war nur undeutlich oder fehlte ganz. Insgesamt ähnelte die Färbung bereits stark der endgültigen Sommerfärbung. Vom Juni liegen keine Aufnahmen vor.
Zwergplumploris verändern im Jahresverlauf Fellfarbe und Zeichnung. Die Färbung im Sommer (Juli-August) unterschied sich in den untersuchten Fällen deutlich von der Färbung in den Wintermonaten (November-Dezember). Da nicht aus allen Monaten Fotos vorliegen, ist nicht genau zu ermitteln, in welchem Monat sich die Veränderungen vorwiegend vollzogen. Ein Zusammenhang zum Alter oder Geschlecht der Tiere wurde nicht festgestellt.

Diskussion

Fellfärbung und Fellzeichnung erlauben keine taxonomische Differenzierung zwischen *N. pygmaeus* und *N. intermedius*.
Bei dem dunklen Rückenstreifen und der silbrigweißen Überreifung, die gelegentlich als Merkmale zur Unterscheidung der beiden Arten genutzt wurden, handelt es sich um saisonale Variationen.
Ein Grund oder Vorteil eines derartigen jahreszeitlichen Farbwechsels beim Zwergplumplori ist derzeit nicht bekannt, aber es scheint interessant, ihn im Zusammenhang mit der Ökologie dieser Art zu betrachten.
Die Winterfärbung ist am ausgeprägtesten zwischen November und Februar. Dies ist die kälteste Zeit des Jahres in Nordvietnam. Die Außentemperaturen fallen bis nahe dem Gefrierpunkt und übersteigen oft tagelang nicht die 15-Grad-Grenze. In dieser Jahreszeit zeigen Zwergplumploris in Gefangenschaftshaltung ausgedehnte Inaktivitätsperioden und schlafen oft über mehrere Tage, ohne die Position zu verändern oder Nahrung aufzunehmen. Erste Beobachtungen an telemetrierten Tieren scheinen zu zeigen, daß dies bei freilebenden Zwergplumploris auch der Fall ist. Es wäre denkbar, daß die unterschiedliche Färbung mit dem dunklen, optisch teilenden Rückenstreifen eine bessere Tarnung in den teilweise kahlen Bäumen bietet.
Möglicherweise existieren auch Farbvarianten innerhalb des Verbreitungsgebietes. So wurde besonders ausgeprägte Überreifung bei Tieren aus den nördlichen Provinzen Vietnams beobachtet und sehr gelblichorange Tiere wurden in der Provinz Dak Lak (Zentralvietnam) gesammelt (Museum der Nationaluniversität Vietnam, Hanoi).
Die hier präsentierten Daten erlauben aber keine Aussage über lokale Farbvarianten, da das genaue Herkunftsgebiet der hier untersuchten Tiere meist nicht bekannt ist.

Es könnte sich aber bei derartigen Farbvarianten auch um rein individuelle Unterschiede handeln, wie sie auch von anderen Loris bekannt sind (Osman Hill 1932).
Aufgrund ihrer kurzen Dauer haben Felduntersuchungen oft den Charakter von Momentaufnahmen der Fauna im jeweiliegen Gebiet. Prozesse, wie die beschriebenen saisonalen Fellveränderungen können hierbei nicht erfaßt und berücksichtigt werden. Systematische Untersuchungen an Tieren in einer Haltung können, wie im vorliegenden Fall, wertvolle Hinweise und Ergänzungen zu Felduntersuchungen liefern.

Zusammenfassung

Fellfarbe und Fellzeichnung des Zwerplumplori werden häufig dazu genutzt, ihn von einer anderen, als Mittelplumplori beschriebenen Art zu unterscheiden. Mit Hilfe von Fotos wurden Färbung und Zeichnung von insgesamt 27 Tieren verschiedenen Kategorien zugeordnet und deren Veränderungen verfolgt. Zwergplumploris verändern im Jahresverlauf Fellfärbung und Fellzeichnung. Im Sommer ist das Fell kräftig orangebraun und weist keinen deutlichen Rückenstreifen auf. Im Winter ist das Fell silbrigweiß überreift und zeigt einen deutlichen dunkelbraunen bis schwärzlichen Rückenstreifen. Diese Veränderungen sind nicht alters- oder geschlechtsabhängig. Das Vorkommen lokaler Varianten erscheint möglich, aber das vorliegende Datenmaterial eralubt hierüber keine definitive Aussage.
Aufgrund des festgestellten saisonalen Farbwechsels ist die Unterscheidung zwischen Zwergplumplori und Mittelplumplori anhand von Fellfarbe und Fellzeichnung nicht möglich.

Summary

Fur colouration and pattern of the Pygmy Loris are frequently used to distinguish it from another loris species, the Intermediate Loris. This study aims to clarify the taxonomic questions concerning the mentioned species. Based on photographic material, 27 individuals were classified according to their fur colouration and fur pattern and their changes were monitored. Pygmy Lorises change fur colouration and fur pattern throughout the year. The summer pelage is bright orange-brown and shows no distinct dark stripe on the back. The winter pelage shows extensive frosting (silvery hair tips) and a distinct dark-brown to blackish stripe along the back. The changes are not related to the age or sex of the animals. Local variations seem possible but the available material does not allow for an evaluation of this aspect.
Due to their seasonal fur change, a distinction between the Pygmy Loris and Intermediate Loris, based solely on fur characteristics, is not possible.

Schrifttum

Boetticher, H. von (1958): Die Halbaffen und die Koboldmakis. Lutherstadt-Wittenberg.
Dao Van Tien (1960): Sur une Nouvelle Espece de Nycticebus au Vietnam. Zoologischer Anzeiger 164, 240-243.
Groves, C. P. (1971): Systematics of the Genus *Nycticebus*. In: Biegert, J. & Leutenegger, W. (Hrsg.): Proceedings of the Third International Congress on Primatology, Zürich 1970, 44-53. Basel.

Groves, C. P. (2001): Primate Taxonomy. Washington.
Osman Hill, W. C. & Phillips, W. W. A. (1931): A new race of slender loris from the Highlands of Ceylon. Ceylon Journal of Science, Spolia Zeylanica XVII (2), 109-123.
Ratajszczak, R. (1998): Taxonomy, Distribution and Status of the Lesser Slow Loris *Nycticebus pygmaeus* and their Implications for Captive Management. Folia Primatol. 69 (suppl. 1), 171-174.
Zhang, Y., Chen, Z. & Shi, L. (1993): Phylogeny of the Slow Lorises (Genus *Nycticebus*): An Approach Using Mitochondrial DNA Restriction Enzyme Analysis. Int. Journ. Primatol. 14, 167-175.

Ulrike Streicher, Endangered Primate Rescue Center, Cuc Phuong National Park, Ninh Binh Province, Vietnam.

Streicher, U.; Nadler, T., 2003: Re-introduction of pygmy lorises in Vietnam. Reintroduction News (Newsletter of the IUCN Reintroduction Specialist Group) **23**: 37-40.

Streicher, U.; Nadler, T., 2003: Re-introduction of pygmy lorises in Vietnam. Reintroduction News (Newsletter of the IUCN Reintroduction Specialist Group) **23**: 37-40.

management seem to prepare animals well for life in a natural habitat and knowledge about food sources is not considered to be an obstacle for the planned release even in the case of captive bred individuals. The center's semi-wild facilities have turned out to be a very suitable tool to prepare langurs for a potential re-introduction, particularly because they allow the animals to adjust to wild food sources, natural climbing substrates, selection of suitable resting sites, and predator avoidance. After a training period in such a facility, animals should be ready to be released into the wild.

There are plenty of potentially suitable habitats for release available in Vietnam. For example an area with sufficient good habitat for the Hatinh and red-shanked douc langurs re-introduction is the newly established National Park at Phong Nha – Ke Bang and this will be first place considered for this program. The area holds severely depleted populations of Douc and Hatinh langurs and has sufficient suitable habitat to hold large populations of both species. But safety from hunting cannot be guaranteed at present anywhere in the country, not even at this National Park. There is evidence that local authorities do feel a strong sense of ownership for re-introduced animals and are more inclined to protect them than the wild "anonymous" populations. Yet this does not guarantee complete safety from hunting.

In addition, tourism is a rapidly developing sector in the Vietnamese economy and the financial incentives for the establishment of tourist structures are considerable. Unfortunately, aggressive tourist development invades even the last strongholds of nature and the potential financial gains through tourism precede any consideration of protection. This absolute lack of wildlife management capacity results in false expectations of the tourism value of re-introduced animals and such tourism development plans are counterproductive for re-introduction programs.

Ex-situ conservation programs are an important tool for conservation. But they cannot be successful, if *in-situ* conservation measures are not strongly coordinated. However successful captive-breeding programs might be, they can not successfully fulfill their role in conservation if no safe habitats are available to eventually re-introduce captive bred animals.

References

Government of Vietnam & Global Environment Facility Project VIE/91/G31. 1995. *Biodiversity Action Plan for Vietnam. Hanoi.*

Gupta, A. K. 2002. Release of golden langurs in Tripura, India. *Re-introduction News 21, 26-28.*

IUCN-Species Survival Commission. 2002. Technical guidelines on the management of ex *situ* populations for conservation. (http://www.iucn.org/themes/ssc/pubs/policy/exsituen.htm)

Nadler, T. & Baker, L. 2000. Release of a group Hatinh langurs (Trachypithecus laotum hatinhensis) into a semi-wild facility to associate with gibbons at the Endangered Primate Rescue Center, Vietnam. *EPRC Newsletter 5, 18-20.*

Nadler, T., Momberg, F., Nguyen Xuan Dang & Lormee, N. 2003. Vietnam Primate Conservation Status Review 2002. Part 2: Leaf Monkeys. *Fauna & Flora International-Vietnam Program and Frankfurt Zoological Society, Hanoi, Vietnam.*

Contributed by Tilo Nadler, Frankfurt Zoological Society, Endangered Primate Rescue Center, Vietnam, e-mail: t.nadler@mail.hut.edu.vn ***& Ulrike Streicher, Endangered Primate Rescue Center, Vietnam, e-mail:*** uli@mail.hut.edu.vn

Re-introduction of pygmy lorises in Vietnam

The distribution of the pygmy loris (*Nycticebus pygmaeus*) is limited to Vietnam, Eastern Laos and a few locations in South Yunnan. Fieldwork in these countries has been limited and little is known about the lorises' ecology or status in the wild (Ratajszczak, 1998). In Vietnam lorises are hunted for traditional medicines and for the pet trade (Compton, 1998). The pygmy loris has been protected by Vietnamese law since 1992 at the highest level (The Government of Vietnam, 1996), but law enforcement is weak and forest protection authorities are little motivated to strictly pursue hunting and trading of this inconspicuous primate. In addition, while international trade of lorises is restricted by CITES, significant numbers are exported illegally. The Red Data Book of Vietnam and the IUCN Red List of Endangered Species list the pygmy loris as vulnerable, but as a result of the excessive hunting lorises are decreasing and apparently have vanished in large parts of their distribution range (Shi, pers. comm. & Thang, pers. comm.). Not only does the Vietnamese law prohibit hunting and trading of this species, it also postulates the release of confiscated animals back into their natural habitat.
In reality, confiscated animals are simply dumped into a forest close to the confiscation point without consideration on their taxonomic status, their state of health and their ability to survive. The same law also postulates the check for "health, plague and ecofeatures" but this is usually ignored and animals are often weak and ill from being transported, they always suffer from extreme stress, and many of them probably die shortly after the release and of course it is possible that these animals introduce diseases into wild populations. The Endangered Primate Rescue Center (EPRC) first received confiscated pygmy lorises in 1996 and has since received numerous animals. To address the current problem of uncontrolled releases, the EPRC decided to conduct a study to investigate how confiscated pygmy lorises are able to be re-established in a wild habitat. The results of this study will hopefully help to develop recommendations for authorities for the further placement of confiscated lorises.

Source of animals

Between November 2000 and November 2002, nine Pygmy lorises were selected for release. Considerations for their selection included geographic origin and taxonomic status, assumed age at time of confiscation and state of health. The selected animals had been confiscated from traders in northern Vietnam and the genetics of each specimen were profiled in order to be sure that they were identical with local pygmy lorises. All animals were adult at the time of confiscation and long-term storage of animals with a trader is not a common practice in Vietnam and since the animals were adult at the time of confiscation they were assumed to be capable of living in a natural habitat. Animals were released as single individuals or simultaneously with a familiar animal, which had been housed in the same or in an adjacent cage.

Quarantine

Prior to release the animals were placed in quarantine for six weeks, where they were kept in isolation and their health was checked regularly. In addition, parasitological treatment was conducted and a Tuberculosis test performed.

Release site

The release site is in the former botanic garden of Cuc Phuong National Park. This garden consists of 1.2 km^2 area of old tree plantations with several large limestone hills, which are covered with poor primary forest. The edge areas, where the former plantations border the primary forest, are characterized by tall trees, numerous climbers and dense scrub. The vegetation in this area is particularly dense and does not form separate horizontal layers rather it forms a continuous three-dimensional network. The specific release site is located at the foot of one of the large hills in the primary forest and a pygmy loris was found in this area in November 1999 and thus it was assumed that the area was suitable for pygmy lorises.

Release time

Animals were released in March, April, September, October and November. The climate in northern Vietnam has quite distinct seasons with hot humid summers and cool humid winters. Spring and autumn have a comparable mild climate with little rain. The majority of trees flourish in spring and insects are abundant in the warm times of the year, whereas they are scarce in the winter months.

Observation methods

The animals were monitored by direct observation and telemetric methods. Pygmy lorises can be easily identified by their characteristic eye shine and since lorises are less able to detect the wavelength of red light, head torches with red-light were used for observation. For telemetry studies the animals were equipped with light-weight transmitters (PD-2C Fa. Holohil, 3.9 g) and the animals had worn the transmitters for several weeks prior to release without problems. Antenna and receiver (Telonics TR-4 and Telonics RA-14) are light-weight and could easily be carried when climbing in the steep and difficult terrain on the hills.

The releases

The releases were performed as "soft releases" following the definitions of *IUCN Guidelines for Non-human Primate Re-introductions* (IUCN, 2002). The cages in which the animals had previously been quarantined were moved to the release site and the animals were fed at the release site in the closed cages at the regular feeding time for several days. Then the cages were opened at dusk and feeding was continued until the animal moved far away from the release area and did not return to the cage site for several days and at this time the cage was removed. The animals were located by triangulation during daytime at their sleeping site and the exact location was ascertained by a direct sighting of the animal. The observer returned right before dusk and followed the animal by direct observation from the time it started to be active. Care was taken not to disturb the animal unnecessarily during the process of it establishing a home range and animals showed signs of habituation to the observer's presence and periods of direct observation ranged between a few minutes up to several consecutive hours. The animals were not followed by telemetry at night since this proved to cause a lot of disturbance to the lorises and also proved to be dangerous due to the treacherous nature of the terrain. After April 2002, animals were only monitored by telemetry and data was still collected on their preferred sleeping sites, movements, and range distance.

Pygmy loris (*Nycticebus pygmaeus*)
@ H. Schulze

Results

Observation period

Significant variation existed in data collection for each animal - one animal disappeared the day after release. From the other animals data could be obtained for only 14, 16, 27, 34, 39, 51, 83 and 134 days respectively.

Feeding

During this study lorises were found to be truly omnivorous as they were observed feeding nearly equally on plant and insect items. Insect prey was searched for by moving slowly along a branch with the nose close to the substrate. Insects were caught using one or both hands and then put into the mouth. Large insects were eaten starting from the head, using the molars to break the hard skin, and pushing the prey into the mouth with the hands. On at least one occasion lorises were seen feeding on ants, which were licked from the branches. Gum and other plant exudates comprised the other main part of observed feeding events. Gum scraping -" tree gouging"- was observed frequently (e.g. on *Spondias axillaris*) and animals returned to once identified gum sources. Different animals were feeding on the same location but not at same time. Intense licking without scraping was observed in a tree that was covered with large bundles of orange blossoms (*Saraca dives*) and the observations suggested that the loris was eating nectar. Licking on branches without scraping was also observed in *Vernicia montana* and *Sapindus* spp. Only one animal returned regularly to the cage site to feed for several weeks after release.

Sleeping site selection

The animals showed a preference for the hills, especially the edge areas, where the vegetation is very dense. Trees with climbers were preferred sleeping places and occasionally the animals slept in plantation trees but never far from the edge areas. They frequently returned to the same sleeping site and different animals used the same sleeping site on different days. If an animal was disturbed at the sleeping site it would leave the site and never return to it again. The range of the sleeping sites for the animals in this study was between 1,000 m^2 and 31,000 m^2 (50% Kernell probability plot). The distance between two sleeping sites in two subsequent nights was up to 289.6 m but on average, the distance between sleeping sites in subsequent nights was 97.2 m.

Movement
Animals were more often observed using vertical than horizontal substrates. Animals tended to use the same pathways through the vegetation and in familiar trees thus managed to avoid dead ends. When exploring a territory, animals were hanging by the hind legs, turning the upper body and head in all directions to get an overview of an area. The animals frequently moved on the ground when suitable climbing substrates were missing, e.g. when the canopy was not closed, animals covered distances up to several hundred metres on the ground. Intense observation of the area from a tree and several short visits to the ground preceded the crossing of an open area. On several occasions the animals probably went to the ground for foraging but this could not be determined with certainty.

Social behavior
Though both male and female lorises were released at the same time and in the same area encounters were not observed. Animals used the same sleeping sites but not on the same day and they never established their range in exactly the same area. As noted above, animals also used the same feeding sites but not at the same time and scent marking was occasionally observed. Social interaction between animals was observed on a single occasion when one of the released animals established intensive whistling contact with a group of caged animals inside the rescue center. After this contact the released loris immediately moved towards the rescue center and it was found sleeping only 30 m from the cage the following day.

Causes of mortality
Predators killed two animals and one was predated on in a low sleeping place (bamboo, height 1.2 m) another one probably when it was on the open ground. In one case the predator was positively identified to be a marbled cat (*Felis marmorata*) and in the other case it was concluded from the bite marks on the collar that the predator might have been a small carnivore as well.

One animal, released in November, possibly died of hypothermia, when it slept in a very exposed spot and was drenched by a hard and cold rain. It was found dead at this location two days later and another one died of an unknown cause during the cold season (February).

Collar loss
One animal lost the radio collar and the collar showed loris gnaw marks and the diameter had been widened so that it had slipped over the animal's head.

Discussion

Because the sample size of this study is small the results must be considered preliminary. In this study healthy, adult animals, genetically identical to the resident loris population have been introduced into habitat that was assumed to be suitable. The animals were able to identify wild food sources and actively search for them. Within the observed time none of the animals showed signs of weakness or illness and none of the animals moved immediately out of the area, thus there seemed to be sufficient food sources in the release area. Only one animal returned to the cage site for feeding and this animal was the individual released at the latest time of year. It had been observed as well using a variety of wild food sources, though it was obviously able to identify those but food sources vary remarkably around the year. It is possible that this individual had to rely more on the supplementary feeding because of adverse environmental conditions at the time of its release such as low food availability and low temperatures. Pygmy lorises do occur in this area and their distribution stretches further north into areas where conditions are likely to be even more seasonal. Surely animals have to be familiar with seasonal processes in their habitat to survive times of food shortage but it is also likely that this knowledge varies in animals from different regions.

Based on their history animals were assumed to be familiar with predators as both predator kills occurred when the animals left the forested hill areas and moved to the more open plantations. Lorises cannot jump or leap and need a very closed canopy and it is possible the animals had to use the ground more often in this area and thus encountered predators more often. Hypothermia is the likely cause of death of the animal released late in the year (November) and one would expect an animal to be able to cope with the normal range of weather in its natural habitat but possibly the animal was not prepared to react to such low temperatures. Within the distribution range of the lorises there are different climatic regions and the climate in southern Vietnam differs remarkably from the climate in northern Vietnam. Genetic studies on Pygmy lorises have found less than 0.2 % DNA variation within the species and no subspecies have been identified (Roos pers. comm., 2001). The wide range of colour variations seems be related to the season rather than to the origin of the animal and thus it is very difficult to identify the exact provenance of the animals. It has been suggested that pygmy lorises in northern Vietnam show that animals have developed specific strategies to survive the northern winter season with low temperatures (Ratajszczak, 1998) and animals from the south might not have these adaptive behaviors.

The selected animals had been confiscated from traders in Northern Vietnam and the genetics of each specimen were profiled in order to be sure that they were identical with local pygmy lorises.

There is insufficient information to draw many conclusions on the role of the lorises' social system for re-introduction. As previously suggested (Fitch-Snyder *et al.*, 2001) they seem to be solitary with overlapping ranges. In this study, the individuals used the same sleeping and feeding sites but not at the same time. The observed scent marking as well as whistling, play key roles in the pygmy lorises' social system (Fitch-Snyder *et al.*, 2001), but observations were too scarce to draw any conclusion.

Conclusion

The study showed that it is very difficult to plan a re-introduction program for a species for which little is known about its natural behavior, ecology, and habitat preference. At the moment lorises are released often on a large scale and the lack of knowledge is replaced by these assumptions and a number of these common assumptions appear to be incorrect given the results of the study! More data on the ecology of pygmy lorises is needed for better designed re-introduction programs. However, data yielded by this study does provide invaluable information for future releases and this is of critical importance because applicable and acceptable solutions are urgently needed for the re-introduction of confiscated lorises in Vietnam and Southeast Asia.

References

Compton, J. and Le Hai, Quang. 1998. Borderline – An Assessment of Wildlife Trade in Vietnam. *WWF Indochina Programme. Hanoi, Vietnam*

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

IUCN. 2002. Guidelines for Nonhuman Primate Re-introductions. *Re-introduction News No. 21 June 2002: 29-53*

Ratajszczak, R. 1998. Taxonomy, Distribution and Status of the Lesser Slow Loris *Nycticebus pygmaeus* and Their Implications for Captive Management. *Folia Primatologica 1998: 69 (suppl 1): 171-174*

The Government of Vietnam. 1996. Instruction from the Prime Minister on Urgent Measures For Wildlife Protection and Development, *No. 359/ Ttg, 29.05.96. Hanoi, Vietnam.*

Contributed by Ulrike Streicher & Tilo Nadler (e-mail: uli@mail.hut.edu.vn), Endangered Primate Rescue Center, Cuc Phuong National Park, Vietnam & Dietmar Zinner, German Primate Center, Germany.

REPTILES

Giant Amazon turtle: eleven years of re-introduction in the Orinoco River, Venezuela

Out of the fresh water turtles in Venezuela and South America, the giant Amazon turtle (*Podocnemis expansa*) faces the highest risk of extinction. Thanks to the German naturalist Alexander von Humboldt, historic abundance records exist for this species. In 1800, Humboldt (1820) estimated a population of 330,000 females in the Middle Orinoco River, based on the number of egg-oil bottles collected that year. Presently only about 1,000 females are left in this population. Unsustainable use by humans has been the main cause for this turtle's decline. There is a long tradition of meat, egg and hatchling consumption along the banks of the Orinoco traceable to Pre-Columbian times. However the species could not withstand the level of commercial extraction imposed on it by the white-man's trade. For the past 40 years consumption has been legally banned; regardless the population has not ceased to decline. Apparently, additional management measures are required to ensure recovery of this species.

Among the protection measures, the "Refugio de Fauna Silvestre Tortuga Arrau" (RFSTA) was declared in 1988 as a wildlife refuge. This refuge is under the administration of the Ministry of the Environment and Natural Resources (MARN), includes the species' main nesting beaches in the Middle Orinoco River. The Environmental Enforcement Unit of the National Guard (GN) lend their support in the refuge providing continuous surveillance to avoid poaching of adults and nests. Their combined efforts have helped reduce the drastic decline of the adult turtle population in the area. In 1992, the MARN started a captive-rearing program for hatchlings in hopes to increase the population size. FUDECI joined this program in 1994 with its captive-rearing

Giant Amazon turtle (*Podocnemis expansa*) @ Giovanni Ramirez

Acknowledgements

This dissertation would not even been started without Wolfram Rietschel, who convinced me to do it and supported it all the way through.

Thanks to Professor Hoffmann for his readiness to supervise this dissertation, for his encouragement and interest in the subject.

I'm very indebted to Helga Schulze. Without her endless assistance in searching for literature it would have been impossible. She also generously helped with the final printing of the document.

Warm thanks to Catherine Workman, Bert Covert, Andrew Grieser-Johns and Gareth Thomas for careful corrections of the English and to Manfred Filla for assistance with the statistics.

Without Manuela Klöden and her interest in the little primates, pygmy lorises might have never come to the EPRC. Thanks to all members of the past and present Cuc Phuong family, in particular to Tilo Nadler, for encouraging me to write down my observations in the first place, for all the valuable discussions and proof reading of various parts of the dissertation.

Thanks to the animal keepers for never complaining, when there was extra work to do for the pygmy lorises and to Hiep and Duc, who helped me with the radiotracking. Thanks to our National Park directors, Dao Van Khuong and Truong Quang Bich, and the head of the scientific department, Do Huu Lap, for being supportive and following my work with interest.

And finally thanks to the Andreas Stihl Stiftung, in particular to Christel Wieland, for the financial support of the veterinary work at the Endangered Primate Rescue Center and for their generosity, when the dissertation caused delay to other project documents.

Curriculum Vitae

Personal Data

Name	:	Ulrike Simone Streicher
Date of birth	:	16.12.66
Place of birth	:	Bamberg, Germany
Nationality	:	German

School Education

1973-1977	:	Karl-Mauch Primary School, Kernen, Germany
1977-1986	:	Gustav-Stresemann High School, Fellbach, Germany
1986	:	Abitur

Studies

1986-1992	:	Veterinary Medicine at the FU Berlin, Germany
1992	:	Final exam (3.Staatsexamen) and Approbation

Veterinary Career

1993-1994	:	Veterinary assistant in the horse and small animal clinic Dres. Strehler und Heinzelmann, Waiblingen, Germany
1995-1996	:	Veterinary assistant in the horse and small animal clinic Dr. O.Heinzelmann, Marbach, Germany
04.- 09.1997	:	Locums at the Penybryn Veterinary Centre, Swansea, Wales, Small animal practice S. Egelhof, Fellbach, Germany Small animal practice Dr. M. Strehler, Waiblingen, Germany Internship at the Wilhelma, Zoological and Botanical Gardens, Stuttgart, Germany
11.97-05.1998	:	Project manager for the Hanoi Rescue Center Project of the Zoological Society for the Conservation of Species and Populations (ZSCSP) at the governmental Hanoi Rescue Center, Vietnam. Veterinary care for confiscated animals from the illegal trade. Involvement in legislation and rehabilitation issues. On call veterinarian for the Endangered Primate Rescue Center
Since 06.1998	:	Resident veterinarian at the Endangered Primate Rescue Center (EPRC), Cuc Phuong National Park, Vietnam, funded by the Andreas-Stihl Stiftung, Germany Veterinary care for primates (langurs, gibbons, lorises) Veterinary assistance for Cuc Phuong National Park (deer, confiscated animals, e.g. civets, bears, small cats) Veterinary care for the Owston's Palm Civet Breeding Project of Fauna and Flora International (FFI)

Training workshops for national park staff and rangers on the handling, husbandry, veterinary care and placement of confiscated wildlife

Veterinary emergency care at several national parks and nature reserves in Vietnam for the Forest Protection department

Pygmy lorises reintroduction study since 9.2000, funded by Embassy of Switzerland, Hanoi, and the RSPCA UK Wildlife Department

Consultancies and training workshops on placement of confiscated wildlife for ZSCSP, WWF

Wildlife Rescue center specialist for SFNC (Project of the European Union), developing a management plan for the Pu Mat Animal Rescue and Release Center