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Cover: Tonkin snub-nosed monkey (*Rhinopithecus avunculus*). Photo: T. Nadler

Introduction

The first announcement for the **Vietnamese Journal of Primatology** was made at the 21st IPS Congress in Uganda in June 2006. Since that time, and especially with the first issue initially planned for October 2006, preparing the journal allowed little time to breath. It took another six months to clarify finances, receive permits, and obtain original articles from authors. A first-birth can be complicated and protracted and occasionally a forceps is required. We now think, however, that our new-born child is attractive, ready, and can make a useful contribution to primate conservation in Vietnam.

The first issue of the journal contains three articles which provide an overview of and basic information about the systematics, phylogeny, distribution, biogeography, threats and status of the Vietnamese primate species. Readers will recognize that the authors of these articles have different opinions on the basic topics listed above and, accordingly, advocate different positions. These differences also reflect that the study of Vietnamese primates is still in its nascent stages. It is the goal of the **Vietnamese Journal of Primatology** to hasten this process by creating a platform for discussion where new results from the latest studies are published.

The journal strives to provide an accurate overview of the current primatological work being conducted in Vietnam. All colleagues involved in editing the journal are involved in and knowledgeable of various primate-related projects in Vietnam. With the involvement of Dr. Christian Roos as the Southeast Asian Primate Coordinator of the IUCN/Primate Specialist Group, the journal creates a connection with this organization, facilitating the efficacious transfer of information with another enterprise involved with Indochinese primates.

In addition to the editors and editorial board, the journal received a great deal of help from Nguyen Thi Thu Hien, Project Assistant of the *Vietnam Primate Conservation Project*, and Jakob Kolleck, one of the head animal keepers at the Endangered Primate Rescue Center. The HAKI Company in Hanoi supported the journal with insight and understanding during its preparation. Finally and importantly, the entire endeavor to publish the journal and to guarantee its continuation was made possible only with great support and commitment by the German Primate Centre.

Many thanks for all your support. We hope to meet your expectations.

May 2007 Editors

Lời nói đầu

Việt Nam được công nhận là 1/16 Quốc gia có tính đa dạng sinh học (ĐDSH) cao. Trong sự đa dạng đó có nhóm thú linh trưởng, thực vậy theo tư liệu nghiên cứu khảo sát thực địa của các nhà khoa học Việt Nam và các nhà khoa học quốc tế thì Việt Nam có tất cả 24 loài thú thuộc nhóm thú linh trưởng trong đó có 5 loài thuộc diện đặc hữu như: voọc Cát Bà (*Trachypithecus poliocephalus*), voọc mông trắng (*Trachypithecus delacouri*), voọc mũi hếch (*Rhinopithecus avunculus*), voọc chà vá chân xám (*Pygathrix cinerea*), vượn đen phía Đông (*Nomascus nasutus*). Mỗi loài đặc hữu phân bố trên các vùng địa lý sinh vật khác nhau.

Chính sự đa dạng thành phần loài, đa dạng về hình thái, về tập tính đã khích lệ sự quan tâm nghiên cứu của các nhà khoa học trong và ngoài nước. Trước những năm 1970 cũng có một số công trình nghiên cứu nhưng còn lẻ tẻ. Sau những năm 1980 và 2000, những công trình nghiên cứu các loài thú thuộc nhóm thú linh trưởng được các viện nghiên cứu: Viện Sinh thái và Tài nguyên Sinh vật, Viện Vệ sinh dịch tễ (Bộ Y tế), các Trường Đại học Lâm nghiệp, Đại học Khoa học Tự nhiên (Đại học Quốc gia Hà Nội). Đặc biệt nhiều tổ chức quốc tế như: Hội Động Vật-Frankfurt (FZS)/Trung tâm Cứu hộ Thú Linh trưởng Nguy cấp tại Cúc Phương (EPRC), FFI, WWF, IUCN... đang quan tâm đầu tư nghiên cứu về các loài thú linh trưởng ở Việt Nam.

Không chỉ dừng lại ở khâu thống kê thành phần loài, mà còn xác định sự phân bố địa lý của từng quần thể, số lượng, tập tính của quần thể, đặc biệt đã quan tâm đúng mức đến nghiên cứu các đặc điểm sinh học, sinh thái học cũng như đi sâu nghiên cứu về diễn biến số lượng quần thể trong các vùng địa lý khác nhau ở Việt Nam.

Kết quả của công trình nghiên cứu về thú thuộc bộ linh trưởng cũng đã được công bố trong một số Tạp chí khoa học của Việt Nam như Tạp chí Lâm nghiệp (trước đây), Tạp chí Bảo vệ môi trường, Tạp chí sinh học, Tạp chí Y học, Báo cáo hàng năm của TTCHTLTNC/EPRC Newsletter, tập sách Bảo tồn Thú Linh trưởng của Việt Nam...

Đó là những thông tin mang hàm lượng khoa học cao góp phần không nhỏ trong việc quy hoạch tổ chức bảo tồn ĐDSH ở Việt Nam. Tuy nhiên những công trình đó mới chỉ công bố bằng tiếng Việt nên phần nào còn hạn chế việc trao đổi các thông tin liên quan đến nhóm thú linh trưởng ở Việt Nam với các nhà khoa học quốc tế cũng như bạn đọc trên thế giới.

Để khắc phục tình trạng nói trên các nhà nghiên cứu thú linh trưởng ở Việt Nam cựng các nhà nghiên cứu thú linh trưởng quốc tế đã phối hợp với nhau xin phép các cơ quan quản lý có thẩm quyền để xuất bản Chuyên đề Thú Linh trưởng Việt Nam bằng tiếng Anh.

Chúng tôi nghĩ rằng tập Chuyên đề Thú Linh trưởng Việt Nam bằng tiếng Anh ra mắt bạn đọc gần xa sẽ có vai trò cực kỳ quan trọng trong qua trình trao đổi các thông tin về hiện trạng các loài thú linh trưởng của Việt Nam với thế giới. Đặc biệt trong thời kỳ này việc bảo tồn ĐDSH, bảo tồn nguồn tài nguyên thiên nhiên đang được Nhà nước và Chính phủ Việt Nam quan tâm thì việc xuất bản tập Chuyên đề Thú Linh trưởng Việt Nam bằng tiếng Anh lại càng có ý nghĩa.

Bởi lẽ các thông tin về tình trạng phân bố, các đặc điểm sinh học, sinh thái cũng như các giải pháp bảo tồn các loài thú linh trưởng sẽ phần nào giúp các nhà khoa học trên thế giới có những thông tin cần thiết, cập nhật, trao đổi nhằm mục đích giúp Việt Nam bảo tồn và phát triển bền vững các loài thú linh trưởng.

Chúng tôi rất hoan nghênh và kỳ vọng rất nhiều vào tập Chuyên đề Thú Linh trưởng Việt Nam bằng tiếng Anh sẽ mang lại nhiều điều bổ ích và thú vị với bạn đọc gần xa. Với tư cách là một cán bộ nghiên cứu về động vật của Việt Nam xin trân trọng giới thiệu và mong nhận được sự hưởng ứng nhiệt tình của các nhà khoa học trong và ngoài nước.

Xin trân trọng cảm ơn!

TM BCH Hội động vật Việt Nam

GS.TSKH. Đặng Huy Huỳnh
Chủ tịch

Foreword

Vietnam ranks among the top sixteen countries globally in biodiversity richness. Emblematic of this diversity is the primate fauna with 24 taxa including five endemic species: the Cat Ba langur (*Trachypithecus poliocephalus*), Delacour's langur (*Trachypithecus delacouri*), grey-shanked douc langur (*Pygathrix cinerea*), Tonkin snub-nosed monkey (*Rhinopithecus avunculus*), and eastern black gibbon (*Nomascus nasutus*). Each of these endemic species has restricted ranges and is found in different geographic regions of the country.

The high diversity of primates and their uniqueness has recently attracted the attention of both national and international scientists. There was little research activity focusing on primates before 1970. But since 1980, and with a significant increase after 2000, research on primates by scientists at Vietnamese institutions including the Institute of Ecology and Biological Resources (IEBR), Institute for Epidemiology, University of Forestry, Xuan Mai, and Hanoi National University has become common. Also during this time, international NGO's, and in particular Frankfurt Zoological Society/Endangered Primate Rescue Center, FFI, WWF, and IUCN, have become active in supporting primate conservation and research in Vietnam.

Goals of this research extend well beyond recording the number of species to include studies about the distribution, status, behavior, biology, ecology, and population dynamics of primates throughout Vietnam.

Some results of these research projects have been published in Vietnamese magazines such as “Magazine of Forestry”, “Magazine for Environment and Conservation”, “Biological Magazine”, “Medical Magazine”, “EPRC-Newsletter”, and the book “Conservation of Primates in Vietnam”.

While there is a great deal of scientific information about the primates of Vietnam, including valuable data for biodiversity conservation, most of this information is not widely accessible for the national and international scientific community.

The “Vietnamese Journal of Primatology” issued in joint cooperation between national and international primatologists aims to disseminate this information broadly and support primate research in Vietnam. Thus, this English published journal will be an important contribution to sharing information about Vietnamese primates to local and international scholars.

The Vietnamese government greatly values activities on biodiversity conservation and preservation of natural resources and the “Vietnamese Journal of Primatology” will be a significant contribution to these efforts.

The content of the journal will provide information and knowledge about conservation, status, and biology of Vietnamese primates that should provide the background and foundation for further national and international conservation activities in Vietnam.

This journal is highly welcomed by primatologists and conservationists as a valuable source of information. As a Vietnamese zoologist I am pleased to introduce this journal and hope it receives the national and international support it richly deserves.

Thank you very much.

On behalf of the
Zoological Association of Vietnam

Prof. Dr. Dang Huy Huynh
Chairman

Lời tựa

Việt Nam và các quốc gia láng giềng bao gồm Lào, Campuchia, và Trung Quốc thuộc điểm nóng đa dạng sinh học khu vực Indo-Burma. Đặc biệt khu vực phía đông sông Mê Kông thể hiện một vùng sinh thái đặc trưng duy nhất với nhiều loài động thực vật đặc hữu. Điều đó còn được nổi bật lên qua những khám phá mới, những phát hiện trở lại những loài thú lớn như, Saola, tê giác Sumatra, một số loài mang, voọc chà vá chân xám, voọc mông trắng. Tuy nhiên tính đa dạng sinh học rất cao của khu vực đang bị đe doạ bởi áp lực săn bắt và sự phá huỷ môi trường sống khiến nhiều loài sinh vật đang đứng trước nguy cơ tiệt chủng. Hiện tại năm loài thú linh trưởng (*Trachypithecus p. poliocephalus*, *T. delacouri*, *Pygathrix cinerea*, *Rhinopithecus avunculus* và *Nomascus nasutus*) được liệt vào danh sách "25 loài thú linh trưởng có nguy cơ tiệt chủng cao nhất trên thế giới". Trong số đó có loài chỉ còn dưới 100 cá thể. Thực trạng trên đòi hỏi cần có những nghiên cứu đầy đủ cũng như những hành động nhanh chóng để bảo vệ các loài trên.

Trung tâm nghiên cứu thú linh trưởng CHLB Đức (DPZ), một đơn vị nghiên cứu đa lĩnh vực trên đối tượng thú linh trưởng, có các trạm thực địa ở Peru, Madagascar, và Indonesia. Tại các trạm thực địa đó những nghiên cứu dài hạn về sinh thái học, sinh học phát triển và tập tính xã hội của các loài linh trưởng được nghiên cứu. Sự kết hợp giữa nghiên cứu ngoài thực địa và nghiên cứu thực nghiệm hiện đại trong phòng thí nghiệm nhằm cung cấp những hiểu biết toàn diện về sinh học của các loài linh trưởng, phương cách các loài linh trưởng thích nghi với tác động của con người. Trong vòng một thập kỷ qua trung tâm đã tiến hành nghiên cứu tại khu vực Đông Dương, những kiến thức quan trọng về phân loại, địa lý phát sinh loài, và sinh học quần thể của các loài linh trưởng trong khu vực đã được khám phá. Với những kiến thức nền tảng này, kế hoạch bảo tồn hiệu quả sẽ được thiết lập. Trên cơ sở hợp tác giữa các tổ chức chính phủ và phi chính phủ, các hành động bảo tồn sẽ được tiến hành nhằm đảm bảo sự tồn tại lâu dài của các loài linh trưởng và môi trường sống của chúng.

Những hành động tập trung, hiệu quả nhằm bảo đảm sự tồn tại dài của các quần thể thú linh trưởng nguy cấp đòi hỏi sự đóng góp và cập nhật những kết quả nghiên cứu, những thông tin liên quan đến bảo tồn một cách rộng rãi. Hiện tại việc phổ biến những kiến thức khoa học như vậy còn đang rất hạn chế. Tạp chí chuyên đề "Nghiên cứu thú linh trưởng học Việt Nam" được xuất bản nhằm thực hiện nhiệm vụ này. Tạp chí chuyên đề này sẽ cung cấp những kiến thức về sinh học, phân bố, phân loại học và tình trạng bảo tồn các loài thú linh trưởng Đông Dương. Trung tâm nghiên cứu thú linh trưởng CHLB Đức luôn hỗ trợ về khoa học và tài chính cho tạp chí. Chúng tôi hy vọng rằng tạp chí chuyên đề sẽ được đón nhận rộng rãi và trở thành diễn đàn của những nhà nghiên cứu về linh trưởng ở Việt Nam và các quốc gia láng giềng. Tạp chí chuyên đề sẽ có những đóng góp quan trọng cho sự nghiệp bảo tồn các loài thú linh trưởng.

GS.TSKH. Stefan Treue
Giám đốc khoa học

TS. Michael Lankeit
Giám đốc điều hành

Preface

Vietnam and its neighbouring countries Laos, Cambodia and China belong to the Indo-Burma biodiversity hotspot. Particularly the region east of the Mekong River represents a unique bioregion with a large number of endemic plant and animal species. This uniqueness is further highlighted by the recent discoveries or rediscoveries of several large mammalian species, such as the saola, the Sumatran rhinoceros, some muntjak species, the grey-shanked douc and Delacour's langur, just to name a few. The diversity of the region, however, is endangered by high hunting pressure and habitat destruction, which brought many species to the brink of extinction. Currently, five primate species (*Trachypithecus p. poliocephalus*, *T. delacouri*, *Pygathrix cinerea*, *Rhinopithecus avunculus* and *Nomascus nasutus*) are included in the "World's 25 Most Endangered Primates". Some of them have population numbers of less than 100 individuals, emphasising the urgent need for ongoing research and immediate action plans to protect these species from extinction.

As an institute working in many primate-related research areas, the German Primate Centre (DPZ) runs field stations in Peru, Madagascar and Indonesia. Those are the platforms for long-term studies on the ecology, life history and sociobiology of primates. Combining such field-based studies with modern laboratory methods gives detailed insights into the biology of these species and how they cope with human disturbance. The research conducted by the German Primate Centre in the Indochinese bioregion during the last decade led to important insights into the systematics, phylogeography and population biology of Indochinese primates. Based on this knowledge and in cooperation with governments and non-governmental organisations, efficient conservation action plans can be established to provide the basis for the long-term survival of primate species and their habitats.

Efficient and focused actions aimed at the long-term sustainment of endangered primate populations require the distribution and access of research results and other information to a broad community. Currently such scientific knowledge is not widely disseminated. To take on this task the "Vietnamese Journal of Primatology", was founded. The journal aims to publish primate-related research focusing on the general biology, distribution, systematics and protection status of Indochinese primates. The German Primate Centre supports the journal scientifically and financially. We hope that the journal will be widely read, that it will serve as a solid platform for primate-related research in Vietnam and its neighbouring countries and contribute significantly to the conservation of endangered primate populations.

Prof. Dr. Stefan Treue,
Scientific Director

Ass. jur. Michael Lankeit
Administrative Director

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Conservation status of Vietnamese primates

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Key words: Vietnam, primates, distribution, systematic, status

Summary

In Vietnam 6 primate genera and 24 primate taxa are recognized. Six taxa are endemic to the country: Con Dao long-tailed macaque (*Macaca fascicularis condorensis*), Delacour's langur (*Trachypithecus delacouri*), Cat Ba langur (*T. poliocephalus poliocephalus*), grey-shanked douc langur (*Pygathrix cinerea*), Tonkin snub-nosed monkey (*Rhinopithecus avunculus*) and eastern black gibbon (*Nomascus nasutus*). The IUCN Red List classified 6 taxa as "Critically Endangered", 9 taxa as "Endangered", 6 taxa as "Vulnerable", 1 taxon as "Near Threatened" and only 2 taxa as "Least Concern". Five endemic species to Vietnam are listed as "Critically Endangered" and face a very high risk of extinction. All primates are protected under the wildlife protection law, but the main threat for the primates is poaching, mostly for the use in traditional medicine but also for food and for the pet trade. Habitat destruction through fuel-wood collection, logging, agriculture encroachment, and often in connection with poaching, has also an increasing impact to the population decrease. Most, if not all populations are already highly fragmented.

Despite an increasing knowledge during the last years about the systematic classification, distribution, threats and also about biology and ecology of the primates in Vietnam more detailed studies are necessary to improve the protection and to save the survival of several species.

Tình trạng bảo tồn các loài linh trưởng Việt Nam

Tóm tắt

Bộ thú linh trưởng ở Việt Nam có 6 giống, 24 loài và phân loài được ghi nhận. Có 6 loài đặc hữu gồm: Khỉ đuôi dài Côn Đảo (*Macaca fascicularis condorensis*), voọc mông trắng (*Trachypithecus delacouri*), voọc Cát Bà (*T. poliocephalus poliocephalus*), voọc chà vá chân xám (*Pygathrix cinerea*), voọc mũi hếch (*Rhinopithecus avunculus*) và vượn đen đông bắc (*Nomascus nasutus*). Trong sách đỏ IUCN, có 6 loài "Cực kỳ nguy cấp", 9 loài "Nguy cấp", 6 loài "Dễ bị tổn thương", 1 loài "Bị đe doạ" và 2 loài "Ít quan tâm". Năm loài linh trưởng đặc hữu của Việt Nam đều được xếp vào tình trạng "Cực kỳ nguy cấp" và có nguy cơ bị tuyệt chủng rất cao. Mặc dù tất cả các loài linh trưởng được bảo vệ bởi luật bảo vệ động vật hoang dã, tuy nhiên các mối hiểm hoạ như: săn bắt trái phép, sử dụng linh trưởng làm thuốc, thức ăn và buôn bán sinh vật cảnh vẫn phổ biến. Ngoài ra, môi trường sống của linh trưởng đang bị phá hoại bởi các hoạt động khai thác gỗ, chặt củi và khai thác đất nông nghiệp cũng đang làm suy giảm quần thể các loài linh trưởng. Hầu hết các quần thể đang trong tình trạng bị phân tán mạnh.

Mặc dù đã có thêm rất nhiều thông tin và kiến thức khoa học được bổ sung trong những năm gần đây về hệ thống phân loại, phân bố tình trạng bị đe dọa và cả sinh học, sinh thái về thú linh trưởng của Việt Nam nhưng thực tế vẫn cấp thiết tăng cường cho công tác bảo vệ nhằm bảo tồn sự tồn tại của các loài thú linh trưởng.

Introduction

During the last decade the knowledge about Vietnam's primate fauna increased noticeable due to research work of national institutions and international organizations, and there is now regularly new information. Meanwhile the content and task of several research works changed already from simple

records on distribution to biological, ethological and ecological studies. But nevertheless there is still a lack on information on the occurrence of several species and their status. Many areas in Vietnam are not yet intensively surveyed and new findings can be also expected during further field work.

Another output of the intensified field work is more detailed information about threats to the wild populations in the regions of the country and to their current or future impact to the primate populations.

One important background for conservation activities is also the clarification of the systematic position of species and populations. A close involvement of genetic studies contributed to decipher several unclear positions of taxa and was helpful in the discovery and systematic classification of them.

The paper will give actual information about systematics, distribution, habitat preferences, threats and the national and international protection status. The threat categories in the Red Data Book of Vietnam are not synonymous with the categories in the IUCN Red List. There are only three categories used (Endangered, Vulnerable, Rare) what seems to be occasionally confusing if an endemic species listed by IUCN Red List "Critically Endangered" but on national level only "Endangered".

The paper should also reveal where are lacks of knowledge about the distribution, the systematic classification and a deficit in information about the threats.

Primate taxa of Vietnam

Pygmy loris (*Nycticebus pygmaeus*)

Pygmy loris is a monotypic species. Over the whole distribution area there are no phaenotypic or genetic differences recognized. (Roos, 2004; Streicher, 2004). The description of the taxon *Nycticebus intermedius* (Dao Van Tien, 1960) was based on a lack of knowledge about the seasonal changes of fur coloration. Studies on fur pattern and genetics proofed that this taxon is to synonymized to *N. pygmaeus* (Roos, 2004; Roos *et al.*, 2007; Streicher, 2004).

This species is found east of the Mekong River in Vietnam, Eastern Cambodia, Laos, and in a small part in south-east Yunnan, in southern China (Duckworth, 1994; Fooden, 1996; Ratajszczak, 1998; Vu Ngoc Thanh, 2002; Zhang Yongzu *et al.*, 2002). It is found up to 1500 m asl (MacKinnon & MacKinnon, 1987). The western limit of distribution in Laos and Cambodia is uncertain, but it appears to be absent or at least naturally very scarce in the extreme west of the Mekong plain (Duckworth *et al.*, 1999).

The pygmy loris has a nocturnal and arboreal lifstyle and is mostly found in evergreen rainforests, semi-evergreen forests and secondary forests, but has also been observed in bamboo plantations (Groves, 1971; Fitch-Snyder & Vu Ngoc Thanh, 2002;).

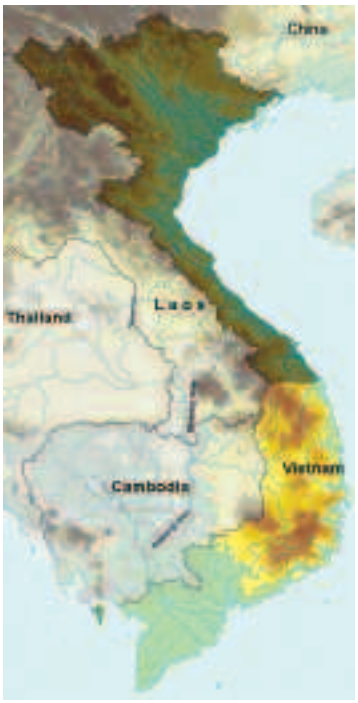
In Vietnam, the species is heavily exploited for traditional medicine and the pet trade, including in international trade, at levels that are not sustainable. It is also used as a food source by many minorities (Streicher, 2004).

The pygmy loris is protected at the highest level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as "Vulnerable".

IUCN Red List Category: Vulnerable; Criteria: A2cd. Listed as Vulnerable as the species is believed to have undergone a decline of more than 30% over the last three generations (25 years, given a generation length of 8 years) due primarily to hunting, but also as a result of habitat loss. This species may warrant listing in a higher category of threat if it subsequently shown that the rate of decline is on the order of 50% (Southeast Asia Mammal Data Bank, 2006).

There is an application present to the CITES-secretariat to transfer this species from appendix II to appendix I in the CITES regulations.

Northern slow loris (*Nycticebus bengalensis*)



The Bengal slow loris has only recently been recognized as valid species (Groves, 1998; Roos, 2004). Bengal slow loris is the largest of the *Nycticebus* species and can reaching a head-body length up to 380 mm (Streicher, unpubl.).

This species is found from northeastern India, through Bangladesh, north Myanmar, north Thailand, south China (south Yunnan and south-west Guangxi) to Cambodia, Laos, and Vietnam (Duckworth *et al.*, 1999; Zhang Yongzu *et al.*, 2002).

The species is rare in Vietnam and in most of its distribution range the populations through high hunting pressure are probably already drastically reduced.

Very little is known about the habitat preferences of the species. There are records from evergreen and deciduous forests, but also from degraded and secondary forest and bamboo groves (Duckworth *et al.*, 1999; Nadler, unpubl.; U Tun Yin, 1967).

The slow loris is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as "Vulnerable".

IUCN Red List Category: Vulnerable (VU) Criteria: A2acd+A3cd+A4acd. Due to loss of habitat over the last 20 years and due to severe pressures from hunting, there is more than 30% reduction in population over three generations. The species is predicted to decline by more than 30% in the next 20 years over its entire range due to continuing hunting pressures and loss of habitat (Southeast Asia Mammal Data Bank, 2006).

In the CITES convention the species is currently listed as a subspecies of *N. coucang* in appendix II. The nomenclature committee proposes recognizing *N. bengalensis* as a full species.

Stump-tailed macaque (*Macaca arctoides*)

The stump-tailed macaque has a wide distribution in Southeast Asia and is found in northern Myanmar, south China (south Yunnan, west Guangxi, south Guizhou), Vietnam, Laos, Cambodia (few records, one from west of the Mekong and only recently recorded from the east in Mondulkiri Province), Thailand and Malaysia (Duckworth *et al.*, 1999; U Tun Yin, 1967; Pfeffer, 1969; Walston *et al.*, 2001; Zhang Yongzu *et al.*, 2002).

This species has in Vietnam a wide habitat range from tropical evergreen forest to semi-deciduous, deciduous forest and limestone forest (Pham Nhat, 2002). In Cambodia and Laos the species is probably more restricted to evergreen and dense forests, though less common in the extreme lowlands (Duckworth *et al.*, 1999; Smith, 2001). In Myanmar it was found up to 2,100 m asl (U Tun Yin, 1967). In agricultural areas the macaques are sometimes crop raiders.

There are no population estimates available in Vietnam but the population is likely declining rapidly throughout its range through high hunting pressure (Pham Nhat, 2002). Trapping in many forest areas, including national parks and other protected areas has a major impact to the reduction of populations. Habitat disturbances that affect this species' survival include selective

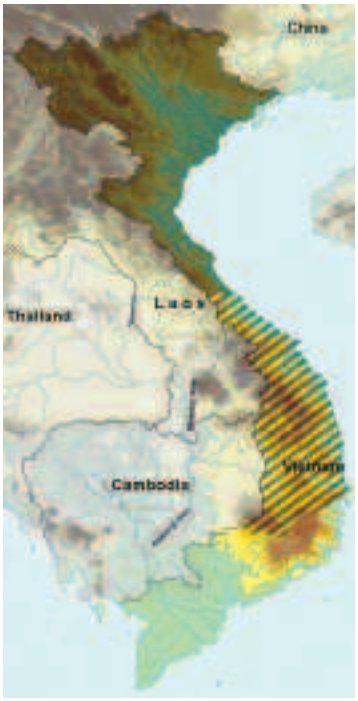
logging, timber and firewood collection, charcoal production, road, dam, power line buildings.

In Vietnam, the species is heavily targeted for traditional medicinal use, both in the country and for the trade to China. The hunting level for food is also very high. As more terrestrial species, it is more affected by snaring than other macaques (Duckworth *et al.*, 1999). Habitat loss is relatively a lower threat compared to hunting.

The species is protected in Vietnam on the second level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as "Vulnerable".

IUCN Red List Category: Vulnerable (VU) Criteria: A4cd. Listed in this category due to the reduction in the past and projected in the future based on habitat loss and the high level of exploitation (Southeast Asia Mammal Data Bank, 2006). In the CITES convention the species is listed in appendix II.

Rhesus macaque (*Macaca mulatta*)



The rhesus macaque has the largest distribution of the Southeast Asian macaque species. The species occurs in several subspecies from central and north India, north Pakistan, Kashmir, Afghanistan, Nepal, Sikkim, Bhutan to south-east China northwards to 36^{o}N and southwards in Myanmar and Thailand to about 17^{o}N in Laos and Vietnam to about 15^{o}N (Zhang Yongzu *et al.*, 2002; Fooden, 1996; 2000). There are also introduced populations in areas within the region as well as outside (e.g. Cat Tien National Park, south Vietnam). Most of the records in Laos come from lower 600 m asl but the species was also observed at 850 m asl (Duckworth *et al.*, 1999).

A large hybrid zone exists between this species and *M. fascicularis* in central mainland Southeast Asia from southernmost Bangladesh through north Myanmar, north Thailand, central Laos and Vietnam (Fooden, 1996, 1997).

The Rhesus macaques resides in a range of habitats, including evergreen forest, deciduous and semi-deciduous forest, and limestone forest, also in bamboo and mixed forest, mangroves and shrub, and is restricted to forest areas where it is generally associated with riverine environments over a range of altitudes (Timmins, pers. comm.). Close to agricultural land the macaques are sometimes crop raiders (Pham Nhat, 2002).

The species is still widespread in north and central Vietnam but hunting for the traditional medicine and also as food has severely depressed the populations (Pham Nhat, 2002). The release of laboratory, farm, or confiscated animals into natural forests is a major threat to wild macaques. There is no information on population size available for Vietnam.

The species is protected in Vietnam on the second level under the wildlife protection law (Government of Vietnam, 2006), and not mentioned in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000).

IUCN Red List Red List Category: Least Concern (LC) due to the widespread distribution in Southeast Asia (Southeast Asia Mammal Data Bank, 2006). The CITES convention lists the species in appendix II.

Assamese macaque (*Macaca assamensis*)

As an upland species the Assamese macaque occurs in mountainous areas south east of the Himalaya, from Nepal eastwards through Bhutan, northern Myanmar, north Laos, north Thailand, south China to north Vietnam. Groves (2001) recognized two subspecies, the nominate form

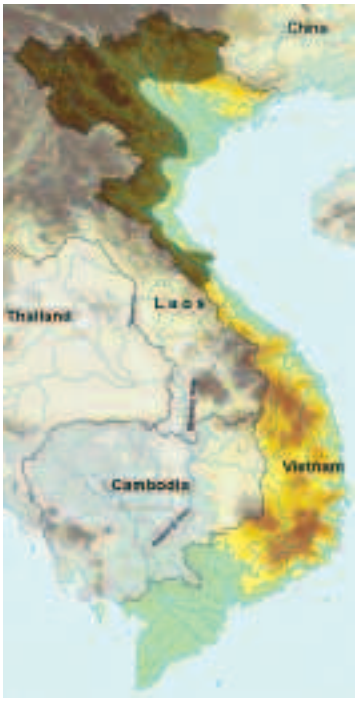
roughly about east of the Brahmaputra and *M. a. pelops* west of the Brahmaputra.

There are no population estimation available for Vietnam and even the distribution in Vietnam is not very clear yet. The southernmost area with confirmed records is Quang Binh Province (Timmins *et al.*, 1999; Pham Nhat, 2002).

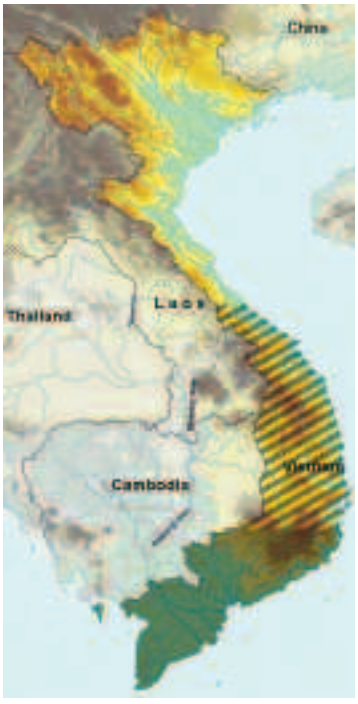
In Vietnam the species usually occur in dense evergreen primary forest, semi-deciduous forest and limestone forest (Pham Nhat, 2002), and not in secondary forest. It is usually associated with hill areas above 500 m asl. In forests on limestone karst, the species occurs also in lower elevations (Timmins *et al.*, 1999).

Hunting for food and as raw material for the production of traditional medicine, the monkey balm, is a major threat in Vietnam. The species is protected in Vietnam on the second level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as "Vulnerable".

IUCN Red List Red List Category: Near Threatened (NT). The population has declined in Vietnam and Laos in the last 30-35 years by more than 30%, and is expected to continue in the future also. (Southeast Asia Mammal Data Bank, 2006). The CITES convention lists the species in appendix II.



Long-tailed macaque (*Macaca fascicularis*)



The long-tailed macaque is a very wide spread and variable species with several subspecies. For the nominate form are more than 30 names synonymized. Groves (2001) recognized eight subspecies. Found from eastern Bangladesh through Myanmar and southern Indochina to Borneo and Timor also throughout the Philippines. Present on many offshore islands. The species found on the Sunda Land up to more than 1,000 m asl. However, in Vietnam the distribution is restricted to the lowlands below 300 m asl.

The species is extremely tolerant of a range of habitats, including mangrove and swamp forests, evergreen, bamboo and deciduous forests, and can be found in agricultural areas near forest. (Fooden, 1991; Pham Nhat, 2002).

On mainland Southeast Asia, there is a wide hybrid zone with *Macaca mulatta* that makes it difficult to determine the northern limits of the range (s.a *Macaca mulatta*; Fooden, 1996, 1997). There are introduced populations in several areas outside its natural range in northern Vietnam (e.g. Cat Ba National Park, Pu Mat National Park, Pu Luong Nature Reserve).

The major threat to the species is hunting. Females are taken into breeding facilities and males are exported primarily for laboratory testing. There is of a lack of controlling which individuals are bred in farms and which individuals caught in the wild.

The species is protected in Vietnam on the second level under the wildlife protection law (Government of Vietnam, 2006), and not mentioned in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000).

IUCN Red List Category: Least Concern (LC). The species is listed in this category in view of its wide distribution, presumed large population, tolerance of a broad range of habitats, occurrence in a number of protected areas and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category. Although the species is under heavy hunting pressure for meat, breeding facilities this is not considered a major threat to the species causing populations to decline (Southeast Asia Mammal Data Bank, 2006).

The endemic subspecies *Macaca fascicularis condorensis* has a restricted area on some islands belong to the Con Dao Archipelago in south Vietnam.

IUCN Red List Category: Vulnerable VU with the criteria D1, D2. The population is estimated at less than 1,000 individuals in total and it is despite the very limited range of the subspecies (the island is a national park) there are no obvious threats that would lead to the species declining very quickly (Southeast Asia Mammal Data Bank, 2006).

The CITES convention lists the species in appendix II.

Northern pigtail macaque (*Macaca leonina*)

The former taxon Macaca nemestrina is now splitted into two species, the southern species *Macaca nemestrina*, and the northern species *Macaca leonina*. The southern pigtail macaque occurs roughly from the Isthmus of Kra on the Malay Peninsula south to Sumatra, Bangka and Borneo (Groves, 2001). The northern pigtail macaque *M. leonina* occurs from Myanmar eastwards through Thailand, Cambodia, Laos, and Vietnam. In Vietnam and Laos most records are as far north as 19^{o}N but there are also records mentioned from Son La and Hoa Binh Provinces (Pham Nhat, 2002). In Yunnan Province, China the species occurs to about 26^{o}N (Zhang Yongzu *et al.*, 2002).

This is a predominantly terrestrial species, although readily climbs and forages in the canopy. It occurs in tropical wet evergreen and semi-deciduous forest, coastal forest, swamp forest, limestone forest, and also in degraded forests. In Vietnam the species is associated with lowlands usually below 500 m asl (Pham Nhat, 2002).

In Vietnam hunting for food and trade is the primary threat, but as a predominately lowland species habitat loss likely is also a major threat to the species. Habitat disturbances that affect this species' survival include selective logging, timber and firewood collection, road building, and forest fragmentation.

The species is protected in Vietnam on the second level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as "Vulnerable".

IUCN Red List Category: Vulnerable (VU) Criteria: A4cd. The decline in the countries of occurrence is different, more than 30% in the last 30-35 years in India, Bangladesh, China, Vietnam and Myanmar. There are perceptible declines in Thailand, Laos and Cambodia, but the rate is close too or lower than 30%. In most of the countries, the species is predicted to decline at a rate higher than 30% over the next three generations (Southeast Asia Mammal Data Bank, 2006).

The CITES convention lists the species in appendix II.

Francois' langur (*Trachypithecus francoisi*)

The Francois' langur occurs only in south China and northern Vietnam. In historical time it was wide spread over the northern provinces in Vietnam but poaching resulted in a dramatic decrease of the population which is now highly fragmented. There are recent records from Ha Giang, Cao

Bang, Tuyen Quang and Bac Kan Provinces (Nadler *et al.*, 2003, Pham Nhat, 2002; Le Khac Quyet, 2003). There is no recent record or evidence that the species still exist in Lang Son and Thai Nguyen Provinces.

The total population for Vietnam is estimated to less than 300 individuals, which occurs in about 10 subpopulations. No population contains more than 50 mature individuals (Nadler *et al.*, 2003).

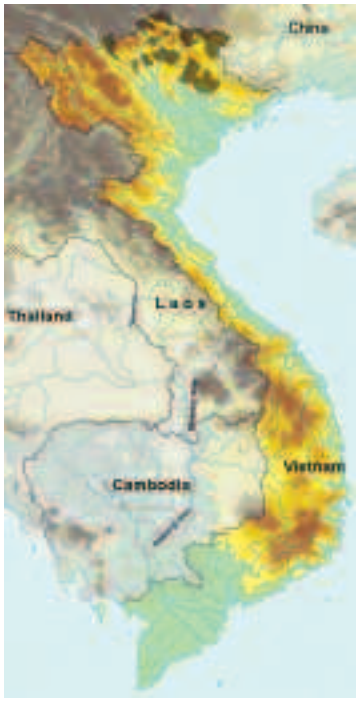
The Francois' langur is a typical "limestone species" closely related to limestone areas with steep limestone outcrops (Nadler *et al.*, 2003; Qihai Zhou *et al.*, 2006; Ratajszczak *et al.*, 1990; Zhaoyuan Li, 2006). The animals utilize the cave formations and overhangs in these areas for shelter.

In Vietnam, and also in China, the major threat to this species is hunting, although some populations face pressures from limestone quarring. Hunting mainly takes place for traditional medicine (Nadler *et al.*, 2003), and to a lesser degree for meat (feeding predominantly Chinese restaurant markets).

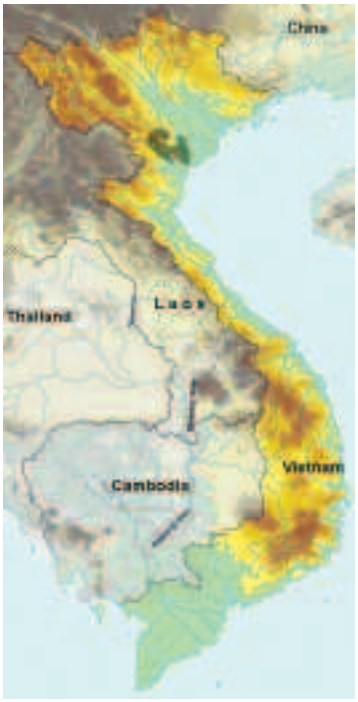
The species is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as "Vulnerable".

IUCN Red List Category: Endangered (EN) Criteria: A2cd; C1+2a(i) with the reason of the fragmented and declining population (Southeast Asia Mammal Data Bank, 2006).

The CITES convention lists the species in appendix II.



Delacour's langur (*Trachypithecus delacouri*)



The Delacour's langur is endemic to Vietnam. It occurs in a very restricted area of about 5000 square km, but the distribution areas of all isolated subpopulations cover together only about 400 square km. The species is also a typical "limestone species" and closely related to limestone mountain ranges in the Provinces of Ninh Binh, Ha Nam, Hoa Binh, Thanh Hoa, and Ha Tay (Nadler, 2004).

The total population is estimated to 200 to 250 individuals, surviving in 19 isolated subpopulations. The species is believed to be extirpated from three additional sites, and some important populations, including Cuc Phuong National Park and Pu Luong Nature Reserve have decreased by 20% in 5 years (2000 to 2004). Previous surveys (1995-1999) had estimated the population at between 281 and 317 individuals (Nadler, 2004). 60% of the total population occurs currently in subpopulations with less than 20 animals (Nadler, unpubl.).

The largest subpopulation exists in one part of Van Long Nature Reserve, Ninh Binh Province, and totals about 50 individuals.

Hunting is the primary threat facing this species. A potential threat is the rapid development of tourist facilities adjacent to protected areas and limestone quarrying (Nadler, 2004; Nguyen Van Thanh & Le Vu Khoi, 2006).

Delacour's Langurs have been successfully kept and bred

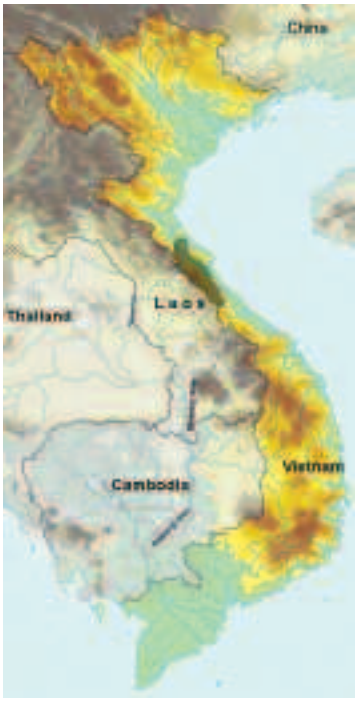
at the Endangered Primate Rescue Center at Cuc Phuong National Park with the goal to support wild populations through reintroduced groups of captive bred animals or to establish new populations in the wild where the species formerly occured (Nadler, 2004).

The species is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as "Endangered".

IUCN Red List Category: Critically Endangered (CR) Criteria: C2a(i) with the reason that present populations doesn't exceed 50 mature individuals (Southeast Asia Mammal Data Bank, 2006).

The species is listed as one of the 25 world's most endangered primates (Mittermeier *et al*., 2006). The CITES convention lists the species in appendix II.

Hatinh langur (*Trachypithecus laotum hatinhensis*)



The Hatinh langur is very closely related to the Lao langur (*Trachypithecus l. laotum*) and therefore classified as a subspecies of laotum (Roos, 2004; Roos *et al*., 2007). In respect to the allopatric distribution and by application of the phylogenetic species concept the taxon is recognized by Groves (2001) a distinct species. The taxonomic status of the black langur described by Brandon-Jones (1995) as subspecies *ebenus* of the Java langur *Trachypithecus auratus*, and recognized by Groves (2001) a distinct species *Trachypithecus ebenus* requires clarification. Based on two samples (including the type specimen) there is no genetic difference between black langurs and Hatinh langurs which resulted in the placement of the black langur as a morph of the Hatinh langur (Roos, 2004; Roos *et al*., 2007). Field observation of mixed groups and intermediary shapes of the white cheeks support this view. But some observation reports also the occurance of black langurs close and in mixed groups with Laos langurs (Duckworth *et al*., 1999; Robinson & Webber, 1999), although there is a clear genetic difference between *hatinhensis* and *laotum* (Roos, 2004). Based on the molecular genetic of the type specimen we recognize the black langur as a morphe of the Hatinh langur. There is a need for further surveys and taxonomic research to resolve the status of this form.

The Hatinh langur is another species of the "limestone langur"-group which occurs in northern Vietnam and southern China. Although the historical range of this species may once have been more extensive, it seems to be currently restricted to limestone areas in the western part of Quang Binh and Quang Tri Provinces, and, to a lesser extent, in the eastern part of Khammouan Province in Lao PDR (BirdLife International, 2005; Duckworth *et al*., 1999; Nadler *et al*., 2003). The western limit of the range of the species in Laos is unclear. The overlap zones of this species with *T. ebenus* (or another black langur taxon) is not well defined (Duckworth *et al*., 1999; Timmins, pers. comm.).

The Phong Nha-Khe Bang area has the largest remaining population of the species (Nadler *et al*., 2003; Pham Nhat, 2002). Although a large area of suitable habitat remains in Phong Nha-Ke Bang the density appears low (Nadler *et al*., 2003). Based on interviews and field observations, Pham Nhat (2000) estimated a maximum of 800 individuals. However, large parts of the area are not easy to survey due to difficult accessible terrain, and likely the size of this population is underestimated.

The main threat to this species is hunting. A predominant hunting method is to close at night the sleeping cave in a limestone cliff with a net after the langurs moved in, and the whole group can be caught inside the cave (Nadler *et al*., 2003). The animals are killed mostly for traditional medicine. There is an ongoing captive-breeding program for this species in the Endangered Primate Rescue Center at Cuc Phuong National Park under supervision of Frankfurt Zoological Society and a

reintroduction project on the way in Phong Nha - Ke Bang National Park.

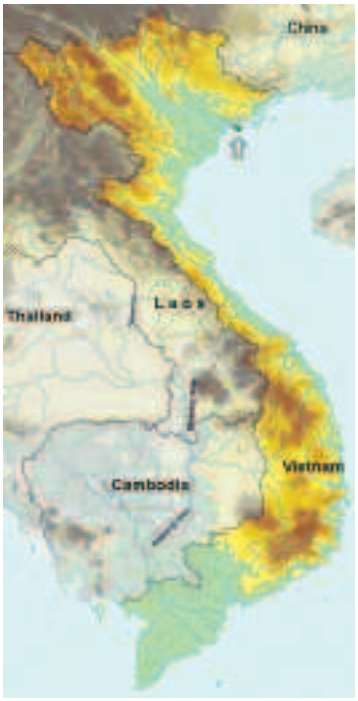
The Hatinh langur is protected on the highest level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as "Endangered".

IUCN Red List Category: Endangered (EN) Criteria: A2cd. The species is likely to have undergone a decline of more than 50% over the last three generations (35 years) due to the ongoing loss and decline of habitat and effects of hunting (Southeast Asia Mammal Data Bank, 2006). The CITES convention lists the species in appendix II.

The black langur is not explicit mention in the Vietnamese law but as a morphe of the Hatinh langur it has the same protection status as the species on the highest level under the wildlife protection law (Government of Vietnam, 2006).

IUCN Red List recognize species level for the black langur and place the taxon in the category: Vulnerable (VU) Criteria: A3cd+A4cd with the reason of a projected decline of more than 30% over the next three generations (35 years) due to the ongoing loss and decline of habitat and effects of hunting (Southeast Asia Mammal Data Bank, 2006). Under the recognition as morphe of the Hatinh langur itís listed in the CITES convention in appendix II.

Cat Ba langur (*Trachypithecus poliocephalus poliocephalus*)



The Cat Ba Langur is morphologically and genetically closely related to the Chinese white-headed langur (*T. policephalus leucocephalus*) and hence recognized as the nominate form of these two langurs.

Only found on Cat Ba Island, north-east Vietnam, this langur has the smallest distribution of all langur species, and is restricted to about a 100 square km area of occurrence, mostly inside Cat Ba National Park (Nadler & Ha Thang Long, 2000; Stenke, 2004). This species is also belongs to the "limestone-langur"-group, and is associated with forests on karst hills.

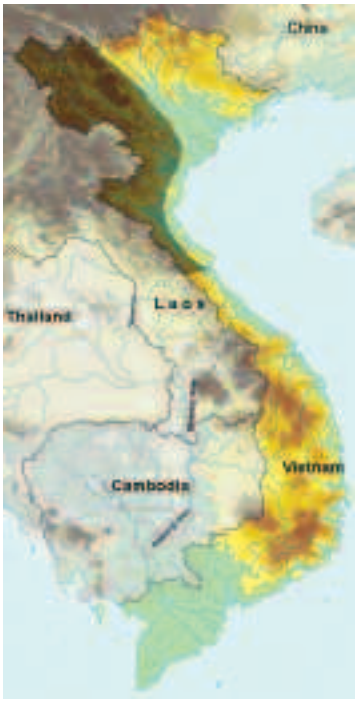
The population size is 64 individuals (August 2006) (Stenke, pers. comm.), and decreased from 104 - 135 individuals in 2000 (Nadler & Ha Thang Long, 2000). The whole population is fragmented into seven isolated subpopulations. An estimation of the population for the beginning of the 20. century - before hunting reduced the population dramatically - is made to 2,400-2,700 individuals on Cat Ba Island (Nadler & Ha Thang Long, 2000).

Poaching for the use in traditional medicine, has been recognized as the most severe threat to Cat Ba langurs, and is the reason for the precipitous decline in their population in the past couple decades. Fragmentation and habitat disturbance resulting from the growing human population on Cat Ba Island, and the inconsiderate and reckless tourist development and their inadequate management is currently the major threat. Forest fire on the limestone cliffs due to honey collectors has a high impact to the habitat.

The Cat Ba langur is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as "Endangered".

The IUCN Red List recognize the taxon as monotypic species with the category: Critically Endangered (CR) Criteria: A2cd. A decline > 80% has been observed in the last 35 years (generation length: 12 years) (Southeast Asia Mammal Data Bank, 2006). The species is listed as one of the 25 world's most endangered primates (Mittermeier *et al.*, 2006). The CITES convention lists the species in appendix II.

Grey langur (*Trachypithecus crepusculus*)



This taxon was formerly classified as a subspecies of the Phayre's langur as *Trachypithecus phayrei crepusculus*. But despite similarities in coloration the taxon is genetically more closely related to the *francoisi*-langur group than to the Phayre's langur (Roos, 2004).

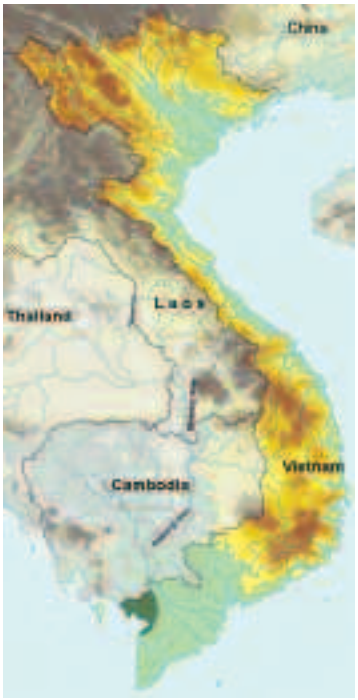
The species is found from central and north-west Thailand north to Yunnan in China east to south-west Laos and northern Vietnam, and west to the coast of the Bay of Bengal, south of the range of the Phayre's langur (Groves, 2001). Information about the western limit of the distribution are not reliable, based on the confusion with the Phayre's langur and the recent split of the taxonomic position.

There are only few reliable records from northern Vietnam during the last years (Nadler *et al.*, 2003) and there are also fewer records than from all other primate species in Laos (Duckworth *et al.*, 1999)

The species prefers primary and secondary evergreen, semi-evergreen forest, and mixed moist deciduous forest. In Laos (Duckworth *et al.*, 1999) and in Vietnam (Pham Nhat, 2002) it also occurs in limestone forest. The major threat is hunting for traditional medicine.

The species is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006), but under the synomyms *Trachypithecus barbei* and *T. phayrei*, and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as "Vulnerable".

The IUCN Red List recognize the taxon under *Trachypithecus phayrei* in the category: Endangered (EN) Criteria: A2cd. It is believed to have undergone a decline of more than 50% over the last three generations (35 years, given a generation length of 12 years) due to a combination of habitat loss and hunting (Southeast Asia Mammal Data Bank, 2006). The CITES convention lists the species in appendix II.



Indochinese silvered langur (*Trachypithecus germaini*)

With a comprehensive collection of samples from the whole distribution area of the silvered langurs the molecular genetic shows a clear differentiation of taxa on species level within the region (Nadler *et al.*, 2005). For the mainland Southeast Asia are two species recognized. The genetic evidence suggests that silvered langurs east of the Mekong, named as Annamese silvered langur, *Trachypithecus margarita*, are distinct from that west of the Mekong, classified as Indochinese silvered langurs, *Trachypitheus germaini* (Nadler *et al.*, 2005). The precise limits of the distribution range between these species need more investigation.

Indochinese silvered langurs are recorded in Vietnam only in Kien Giang Province, south of the Mekong. In this area exist several isolated populations mostly on limestone blocks with degraded forest cover.

The species is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006),

but under the synomyms *Trachypithecus villosus* and *T. cristatus*. No silvered langur taxon is listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000).

IUCN Red List Category: Endangered (EN) Criteria: A4cd. This species has declined significantly and is only locally abundant in Cambodia. A decline on 50% due to 70-80% habitat loss and hunting pressure give the reason for this category (Southeast Asia Mammal Data Bank, 2006). The CITES convention lists the species in appendix II.

Annamese silvered langur (*Trachypithecus margarita*)

The Annamese silvered langur has a wide distribution east of the Mekong in Cambodia, south Laos and south and central Vietnam. In Vietnam, the southern limit is Dong Nai Province and the northern limit is Quang Tri Province.

The apparently extremely low density of this species in Vietnam suggests that the population has been seriously reduced due to human pressure. In Vietnam, there are only a few sightings documented in the last 50 years, though this may be also a result of limited surveys conducted in the species range (Nadler *et al.*, 2003).

The Annamese silvered Langur is primarily a lowland species, found in evergreen and semi-evergreen forest, mixed deciduous forest, and riverine and gallery forest. Records in hilly areas or at higher elevations are a few.

Hunting, mainly for subsistence use, traditional medicine is a major threat to this species, as is habitat loss mainly due to agricultural expansion.

The species is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006), but under the synomyms *Trachypithecus villosus* and *T. cristatus*. No silvered langur taxon is listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000).

This species is not listed separately from the Indochinese silvered langur and hence it has the same protection status, and assessment. IUCN Red List Category: Endangered (EN) Criteria: A4cd. This species has declined significantly and is only locally abundant in Cambodia. A decline on 50% due to 70-80% habitat loss and hunting pressure give the reason for this category (Southeast Asia Mammal Data Bank, 2006). The CITES convention lists the species in appendix II.

Red-shanked douc langur (*Pygathrix nemaeus*)

The red-shanked douc langur occurs in central Laos, and northern central Vietnam. In Laos occur the core population of the species and is much more stable than that in Vietnam, after several decades of intense human pressure. In Vietnam the species occur from Nhe An Province in the north to Kon Tum Province in central Vietnam (Nadler *et al.*, 2003). The species has a very small hydridisation zone with the grey-shanked douc langur (*P. cinerea*) in the northern part of Quang Nam Province. Areas of sympatry, where interbreeding between species of this genus may occur, are limited (Vu Ngoc Thanh and Ha Thang Long, pers. comm.).

This species occurs in primary and secondary evergreen forest, semi-deciduous forest and also in limestone forest (Pham Nhat, 2002).

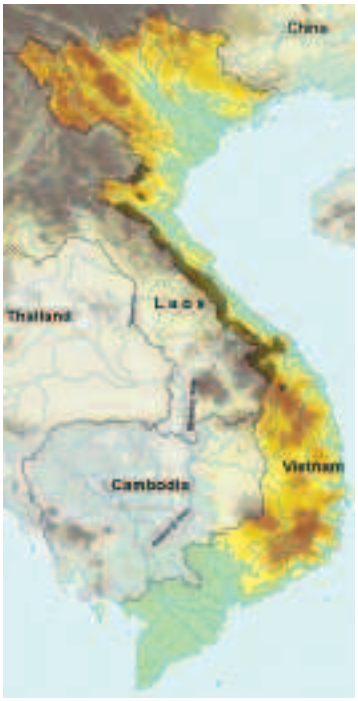
Hunting is currently the major threat to this species, most often for subsistence use and traditional medicine, and also sometimes for the international pet trade, especially from Laos to Vietnam and Thailand (Timmins & Duckworth, 1999; Nadler *et al.*, 2003). Zoos in China purchase also animals from the illegal trade (Nadler, unpubl.). Destruction of its natural habitat is also a threat to this species, a large portion in the central part of Vietnam has suffered from post-war human

demographic explosion and extensive logging for coffee, rubber, and cashew plantations. The translocation of some 3 million people from the north of Vietnam to the central highlands is likely to exacerbate rates of habitat loss through the Vietnamese range of the species (Nadler *et al.*, 2003).

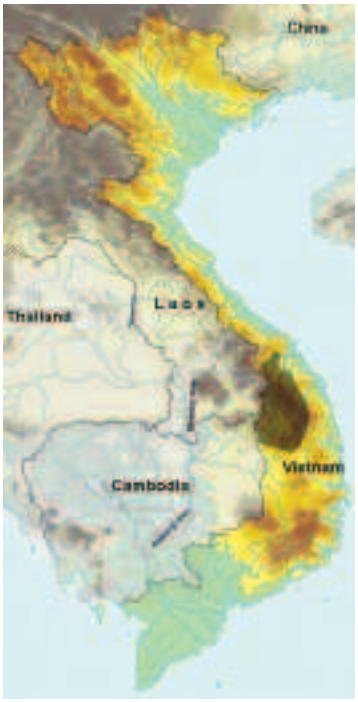
There is an ongoing captive-breeding program for this species at the Endangered Primate Rescue Center at Cuc Phuong National Park under the supervision of the Frankfurt Zoological Society for further reintroduction.

The species is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as "Endangered".

IUCN Red List Category: Endangered (EN) Criteria: A2cd+A4cd. The species is believed to have undergone a decline of more than 50% in the last three generations (35 years, based on a generation length of 10-12 years) due to forest loss and hunting (Southeast Asia Mammal Data Bank, 2006). The CITES convention lists the species in appendix I.



Grey-shanked douc langur *(Pygathrix cinerea*)



The grey-shanked douc langur is genetically closely related to the red-shanked douc langur but based on morphological and molecular genetic differences the taxon is recognized as distict species (Groves, 2001; Roos, 2004; Roos & Nadler, 2004).

The grey-shanked douc langur occurs in central Vietnam from Quang Nam Province in the north to Binh Dinh and Gia Lai Provinces in the south. (Nadler *et al.*, 2003; Ha Thang Long, 2004). On the northern limit exists a small hybridization zone with the red-shanked douc langur. The total population is estimated to a maximum of about 800 individuals (Ha Thang Long, 2004). But there are still surveys necessary to proof some more areas. The southern limit of the distribution is still to clarified. The southernmost provisional report was made from Cu Jut District, Dak Lak Province but is not confirmed in the field yet (Ha Thang Long & Le Thien Duc, 2001).

This species occurs in evergreen and semi-evergreen primary forest but also in highly degraded forest (Ha Thang Long, 2004; Nadler, unpubl.).

The Central Highland where this langur occur lose almost 10,000 ha of forest annually due to logging and agricultural conversion. This creates a more and more fragmented habitat and population structure (Ha Thang Long, 2004). The species suffer also from high hunting pressure for food, traditional medicine, and for sale as pets (Ha Thang Long, 2004). But a douc langur as pet has, with the highly sensitive digestion system, mostly not a chance for long survival.

There is an ongoing captive-breeding program for this species in the Endangered Primate Rescue Center at Cuc Phuong National Park under supervision of Frankfurt Zoological Society with the goal of further reintroduction.

The species is protected in Vietnam on the highest level under the wildlife protection law

(Government of Vietnam, 2006). The species is not mention in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000).

IUCN Red List Category: Critically Endangered (CR) Criteria: A2cd+A4cd. The species has undergone more than an 80% population reduction across much of its range due to increasing human activities (agriculture and hunting) (Southeast Asia Mammal Data Bank, 2006). The species is listed as one of the 25 world's most endangered primates (Mittermeier et al., 2006). The CITES convention lists the species in appendix I.

Black-shanked douc langur (*Pygathrix nigripes*)

The species is found in north-east Cambodia, only east of the Mekong and in southern Vietnam. In Vietnam it occurs from Dak Lak Province in the north southwards to Dong Nai Province. Records from northernmost Kon Tum Province are questionable and need to be confirmed. There is probably a confusion with the occurance of grey-shanked douc langurs. A sympatric distribution with the grey-shanked douc langur is not confirmed.

There is no population estimate for Vietnam. The largest population in Vietnam may be in Nui Chua National Park (Ninh Thuan Province) which is estimated at 500-700 individuals (Hoang Minh Duc & Ly Ngoc Sam, 2005). The population in Nam Cat Tien National Park numbers at about 100 individuals. (Phan Duy Thuc *et al.*, 2005).

Black-shanked doucs are found in evergreen, semi-evergreen and mixed deciduous forests, as well as in coastal dry forest. It seems that species of this genus can adapt to relatively heavily disturbed forest (Nadler *et al.*, 2003).

Hunting is currently the major threat to this species. It is most often hunted for meat and traditional medicine. Destruction of its natural habitat is also a threat to this species, a large portion in the central and south of Vietnam suffered human demographic explosion and extensive logging for coffee, rubber, and cashew plantations. Most forest at lowland elevations has been cleared and little forest remains undisturbed (Ha Thang Long & Le Thien Duc, 2001; Nadler *et al.*, 2003).

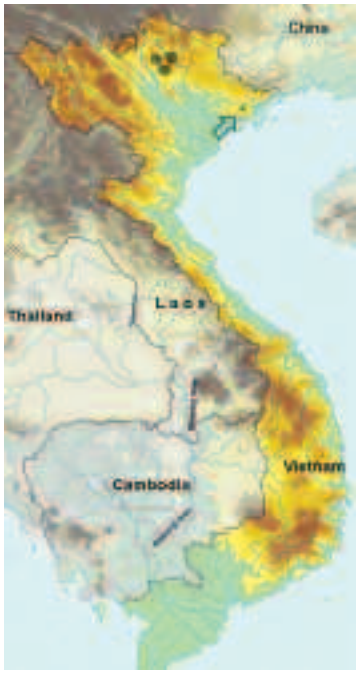
The species is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as "Vulnerable".

IUCN Red List Category: Endangered (EN) Criteria: A2cd. The species is believed to have undergone a decline of more than 50% in the last three generations (35 years, based on a generation length of 10-12 years) due to forest loss and hunting (Southeast Asia Mammal Data Bank, 2006). The CITES convention lists the species in appendix I.

Tonkin snub-nosed monkey (*Rhinopithecus avunculus*)

The Tonkin snub-nosed monkey is one of four unusual, large Asian colobine monkeys of the genus *Rhinopithecus*, all of which possess a characteristic turned-up nose. The three other species are endemic to China, while the Tonkin snub-nosed monkey is endemic to northern Vietnam.

Historically the species was distributed over a relatively large area in northern Vietnam east of the Red River. Due to massive deforestation and intensive hunting in recent decades, its distribution has become dramatically restricted. Now it's occur only in Tuyen Quang and Bac Kan Provinces and to a lesser extent in Ha Giang Province (Nadler *et al.*, 2003). Former Information about the occurrence in Tuyen Quang and Quang Ninh Provinces are recently not confirmed (Le Khac Quyet, pers. comm.).

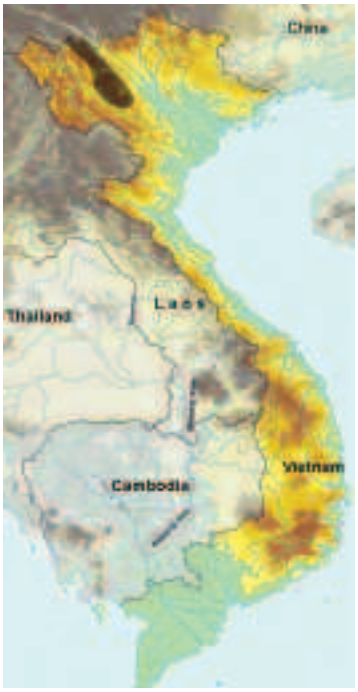


Currently, there are only four known locations with recent evidence where Tonkin snub-nosed monkeys occur, and these are completely isolated. For the subpopulation in Na Hang Nature Reserve (Tat Ke sector), Tuyen Quang Province a study in 2004-2005 have been estimated only 17-22 individuals. No recent information is available form the other isolated part of Na Hang Nature Reserve (Ban Bung sector). A population of about 70 individuals was estimated for Cham Chu Nature Reserve, Tuyen Quang Province in 2001 (Long & Le Khac Quyet, 2001) but a survey in 2006 provided no sightings and no reliable evidence of the survival of the population. Local reports indicate, however, a small group of 8-12 individuals still in the area (Dong Thanh Hai *et al*., 2006). A population of about 60-90 individuals was discovered 2001 in Khau Ca, close to Du Gia Nature Reserve, Ha Giang Province (Le Khac Quyet, 2004). This is the only population which is not immediately threatened. The total population of the Tonkin snub-nosed monkey is estimated not to exceed 150 individuals.

The species is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as “Endangered”.

IUCN Red List Category: Critically Endangered (CR) Criteria: C2a(i). Basis for the classification is the observed and ongoing dramatical population decline, and the small populations of mature indivuals estimated less than 50 individuals (Southeast Asia Mammal Data Bank, 2006). The species is listed as one of the 25 world’s most endangered primates (Mittermeier *et al*., 2006). The CITES convention lists the species in appendix I.

Western black gibbon (*Nomascus concolor*)



The western black gibbon is a monotypic species. The molecular genetic shows no differences between all described subspecies (Roos *et al*., 2007).

The species occurs in north Laos, southern part of Yunnan Province, China and northern Vietnam between Black and Red River in the provinces Lao Cai, Yen Bai, and Son La.

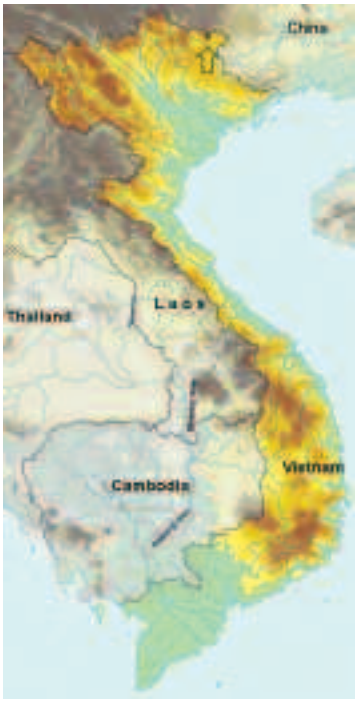
The largest and most important populations are located in the districts Van Ban, Mu Cang Chai and Muong La in the south of the Hoang Lien mountain range. In total there exist probably less than 150 individuals, with less than 50 mature animals (Tallents *et al*., 2000a; 200b; 2001; Le Trong Dat *et al*., 2001; 2005).

The biggest threats to the gibbons throughout its range include hunting and destructive forest use; mostly it’s ultimately always a combination of the both (Geissmann *et al*., 2000; Ngo Van Tri & Long, 1999). Despite a gun collection (1800 guns have been collected in only 3 communes!) there is still hunting in the area and nearly daily gun shots were heard during a survey (Le Trong Dat *et al*., 2005).

The species is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as “Endangered”.

IUCN Red List Category: Critically Endangered (CR) Criteria: A2cd, because there is an estimate of over 80% decline in the last 45 years (3 generations) (Southeast Asia Mammal Data Bank, 2006). The CITES convention lists the species in appendix I.

Eastern black gibbon (*Nomascus nasutus*)



Recent molecular genetic studies have determined a clear difference on species level between the allopatric populations of Hainan Island and on the mainland (Roos *et al.*, 2007), and hence the Chinese Hainan gibbon is classified as *Nomascus hainanus*. Also the vocalization supports a separation on species level (Geissmann, pers. comm.).

The eastern black gibbon occurs only in a very small area in northeast Vietnams close to the Chinese border, in Trung Khanh District, Cao Bang Province. There is a recent information about a small relict population with 17 individuals adjacent to the area in Vietnam in Bangliang forest area of Jingxi County, Guangxi Province, China (People's Daily Online, 2006) . There is no recent evidence that in Vietnam eastern black gibbon populations still exists where historically the species occurred, in Bac Kan and Thai Nguyen Provinces (Geissmann *et al.*, 2000).

The population in Phong Nam-Ngoc Khe forest in Trung Khanh District was discovered in 2002 (La Quang Trung & Trinh Dinh Hoang, 2001; 2004). A provisional record was made in 1999 in Kim Hy Nature Reserve but without evidence that the species still exists in the area (La Quang Trung & Trinh Dinh Hoang, 2004).

The highest number recorded of this species in Vietnam has been 37 individuals (Trinh Dinh Hoang, 2004). In 2005 27 individuals in 6 groups have been confirmed inside the Phong Nam-Ngoc Khe proposed Species/Habitat Conservation Area. Two additional groups with about 8 individuals are mentioned outside the surveyed area (Vu Ngoc Thanh *et al.*, 2005).

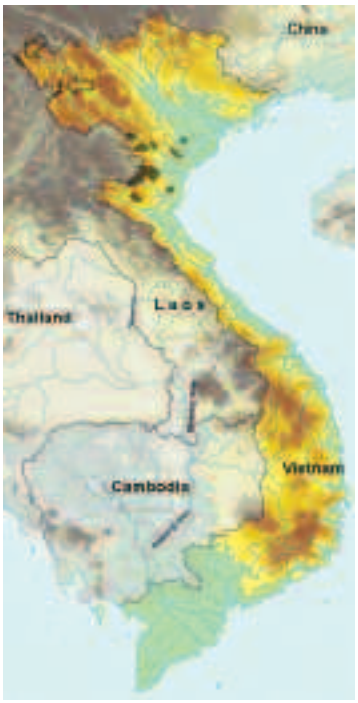
The location with the last remaining population of the eastern black gibbon, the Phonh Nam-Ngoc Khe proposed Species/Habitat Conservation Area, is a typical karst area with limestone forest but widely degraded by human activities. Currently only about 700 ha of forest is in a good condition (Vu Ngoc Thanh *et al.*, 2005). Due to the limitation of its habitat, the gibbon groups are concentrated in an area of 400 ha in the center of the proposed nature reserve.

At present, hunting pressure is not particularly high. Timber logging and choarcoal production are low. A major threat to the proposed nature reserve is fuel wood collection, non-timber forest product collection and agricultural activities in the valleys. In addition, local people often graze cattle and livestock inside the proposed nature reserve and allow their dogs to run free. This is a major disturbance to the wildlife (Vu Ngoc Thanh *et al.*, 2005).

The species is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006) but not mentioned in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000).

The IUCN Red List treat the Hainan gibbon and eastern black gibbon as subspecies to *N. nasutus* and classified in the Category: Critically Endangered (CR) Criteria: A2acd; B1ab(iii,v); C2a(i,ii); D1. The species is threatened from problems intrinsic to extremely small population size such as inbreeding effects, poor mate-choice, and human or natural disaster (Southeast Asia Mammal Data Bank, 2006). The species is listed as one of the 25 world's most endangered primates (Mittermeier *et al.*, 2006). The CITES convention lists the species in appendix I.

Northern white-cheeked gibbon (*Nomascus leucogenys leucogenys*)



The northern and the southern white-cheeked gibbons are molecular genetically closely related, and hence they are classified as subspecies to the species *N. leucogenys* (Geissmann *et al*., 2000; Roos, 2004). Despite the close relationship also in vocalization as another important feature for the taxa identification in gibbons placed Groves (2001) both taxa on species level.

The northern white-cheeked gibbon occurs in north Laos, northwest and northern central Vietnam. In China, the taxon was previously reported in Xishuangbanna National Nature Reserve, south Yunnan Province (Zhang Yongzuo *et al*., 2002) but is now most probably extirpated (Bleisch, pers. comm.).

In Vietnam this gibbon was recorded west and south of the Black River. It has been extirpated from several areas from which it was previously recorded and is now only known from a few localities in northwest, Lai Chau Province, and northern central Vietnam, Thanh Hoa and Nhe An Provinces (Geissmann *et al*., 2000).

The population in Vietnam is extremely low and highly fragmented. Geissmann *et al.* (2003) recorded 27 sites at which this species should have occurred, but it was only confirmed surviving at four, and may be survived in a further three. In Pu Huong Nature Reserve, the number of groups remaining is less than 10, while in Pu Hoat Nature Reserve - both reserves in Nghe An Province - fewer than three groups survive (Nguyen Manh Ha, 2005). Most probably no population exists anymore with more than 50 individuals.

Hunting for traditional medicines and for the pet trade is the major threat across the range, and is the primary cause for the decline of the populations. Despite the gibbons are exist in evergreen primary and also heavily degraded evergreen and semi-evergreen forests the forest fragmentation through agricultural encroachment into mountainous areas, fuel-wood, and timber extraction support the isolation of individuals and poaching.

The species is the most common species of *Nomascus* maintained in zoos, but nothing whatever is known about it in the wild.

The species is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006), and listed in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000) as “Endangered”.

IUCN Red List Category: Critically Endangered (CR) Criteria: A2cd+A3cd. The taxon is placed in this category based on the drastic population reduction occurred and ongoing, due mainly to habitat loss and hunting pressure (Southeast Asia Mammal Data Bank, 2006). The CITES convention lists the species in appendix I.

Southern white-cheeked gibbon (*Nomascus leucogenys siki*)

The southern white-cheeked gibbon occurs in south Laos and central Vietnam. The northern limit of the distribution in Vietnam is in Nghe An Province by about 19^{o}N. The southern limit of the distribution is not clear because there is probably a contact or hybridization zone with the yellow-cheeked gibbon (*N. gabriellae*) between Quang Tri Province and the northern part of Kon Tum Province.

The habitat of the species is heavily fragmented due to logging and agricultural encroachment, and a high population density of humans continues to threaten this species’ habitat and population numbers.

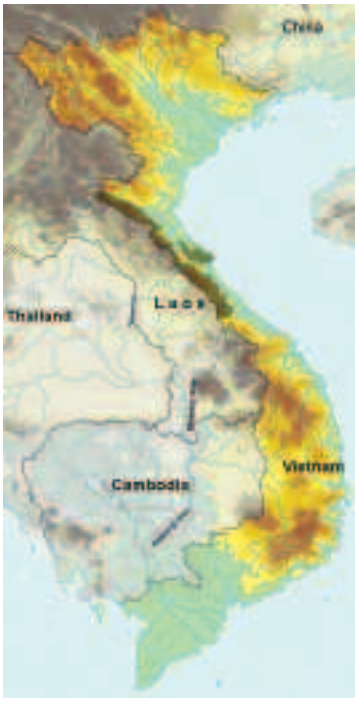
There are no available population estimates for Vietnam. The most important populations are in

Phong Nha-Ke Bang and Pu Mat National Parks (Nguyen Manh Ha, 2005). In Pu Mat National Park the population are believed to have declined in six years (1999 to 2004) about 40% (Grieser Johns, 2004). A relatively large population exists in Dak Rong Nature Reserve, Quang Tri Province, with a minimum of 25 groups (Nguyen Manh Ha, 2004). But the systematic status of gibbons in this area still requires clarification.

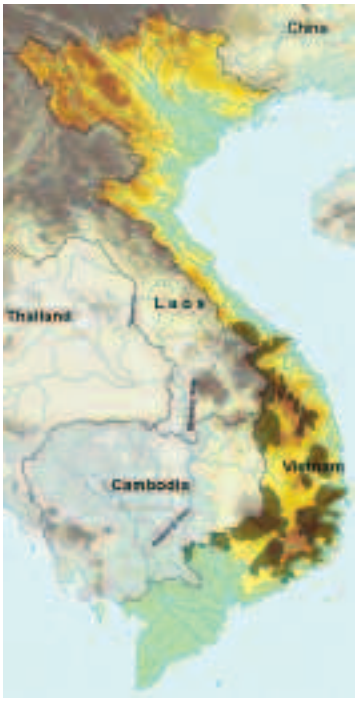
The gibbons are primarily occur in tall primary evergreen forest. Habitat fragmentation trough logging and agricultural encroachment has a high impact to the populations, but hunting is the major threat for the population decline. The species is used in traditional medicine, as food, and in the pet trade (Geissmann *et al.*, 2000).

The southern white-cheeked gibbon is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006), but not mentioned in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000).

IUCN Red List Category: Endangered (EN) Criteria: A2cd. The reason for the classification is the occurred and ongoing population reduction due to habitat loss and hunting pressure (Southeast Asia Mammal Data Bank, 2006). The CITES convention lists the species in appendix I.



Yellow-cheeked gibbon (*Nomascus gabriellae*)



The yellow-cheeked gibbon is distributed in north-east Cambodia, and southern Vietnam. There occurs probably also a population far south in Laos but their taxonomic position needs to be clarified (Duckworth *et al.*, 1999).

The southern limit of the distribution in Vietnam is Dong Nai Province. The northern limit is not clear because of the confusion with the southern white-cheeked gibbon (*N. leucogeny siki*) and possible interbreeding. Kon Tum Province is probably the northern limit where pure *N. gabriellae* is doubtless to identified.

There is no population estimate for Vietnam but it is likely that this species is the most common of the crested gibbons in Vietnam.

In Nam Cat Tien National Park, Dong Nai Province has been estimated at about 500 individuals in 150 groups. Other important populations hold Bu Gia Map and Nui Chua National Parks. The Lam Dong Plateau seems to support a relatively large population of this species (Brickle *et al.*, 1998; Geissmann *et al.*, 2000).

The species is found in tall evergreen and semi-evergreen forest, probably ranges into other forest types (e.g., mixed bamboo and woodland forest) adjacent to these; they may also occur in riverine and gallery forest associations.

The major threat in Vietnam is hunting for the pet trade. Areas in southern Vietnam have been heavily degraded by defoliant spraying during the war time, agricultural encroachment, and logging, yet this species appear to survive in moderately disturbed forest, as suggested by its continued presence in Cat

Tien National Park and Dak Uyn State Forest Enterprise (Geissmann *et al.*, 2000).

The species is protected in Vietnam on the highest level under the wildlife protection law (Government of Vietnam, 2006) but not mentioned in the Red Data Book of Vietnam (Ministry of Science, Technology and Environment, 2000).

IUCN Red List Category: Endangered (EN) Criteria: A4cd. There is a need for close monitoring of this species since, given predicated likely rates of both habitat loss and hunting in the future, this species could well warrant listing in a higher category of threat (Southeast Asia Mammal Data Bank, 2006). The CITES convention lists the species in appendix I.

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Speciation and biogeography of Vietnam's primates

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Key words: Primates, Vietnam, biogeography, Pleistocene climatic change

Summary

Vietnam is home to approximately 24 primate taxa including two lorises, five macaques, 11 colobines, and six gibbons. The biogeography of these primates is quite interesting with the vast majority being restricted to the region of Southeast Asia to the east of the Mekong River making this area, with Vietnam forming its heart, much richer in primate diversity than the area to the west of the river. This is quite interesting because the Mekong does not appear to be an important barrier for most other mammalian groups. In addition, within Vietnam, there is an interesting north – south distribution of primate taxa with closely related species replacing one another along this gradient. While this north – south distribution appears to be closely related to modern climatic conditions, the distinct distribution of primate taxa east of the Mekong appears to be related to Pleistocene climatic change caused by glacial cycles. A final fascinating feature of primate biogeography in Southeast Asia is the close association of a number of *Trachypithecus* species with the distinctive limestone geography of northern Vietnam – this union is so tight that the common name "limestone langurs" aptly characterizes the distribution of these taxa.

Sự hình thành loài và địa lý sinh vật học của các loài linh trưởng Việt Nam

Tóm tắt

Việt Nam là nơi cư ngụ của khoảng 24 loài và phân loài thú linh trưởng bao gồm, 2 loài culi, 5 loài khỉ, 11 loài voọc ăn lá, và 6 loài vượn. Địa lý động vật học của các loài linh trưởng này rất thú vị với đặc trưng như sau: phần lớn các loài phân bố khắp vùng Đông Nam Á đến phía đông sông Mê Kông với Việt Nam ở vị trí trung tâm, sự đa dạng thành phần loài ở khu vực này hơn hẳn khu vực phía tây của sông Mê Kông. Tuy nhiên sông Mê Kông lại không phải là yếu tố cách ly địa lý quan trọng đối với các nhóm động vật khác. Mặt khác, ở Việt Nam các loài linh trưởng lại phân bố theo trục Bắc - Nam với các loài gần nguồn gốc lần lượt thay thế nhau. Phân bố của các loài linh trưởng ở Việt Nam theo trục Bắc - Nam liên quan đến mô hình thay đổi của khí hậu theo vĩ độ, trong khi sự phân bố một cách tập trung ở đông sông Mê Kông lại liên quan đến sự thay đổi khí hậu ở thời kỳ Pleistocene gây ra bởi chu kỳ băng hà trên trái đất. Một đặc trưng thú vị khác về địa lý sinh vật của bộ thú linh trưởng ở vùng Đông Nam Á đó là mối liên quan giữa các loài thuộc giống *Trachypithecus* với hệ thống núi đá vôi biệt lập ở phía bắc Việt Nam. Mối liên hệ chặt chẽ đến mức các loài này thường được gọi là "voọc núi đá" để chỉ đặc trưng vùng phân bố của nhóm loài.

Introduction

There are perhaps 24 living species of primates in Vietnam (Table 1, Groves 2004). The uncertainty arises both because of queries about the validity of certain species, and because it is unclear whether a couple of them do actually occur within the territorial limits of Vietnam.

In what follows, I adopt the following definition of a species (based on the Phylogenetic Species Concept, or PSC):

Table 1. Primate Species in Vietnam

Suborder Strepsirrhini	
Family Loridae	
Genus Nycticebus	
Nycticebus bengalensis	Greater slow loris
Nycticebus pygmaeus	Pygmy slow loris
Suborder Haplorrhini	
Family Cercopithecidae	
Subfamily Cercopithecinae	
Genus *Macaca*	
Macaca arctoides	Stumptailed macaque
Macaca assamensis	Assam macaque
Macaca leonina	Northern pigtailed macaque
Macaca mulatta	Rhesus monkey
Macaca fascicularis	Crab-eating (Longtailed) macaque
Subfamily Colobinae	
Genus *Trachypithecus*	
Trachypithecus crepusculus	Dusky langur
Trachypithecus margarita	Margarita langur
Trachypithecus germaini	Northern silvered langur
Trachypithecus francoisi	Francois' langur
Trachypithecus poliocephalus	Cat Ba langur
Trachypithecus hatinhensis	Hatinh langur
Trachypithecus ebenus	Black langur
Genus *Pygathrix*	
Pygathrix nemaeus	Red-shanked douc
Pygathrix nigripes	Black-shanked douc
Pygathrix cinerea	Grey-shanked douc
Genus *Rhinopithecus*	
Rhinopithecus avunculus	Tonkin snubnosed monkey
Family Hylobatidae	
Genus *Hylobates*	
Hylobates pileatus [1)]	Pileated gibbon [1)]
Genus *Nomascus*	
Nomascus concolor	Western black gibbon
Nomascus nasutus	Eastern black gibbon
Nomascus leucogenys	Northern white-cheeked gibbon
Nomascus siki	Southern white-cheeked gibbon
Nomascus gabriellae	Buffy-cheeked gibbon

1) Note from the editor: There is no evidence that *Hylobates pileatus* occured in recent time in Vietnam.

A species is the smallest cluster of individual organisms within which there is a parental pattern of ancestry and descent and that is diagnosable distinct from other such clusters by a unique combination of fixed character states.

This concept of what a species is contrasts with the once widely-adopted Biological Species Concept (BSC), in which it is a requirement that different species do not 'actually or potentially' interbreed under natural conditions. There are numerous reasons why the BSC cannot be maintained: one is that 'potentially' is undefined, and probably undefinable, so that there can be no criterion for deciding whether allopatric forms are distinct species or not, and another is that we now understand that distinct sympatric species may interbreed widely and possess another species' mtDNA or Y chromosome DNA! The PSC also contrasts with the more recently proposed Genetic Species Concept (GSC), in which different species have to exhibit a given amount of genetic distance in a specified DNA sequence, usually a mtDNA locus. The reasons why this concept is unsatisfactory include the fact that perfectly distinct sympatric species may differ extremely little genetically, that some populations within a species may have greater genetic distances between them than some distinct species, and that different parts of the genome will show varying amounts of differentiation. The fact that non-recombining parts of the genome – mtDNA and Y chromosome DNA – may 'leak' across species boundaries argues against both BSC and GSC.

The advantages of the Phylogenetic Species Concept are considerable:

- It relies on observable **pattern**, not on the **process** by which the pattern is supposed to have arisen or to be maintained;
- It is **objective**, not dependant on some hypothesis of evolutionary relatedness;
- It is **operational**, not dependant on a subjective assessment of whether "they might interbreed were their ranges to meet";
- It depends on whether the differences are **fixed** (as far as the available evidence indicates), not on the **degree** or **amount** of difference;
- It does not depend on speculation about **mechanisms** of speciation involved - even in the case of species of hybrid origin;
- No assumptions are necessary about the **time elapsed** since speciation was begun or completed;
- We do not need to speculate on the **functional significance** of species differences;
- There is no need to panic if **interbreeding** is detected between species;
- Species are the **units of evolution**: they have "their own unitary evolutionary role and tendencies" (the Evolutionary Species);
- Species are the **terminals** on a **cladogram**: below the species level, genealogy becomes reticulate;
- Species, being consistently defined, are suitable as **units of biogeographical analysis**;
- The species, finally, is suitable as the focus of conservation concern, being more or less equivalent to the **Evolutionary Significant Unit** (ESU).

Two of the primate species in Vietnam are strepsirrhines; 16 are Old World monkeys (5 macaques, 11 langurs); six are gibbons.

Biogeography

Some of Vietnam's primate species are endemic; some of them may extend over the border into Laos, a country whose fauna is less well-known than that of Vietnam; and others may nowadays be confined to Vietnam because they have recently become extinct in adjacent regions of China. What is perfectly true however is that, if we take the region east of the Mekong as a whole (that is to say, all of Vietnam except for the extreme south, all of Laos except for two small areas in the west and southwest, about one third of Cambodia, and a small part of China immediately north of the border), over half of the primate species of that region (and at least two genera, *Pygathrix* and *Nomascus*, and in one perspective a third, *Rhinopithecus*) are endemic, and Vietnam lies at the heart of this region.

An interesting aspect of this situation is that, with the exception of the gibbons at the generic level, and possibly of the *Trachypithecus cristatus* group at the specific level, vicariance is not involved: none of the species or species-groups that are confined to the east of the Mekong has representatives to the west of it. In other words, the primate fauna east of the Mekong is richer and more diverse than that elsewhere in mainland Southeast Asia. The primates are, in fact, unusual in this respect; very few other mammals are represented by 'surplus' species east of the Mekong in the same way as are primates (Meijaard & Groves, 2006).

Within Vietnam itself, there is also a division between the more seasonal northern half of the country and the more tropical southern half. All of Vietnam's nonhuman primates, with the exception of the two species of loris and of one of the macaques, are affected by this division: either vicariant species replace each other in the two zones, or else (as in the case of the limestone langurs) they are restricted to one of the zones and absent from the other.

The reasons for this endemicity were briefly discussed by Groves (2004) and, in more detail, by Meijaard & Groves (2006). In summary, it involves the history of climatic fluctuations in the region and of the Mekong River itself. Studies of geomorphology (such as the filling rate changes of offshore sedimentary basins), and of the relationships of freshwater fish and mollusc faunas, all combine to suggest that the Mekong has moved sporadically eastward throughout the Plio-Pleistocene. In the Pliocene and most of the Pleistocene, the upper Mekong flowed along with the Salween into the Chao Phraya. The present-day middle course of the river was established in the Middle Pleistocene, though the lower Mekong still flowed into the Chao Phraya. Apparently the present lower course, south of Khong Island, was a separate stream until it captured the main river as little as 5,000 years ago.

Rainforest existed in Indochina in most of the Miocene and Pliocene, but was largely replaced by grassland and bush in the Late Pliocene and most of the Pleistocene. The climate was gradually cooling over this period, probably exacerbated by an extraterrestrial impact, centred in the Ubon district of eastern Thailand, about 800,000 years ago. During the Middle and Late Pleistocene, climates fluctuated in phase with the rise and fall of sea levels, but even during cool, dry climatic phases the Truong Son range remained forested throughout, so that it remained a refuge for rainforest taxa even when they disappeared elsewhere - and this is what permitted the distinctive East-of-Mekong primate fauna to differentiate in isolation.

The north/south zonation is explicable in terms of the modern climate. The northern and southern halves of the country contrast in their seasonality and consequent vegetation. Not surprisingly, species have spread as far as their ecological circumstances will allow, or until they are out competed by better adapted congenerics. But this north/south replacement is not a simple two-way affair. In two cases (*Macaca assamensis* and *M. leonina*; *Trachypithecus crepusculus* and *T. germaini/margarita*), congeneric species which are not sister species replace each other only approximately; in a third case (*Macaca mulatta* and *M. fascicularis*), two somewhat more closely related species hybridise extensively where their ranges meet; and in the other two cases (*Pygathrix nemaeus* and *P. nigripes*; *Nomascus leucogenys* and *N. gabriellae*), an arguably intermediate third species exists which, I will suggest, originated as a hybrid between the other two.

Finally, there is a unique habitat which is centred on the northern Vietnam and extends over the borders into northern Laos and southern China: the limestone hills. They are responsible for a wholly endemic species-group of primates, the so-called limestone langurs, as well as a number of endemic rodent genera (*Laonastes, Tonkinomys, Saxatilomys*). It has recently been argued (Li & Rogers, 2005) that limestone hills are not necessarily the preferred habitat for the limestone langurs – at least, in the case of the Southeast Chinese endemic *Trachypithecus leucocephalus* - rather, they are a refuge from human disturbance. It is certainly true that the various species of this group must theoretically be capable of traveling through suitable habitat beyond limestone hills, because each of them is found today in several separate limestone blocs; nonetheless, it is worth noting that the entire group is restricted to the (Northern) region where the limestone blocs occur, and that even in this area *Trachypithecus crepusculus* is found in forest areas away from limestone hills, which the limestone langurs are not.

Loridae

There are two species of loris in Vietnam. The larger of the two, the Bengal slow loris (*Nycticebus bengalensis*), is one of a number of vicariant species into which the *N. coucang* group (sometimes called the greater slow lorises) is nowadays divided; the other species of the group live in the Malay peninsula, western Indonesia and the Tawitawi Islands of the southern Philippines. The Bengal species is much the largest of the group, and also the lightest in colour – white, or nearly so, on the foreparts, with rather poorly marked dorsal stripe and head markings. It is found all across mainland Southeast Asia, north of the Isthmus of Kra, from Bengal East across the Mekong, and north into southern China.

The smaller loris of Vietnam is the pygmy loris (*Nycticebus pygmaeus*). This is one of the species endemic to the region east of the Mekong. It is much smaller than any of the species of the *N. coucang* group, and is distinguished from all of them by various cranial, dental and external features - most characteristically by its large ears. It is reddish or brownish, with a dorsal stripe and dark fork-marks on the head; Streicher (2004) found that the colour changes, and the dark markings fade and reappear, according to season (and see also Groves, 2004). *Nycticebus intermedius*, still believed in by a few biologists, is a synonym of *N. pygmaeus*; *N. pygmaeus* was first described on the basis of a subadult specimen, and the species was so poorly known for the first half-century after its original description that, when the first adult was examined in detail, it was not recognized as being the same species and so described as something new!

How significant it is that the only taxa of the genus *Nycticebus* that exist in sympatry are the one that is largest and lightest coloured and the one that is smallest and darkest coloured? It is possible that we may have here an example of character displacement; after all, *N. pygmaeus* is only found where *N. bengalensis* is also found and could presumably have become more physically distinctive as a result. *N. bengalensis*, however, as a wide distribution west of the Mekong as well as east of it, and of course over most of this wide range it is the only loris, and it is therefore unlikely to have been changed just because of sympatry with *N. pygmaeus*. It may be simply that the two species are so very different that they are the only ones that are capable of existing in sympatry, and they have not affected each other morphologically.

We know little about how the two species differ ecologically, although Gause's Principle predicts that they must.

Cercopithecidae: Cercopithecinae

The five species of cercopithecine monkeys in Vietnam are all macaques. One of them, the stumptailed or bear macaque (*Macaca arctoides*), is found throughout Vietnam without, as far as is known, varying between the northern and southern regions, although no detailed study has been undertaken to verify this. Although it is not endemic to the east-of-Mekong region, it is of special interest as being a species of hybrid origin (Tosi *et al.,* 2000), and so potentially a model for the formation of a few other species in the region.

Among the other four species, there are two north/south pairs. The Assam macaque (*M. assamensis*) occurs in the north, and is replaced by the northern pigtail (*M. leonina*) in the south; but the replacement is not precise (they overlap very widely), and the two species belonging to different species-groups.

The species other north/south pair interbreed where their ranges meet. The rhesus macaque (*M. mulatta*) and the crab-eating or long-tailed macaque (*M. fascicularis*) are members of the same species group, but within it they are not themselves sister species; they nonetheless hybridise where their ranges meet along an approximately East-West line across mainland Southeast Asia, including Vietnam. North from the hybrid zone, rhesus monkeys extend far into China, and west into India and somewhat beyond; south of the zone, crab-eating macaques extend into western Indonesia and Philippines.

But the hybridisation between them is not a simple two-way affair: fewer genes appear to be flowing north than are flowing south, because whereas *M. mulatta* appears to be fairly typical right up to the hybrid zone, *M. fascicularis* shows signs of the presence of *M. mulatta* genes. Mainland

M. fascicularis, compared to those in the Malay peninsula and in islands of Southeast Asia, commonly have relatively short tails, especially towards the hybrid zone; they often possess cheek hair similar to *M. mulatta* (the so-called infrazygomatic crest, rather than the transzygomatic type which tends to be characteristic of the species elsewhere); and a *M. mulatta* Y chromosome has been recorded from a *M. fascicularis* in Vietnam.

Recently, I have put forward a hypothesis to explain this asymmetrical hybridisation (Groves, in press). I proposed that *M. fascicularis* evolved in Sundaland (islands of Southeast Asia) and that the original boundary between it and *M. mulatta* was the Isthmus of Kra, which for most of the Pleistocene was a seaway. When the land-bridge that is now the Isthmus was established, *M. fascicularis* spread north into the tropical rainforest on the mainland, replacing *M. mulatta* (a species better adapted to deciduous forests) and interbreeding with it along a moving frontier. The various *M. mulatta*-like features of mainland *M. fascicularis* are a legacy of this. On the other hand, as *M. mulatta* is the larger species, the males are likely to be dominant over males of *M. fascicularis*, so that the hybridisation would be mostly male rhesus with female crab-eaters.

Cercopithecidae: Colobinae

There are three genera of colobine monkeys in Vietnam: *Rhinopithecus* (snub-nosed monkeys, a more typically Chinese group), *Pygathrix* (the Douc langurs, a prime example of a genus endemic to the East-of-Mekong region) and *Trachypithecus* (more typical langurs, the genus being widespread throughout mainland and islands of Southeast Asia).

The Vietnamese species of snub-nosed monkeys is the Tonkin snubnosed monkey *Rhinopithecus avunculus* (Fig. 1). This is arguably the most important primate in the whole of Vietnam. This is because, while it is not alone in being endemic to Vietnam, it is a more thoroughly distinct species than any other Vietnamese primate, occupying an isolated position within its genus both morphologically (its long slender fingers and toes, its bizarre facial appearance) and ecologically (the only subtropical snub-nosed monkey); it numbers little more than 100 and is still declining because of hunting pressure despite ostensibly being protected by political decree (Government of Vietnam, 2006). While at least one other endemic Vietnamese species, *Trachypithecus poliocephalus*, is even more critically endangered in terms of absolute numbers, it has at least registered a slight increase in numbers over the past 2-3 years, and one might argue that the limestone langurs form a more close-knit group than do the snub-nosed langurs, and within them *T. poliocephalus* itself may be conspecific with a slightly more numerous Chinese taxon, the white-headed langur, *T. (cf. poliocephalus) leucocephalus*. Without wishing to be invidious in regard to which species is more critically endangered than any other, I would like to highlight the plight of the Tonkin snub-nosed monkey as of supreme national and global importance, and to emphasize that it will be an international scandal should it become extinct.

The east-of-Mekong endemic genus, *Pygathrix*, known as douc langurs, has a limited distribution in the southern and central parts of the region. The red-shanked douc, *Pygathrix nemaeus*, was the very first Vietnamese primate to be made known scientifically. It was described, as 'le douc', by Buffon (1766); on the basis of Buffon's description it was given the scientific name *Simia nemaeus* by Carl Linnaeus, the founder of the modern system of biological taxonomy and nomenclature (Linnaeus, 1771), and later the species was placed in a special genus, *Pygathrix*, by Étienne Geoffroy St-Hilaire in a paper which may be said to mark the foundation of modern primate taxonomy. The specimen described by Buffon (1766), hence the type specimen of the species, still exists in the Muséum National d'Histoire Naturelle, Paris; its red shanks, although much altered in the original tone over the past 250 years, can be discerned (Fig. 2), even though Buffon did not actually mentioned them in his description. There is no doubt, therefore, that the name *Pygathrix nemaeus* is correctly applied to the northerly representative of the genus, the red-shanked douc, despite Buffon having given the place of origin as 'Cochin-China'.

The distributions of the three species are given by Nadler *et al.* (2003). Essentially, the red-shanked douc (*Pygathrix nemaeus*) occurs from about 19°N south to nearly 13°N along the Lao border, but only as far as 14°33'N further seaward. The black-shanked douc (*Pygathrix nigripes*) occurs from 14°33'N as far south as Ho Chi Minh City; it overlaps with the red-shanked species in

Fig. 1. The type skin of Tonkin snubnosed monkey (*Rhinopithecus avunculus Dollman, 1912*). Photo: Colin P. Goves

Fig. 2. 'Le douc' described by Buffon & Daubenton in 1766, hence the type specimen of *Simia nemaeus* Linnaeus, 1771 (now *Pygathrix nemaeus*). Photo: Colin P. Groves

Kon Ka Kinh National Park[1], and hybrids are known. The grey-shanked douc (*Pygathrix cinerea*) has a very small range between the two, and overlapping with both; it occurs from 15°25'N (and possibly still further north) to about 14°25'N. Since its distribution is more or less confined to the overlap zone between the other two species, the question arises whether it might not be a stabilized hybrid between them. At least one species of hybrid origin is already known in primates, *Macaca arctoides* (see above). Roos (2004) found the mtDNA of *P. cinerea* to be closer to that of *P. nemaeus*, so that if it is indeed of hybrid origin it is likely to be ♀ *nemaeus* x ♂ *nigripes*, a proposition which could be tested by sampling Y chromosome DNA. As the mtDNA of *P. cinerea* and *P. nemaeus* are not identical, the presumptive hybridisation event is of some antiquity, and indeed the species is by now apparently perfectly homogeneous.

The third genus of colobine in Vietnam is *Trachypithecus*. A recent revision of the tropically distributed *T. cristatus* group (Nadler *et al.,* 2005) identified two separate species in the Indochinese region, *T. germaini* and *T. margarita*, which had not been distinguished by Groves (2001). They suggested that the boundary between these two might be the Mekong River, but as noted above the Mekong does not usually separate sister species, and, especially considering that the two have traditionally not been distinguished, caution must be expressed, and field surveys are desirable. One of these two species, presumably *T. margarita*, is found as far north as 16°37'N. a species belonging to a different species group, the dusky langur (*Trachypithecus crepusculus*), is found from about 18°N, north across the Chinese border. No lowland forest langur is known between the ranges of these two last species.

There is no doubt that the species group of *Trachypithecus* that is of most interest and concern here is the group known as limestone langurs: of most interest, because they are endemic to the East-of-Mekong region; of most concern, because every one of the species of the group is "Endangered" or (mostly) "Critically Endangered". They are glossy black animals, with a crest of hair on the scalp; a curved tract of elongated hair from mouth to ear, resembling a handlebar moustache; and (in all but one species) areas of white or yellowish on the head and, often, on the rump and/or tail. As in all species of *Trachypithecus*, the unweaned infants are a golden orange colour.

1) Note from the editor: S. page 55-60: Ha Thang Long: Distribution of grey-shanked douc in Gia Lai Province.

Fig. 3. White-headed langur (*Trachypithecus leucocephalus*) in Fusui Nature Reserve, Guangxi Province, China. Photo: Tilo Nadler.

Fig. 4. Cat Ba langur (*Trachypithecus poliocephalus*) on Cat Ba Island, Vietnam. Photo: Stefan Kobold.

There are seven species, one of them rather controversial but I will treat it as a species in order to focus attention upon it until such time as it may be shown to be merely a colour morph. The species are as follows:

T. francoisi. The northernmost representative of the group; it occurs in suitable country north of the Red River, extending as far north as about 29°N in Guizhou Province, China. It is black, except for the handlebar moustache which is white as far as the upper edge of the ear.

T. hatinhensis. The southernmost representative of the group, found from about 19°40'N south to about 16°N in Vietnam; it probably extends over the border into Laos. Superficially looks very similar to *T. francoisi*, but the white tract extends behind the ear, approaching the midline of the nape sometimes very closely.

T. poliocephalus. Restricted to Cat Ba, the largest island in Ha Long Bay. The head is creamy white or golden yellow, this colour extending down the neck to the shoulders; the tips of the crest hairs remain black. There are yellow-brown hairs on the feet, and grey hairs on the sacral region and, generally, the thigh-backs.

T. leucocephalus. Not known from Vietnam; known from a small range in Guangxi Province in China; it hybridizes with *T. francoisi* where their ranges meet. The head is white (not creamy or yellow), and this colour extends further onto the chest and shoulders than in *T. poliocephalus*; the feet and sacral region have white hairs, and the tail is terminally white, this colour extending to as much as three-quarters of the tail length in some individuals. Differences between this species and *T. poliocephalus*, which it very much resembles, can be seen in Fig. 3 and 4.

T. laotum. This species is not known from Vietnam, but only from a small region of Laos, about 17°50'-18°30'N (Duckworth *et al.,* 1999). The head is white except for the black crest and a black strip down the nape from the crest to the shoulders (Fig. 5 and 6).

T. delacouri. From south of the Red River, to only about 20°N, and known only from Vietnam. This species and *T. poliocephalus* are therefore the only members of the group that are strictly Vietnamese endemics. It is the most distinctive in appearance of the group, with white hindparts and thighs, and long grey cheek whiskers; the tail is curiously bushy.

Fig. 5. The type specimen of Laos langur (*Pithecus laotum* Thomas, 1921 - now *Trachypithecus laotum*). Photo: Colin P. Groves.

Fig. 6. Laos langur (*Trachypithecus laotum*) at the Endangered Primate Rescue Center, Vietnam. Photo: Tilo Nadler.

T. ebenus. Known from the Nui Giang Man proposed nature reserve in Quang Binh Province, Vietnam (Le Khac Quyet, 2004), extending westward apparently as far as the Mekong in Laos (Duckworth *et al.,* 1999). It is completely black, with just faint yellow tipped hairs on cheeks, chin and upper lip, and around palms and soles, and whitish hairs at front of ear. The very existence of this species is controversial; it is said to form homogeneous troops in its Vietnam range, but it is unclear whether it does so in Laos, or whether it behaves as merely a polymorphic variant of *T. laotum* or perhaps *T. hatinhensis*.

The relationships of these species, according to the evidence of cytochrome b sequences (Roos 2004), are as follows: [((*francoisi* (*poliocephalus*, *leucocephalus*)) ((*delacouri* (*laotum, hatinhensis+ebenus*))].

They divide, therefore, into a northern and a southern group, with the Red River as the boundary; the superficially similar *T. francoisi* and *hatinhensis* belong to different groups. The sequences for the two available specimens of *T. ebenus* were intermingled among those of *T. hatinhensis*; Roos (2004) interpreted this to mean that the all-black *T. ebenus* is simply a colour morph of the latter, but, as discussed above, past or even continuing hybridisation events between the two could be an alternative explanation. The genetic distances between *T. poliocephalus* and *leucocephalus*, and between *T. laotum* and *hatinhensis*, were low, and Roos (2004), basing himself implicitly on the GSC, proposed to unite the first two as subspecies of *T. poliocephalus* and the second two as subspecies of *T. laotum*. Again, as discussed above, application of the PSC requires that all of them be maintained as distinct species, the differences between them being, as far as the evidence goes, fully consistent; this applies not only to external morphology, but apparently to the cytochrome b sequences themselves, which have quartet puzzling support values of 93% (*T. hatinhensis* from the single specimen of *T. laotum*) and 97% and 99% (*T. leucocephalus* and *T. poliocephalus* respectively).

Because these species are so poorly studied, I collected together all the measurements I could find (mainly from Brandon Jones, 1995), and here present graphs of them. External measurements must always be used with some caution, as different collectors may have used slightly different techniques, but there is a certain consistency about the measurements for each taxon in this sample, regardless of who took the measurements.

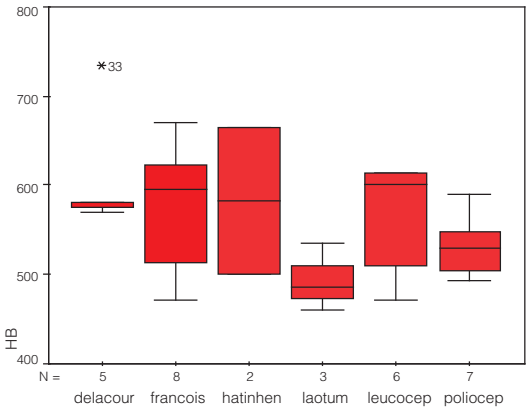

Fig. 7. Head and body length in limestone langurs.

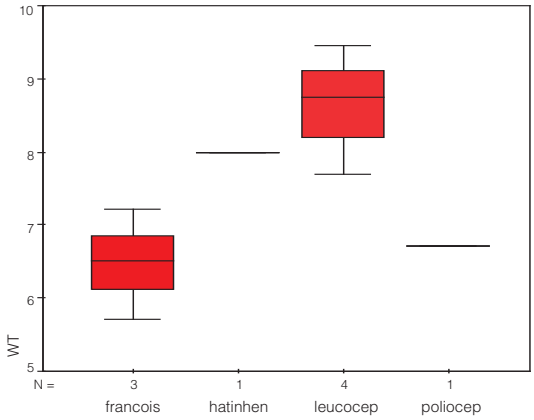

Fig. 8. Weight in limestone langurs.

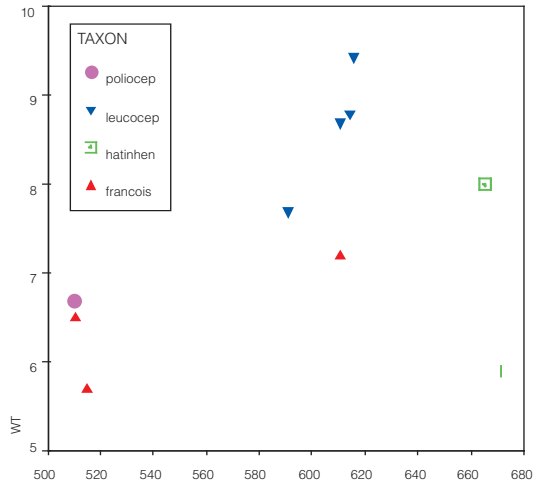

Fig. 9. Weight compared to head and body length in limestone langurs.

As far as linear size is concerned (head and body length), *T. laotum* seems to be somewhat smaller than the others; *T. delacouri* appears strikingly homogeneous, whereas the two available specimens of *T. hatinhensis* are strikingly different in size (Fig. 7). In linear size, *T. leucocephalus* is much the same as *T. francoisi*, whereas its weight is much greater (Fig. 8). When weight is graphed against head and body length, the apparently heavier build of *T. leucocephalus* is very clear; a single specimen of *T. poliocephalus* is relatively heavy (for its rather small size) like *T. leucocephalus*, whereas a single specimen of *T. hatinhensis* is lightly built for its linear dimensions like *T. francoisi* (Fig. 9).

T. leucocephalus and *hatinhensis* would seem to be relatively smaller-eared than other species according to these data; *T. laotum* and *delacouri* apparently have rather large ears (Fig. 10). Relative tail length (Fig. 11) shows less consistent differences; *T. laotum* has a long tail, *T. leucocephalus* averages shorter-tailed than *T. poliocephalus*, *T. delacouri* is fairly short-tailed, but plots for *T. francoisi* and *hatinhensis* are inconsistent.

Putting all these together into a Discriminant Analysis (Fig. 12) gives good separation between the closely related *T. poliocephalus* and *leucocephalus*, and separates *T. laotum* from all the others. There is clearly a need for longer series of measurements, taken by a single person, to test these provisional results.

From photographs, and from my personal observations of living animals and museum skins, it is clear that there are consistent differences among the species in the form of the crest on the crown. The crest of *T. delacouri* is distinctively high and thin, very upright anteriorly, but sloping forward posteriorly; in this species, the ears noticeably stand out from the head. The crest of *T. francoisi* is thicker, but still well-defined, and stands upright both anteriorly and posteriorly; the ears are adpressed to the head. *T. hatinhensis* is very different from *T. francoisi*: the crest is low, scruffy in appearance and relatively poorly defined both anteriorly and laterally, but it is upright posteriorly; the ears are very adpressed, flat against the temples; those of *T. ebenus*, *laotum* and *leucocephalus* most closely resemble this shape from the front, but like *T. francoisi* they are upright anteriorly instead of sloping backward. The crest of *T. poliocephalus* is distinctively low, wide and conical.

There also differences in the way each species tends to hold its tail (Nadler & Ha Thang Long, 2000). Other features, such as gait and sitting postures, remain to be studied.

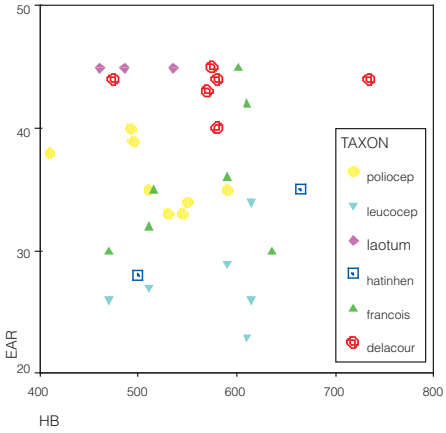

Fig. 10. Relative ear size in limestone langurs.

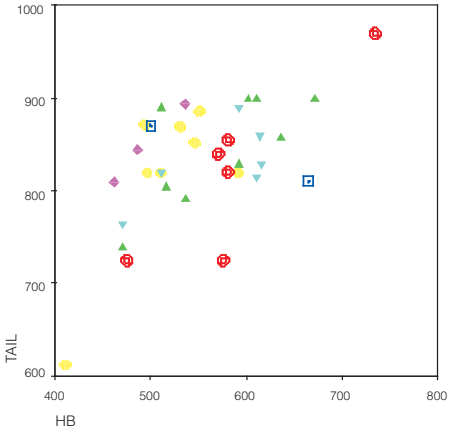

Fig. 11. Relative tail length in limestone langurs.

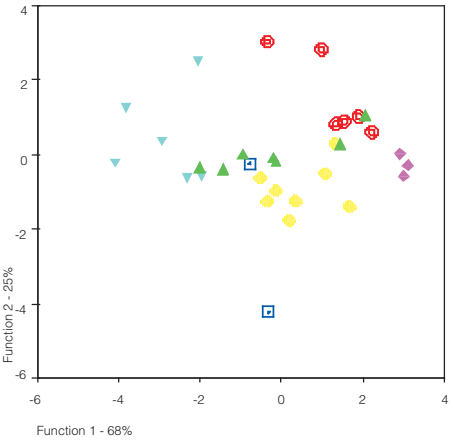

Fig. 12. Discrimant analysis of external measurements in limestone langurs.

Hylobatidae

Gibbons, the long-armed 'lesser apes' of Southeast Asia, are noted for their social monogamy, unusual among catarrhines. Among their conspicuous vocalisations is a morning duet, the Great Call, in which the female's contribution is, in three out of four genera of the family, much more striking and conspicuous than the male's. The exception to this is the genus *Nomascus*, which is endemic to the region east of the Mekong.

It is probable that, in the past, *Hylobates pileatus* occurred in Vietnamese territory to the west of the Mekong Delta; but east of the Mekong only the genus *Nomascus* occurs. It is interesting that three of the four genera of gibbons are strictly allopatric: *Nomascus* occurs east of the Mekong (except for a small population of *N. concolor* in Yunnan, perhaps cut off west of the Mekong by a meander); *Hoolock* occurs west of the Salween; *Hylobates* occurs between these two rivers, and extends further south into Sundaland. The fourth genus, *Symphalangus* (the siamang), is sympatric with *Hylobates* in the Malay peninsula and Sumatra; it is much larger than other gibbons, and presumably it is this size difference that enables this coexistence (as in the case of the lorises, above).

In *Nomascus* (as in fact is the case in *Hoolock* as well), the unweaned infant is buff, and juveniles of both sexes are black, with such facial adornment as may occur in a given species; at sexual maturity, the female turns buffy, with just a black streak on the crown and nape, whereas the male remains coloured like the juveniles. A troop of *Nomascus*, therefore, may include several black individuals, among them two or three juveniles of either sex as well as the adult male, but will have only a single buff coloured individual (the adult female). An exception to this may be the three northernmost species, the ones in which the black phase has no whitish areas on the face. The existence of polygynous troops has from time to time been claimed for *Nomascus concolor*; recently it was confirmed that the two remaining troops of *Nomascus hainanus* both contain two buff-coloured females, despite the additional presence of two solitary males (Zhou *et al.,* 2005), and of five troops of *Nomascus nasutus* recorded by La Quang Trung & Trinh Dinh Hoang (2004) three had two buff-coloured females. (At least two troops in the latter sample were listed as having two adult males, but it might be hard to distinguish a fully mature male from a subadult).

In *Nomascus*, there are three species in which the black phase is without any white or whitish

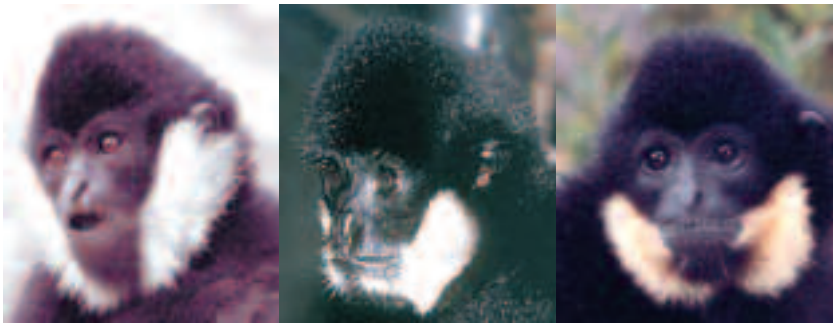

Fig. 13. Left to right: *Nomascus leucogenys*, *N. siki*, *N. gabriellae*. Photos: Colin P. Groves.

facial adornment, and three (or at least three?) in which black individuals have white or whitish patches on the cheeks. The six species are as follows:

Nomascus concolor. Found between the Red and Black Rivers, from Vietnam northwest into Yunnan; and there is an isolated population in Laos, on the Mekong at about 20°N. Black individuals (adult males and juveniles of both sexes) are completely black and adult females have a large black patch on the chest and belly; the pelage is full and plush. Several subspecies, of uncertain validity, have been described; the isolated population in Laos, *N.c.lu*, in particular, needs further investigation.

Nomascus nasutus. Found north of the Red River, in Cao Bang Province, where they were recently rediscovered by La Quang Trung & Trinh Dinh Hoang (2004). In the black phase, there is a characteristic brown zone on the chest; to judge by descriptions of skins by Dao Van Tien (1984), the adult female lacks black on the chest.

Nomascus hainanus. Restricted to Hainan. Externally, this species would seem to be distinguished from *N. nasutus* by its short, thin pelage.

Nomascus leucogenys. Found southwest of the Black River (except where *N. concolor lu* is found), south to about 19°N in both Vietnam and Laos. In the black phase, there is a conspicuous white streak on the cheeks, running in a thick straight line from the level of the eye to the corner of the chin; in the adult female, there is a thin white edging round the face, and there is no black on the ventral surface. The pelage is full and plush. This species has evidently, in comparatively recent times, extended its range northwest, replacing *N. concolor* which has been reduced to a larger area on the left bank of the Black River and a tiny area in far western Laos.

Nomascus siki. The distribution of this species begins, or began, immediately south of that of *N. leucogenys*, and extends an unknown distance to the south. The black phase also has white cheek whiskers, but these do not form a long straight line, but surround the corners of the mouth in a wide bushy arc; the adult female seems to be indistinguishable from *N. leucogenys*. This gibbon is currently referred to as *Nomascus leucogenys* siki by Geissmann *et al.* (2000), Roos (2004) and Konrad & Geissmann (2006), but clearly it is consistently different from the more northerly *leucogenys*, and indeed (see below) it would appear to be its relationship to *N. gabriellae* which needs attention. Black-phase examples of these three pale-cheeked species are in Fig. 13.

Nomascus gabriellae. This species is certainly found south of about 13°N, and extends in more or less to the Mekong Delta. The black phase resembles *N. siki*, except that the white of the cheeks is replaced by buffy, occasionally red-tinged, and does not extend so far along below the mouth but extends further down the sides of the chin, and also there is some brown on the chest; the adult female lacks the white facial edging.

According to Geissmann *et al.* (2000), all of these species can readily be distinguished by their different vocalizations. *N. concolor*, *leucogenys*, *siki* and *gabriellae* have slightly different karyotypes, although not enough specimens have been studied to verify that the differences are consistent. The baculum also differs between different species.

According to Roos (2004), the phylogeny (*N. hainanus* was not studied) is: [(*nasutus* (*concolor* (*leucogenys*, *gabriellae*)].

Fig. 14. "Patzi" as juvenile. Photo: Tierpark Berlin.

Fig. 15. "Patzi" as adult about 1980.

For his phylogenetic study, Roos (2004) also included five individuals of *N. siki*. Two of these clustered with *N. gabriellae*, forming a separate subclade from the three individuals of the latter, and the other three clustered with *N. leucogenys*, two of these forming a separate subclade and the other clustering with the six *leucogenys* individuals. On the face of it, this might suggest that *siki* is a species of hybrid origin, which has not yet achieved full reciprocal monophyly with respect to its parent species in some characters. But the situation seems to be more complicated than that.

Geissmann *et al.* (2000) found a complex mosaic of character states between *N. siki* and *N. gabriellae*. Males resembling *siki may have gabriellae*-like features in vocalizations; wild-caught individuals resembling *gabriellae* in appearance and in song, may have *siki* karyotypes or hybrid karyotypes. Of interest, three captive-bred hybrids resembled *gabriellae* but the songs were intermediate, and the two males lacked brown on chest. The type specimen of *siki* is from Thua Luu, south of Hue, and close to Bach Ma National Park (16°13'N), but a second museum specimen from that locality is *gabriellae*; on the other hand, a museum specimen from southern Laos - well to the south of the latitude of Bach Ma - is intermediate between the two. Putting all this together with their observations that the large area in northern Cambodia, southern Laos and central Vietnam has gibbons of indeterminate or intermediate traits, they proposed three hypotheses to explain the odd situation in this large intervening area: (1) it is inhabited by an undescribed taxon, or (2) it is a wide intergrade area between *gabriellae* and *siki*, or (3) a combination of the two.

The vocalizations of *N. gabriellae* and *siki* have been further explored by Konrad & Geissmann (2006). Typical *N. gabriellae* songs were recorded in Samling logging concession, at about 12°20'N, and sightings were of individuals typical of that species. Yet, in northeastern Cambodia at about 14°N, apparent *N. gabriellae* were making vocalizations much more like those recorded at Bach Ma, virtually the type locality of *N. siki*, as noted above. Vocalisations at the three northeastern Cambodian sites were not precisely identical to each other or to those at Bach Ma, nor in fact were they identical to those of captive gibbons identified phenotypically as *N. siki*, but they were very unlike those of *N. gabriellae*.

Konrad & Geissmann (2006) consider these new findings in the light of the three hypotheses of Geissmann *et al.* (2000), and argue that they support the first hypothesis - that the area is inhabited by an undescribed taxon, and that the two different clusters formed by *N. siki* in Roos's (2004) phylogeny 'may be geographically separated taxa'. Alternatively, one notes that, as far as external appearance is concerned, the dividing line between the *gabriellae* and *siki* phenotypes may slant southwest from Bach Ma to southernmost Laos, and if future research on vocalizations proves to substantiate this, the hybrid zone hypothesis may not be ruled out after all. Whether indeed *Nomascus siki* is itself a species of hybrid origin, as proposed by both Groves (2004) and Roos (2004), would still be interesting to investigate.

There remains a final conundrum. "Patzi", a female gibbon that lived in Tierpark Berlin from 1952 (at an estimated age of 1 year or slightly more) until 1986, was unlike any other known individual, particularly in her extensively blackened underside, connected to an extraordinarily wide and long crown streak (in fact, covering almost the entire width of crown, and extending backward onto the shoulders) by a narrow black circumfacial ring (Fig. 15). All that is known of her is summarized extensively by Geissmann (1989). When young, she was of course black, but I cannot find whether

she had a brown zone on the chest or not (Fig. 14). She was reputed to have been captured in the hinterland of Hon Gai, just northeast of the Red River delta on Halong Bay; there would seem to be no plausible barrier between this locality and the area further northeast where *Nomascus nasutus* still exists, yet she is entirely unlike the females of that population as described by Dao Van Tien (1984). According to Geissmann, her vocalizations were very like those of the surviving northeastern gibbons. A possibility might be that she was a hybrid between *N. nasutus* and *N. concolor*; it seems hardly possible that she was an extreme variant of *N. nasutus*, nor that she could have represented yet another (extinct) species. Two photos of her, in adult and in juvenile phase, are given in Fig. 14.

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Molecular systematics of Indochinese primates

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Key words: *Nycticebus*, *Macaca*, *Trachypithecus*, *Pygathrix*, *Rhinopithecus*, *Nomascus*, mtDNA, Y chromosome, phylogeny, systematics

Summary

The systematics of primates distributed in the Indochinese bioregion is still controversial. Based on molecular data, we established a solid platform for the classification of all the Indochinese primate taxa.

Accordingly, among strepsirrhines, two slow loris species (*N. pygmaeus* and *N. bengalensis*) occur in Indochina. The only cercopithecines distributed in Asia are members of the genus *Macaca*. Among them, five species occur in Indochina (*M. arctoides*, *M. assamensis*, *M. fascicularis*, *M. mulatta* and *M. leonina*). The distinct species status for all of them is confirmed and two subspecies are provisionally recognised for *M. fascicularis*.

The colobines of Indochina are divided into the three genera *Pygathrix*, *Rhinopithecus* and *Trachypithecus*. The douc langurs (*Pygathrix*) are represented by the three monotypic species *P. cinerea*, *P. nemaeus* and *P. nigripes*. Within the snub-nosed monkeys (genus *Rhinopithecus*), the distinct species status for the four recognised species (*R. avunculus*, *R. bieti*, *R. brelichi*, *R. roxellana*) is confirmed, but further investigations are necessary to elucidate the taxonomic position of the three described *R. roxellana* subspecies. In Indochina, the genus *Trachypithecus* is represented by three species groups [*T. obscurus*], [*T. cristatus*] and [*T. francoisi*]. Based on the molecular data, the only Indochinese representative of the [*T. obscurus*] group, *T. crepusculus*, is mitochondrially more closely related to the [*T. francoisi*] group. However, in the Y-chromosomal data set, the taxon forms a clade together with the other [*T. obscurus*] group members, indicating that the species is the result of ancestral hybridisation between the two species groups. The [*T. cristatus*] group in Indochina is represented by the two species *T. margarita* and *T. germaini*, most likely separated from each other by the Mekong River. Within the [*T. francoisi*] group, the four taxa *T. delacouri*, *T. francoisi*, *T. poliocephalus* and *T. laotum* should be recognised as distinct species, with *leucocephalus* and *hatinhensis* being subspecies of *T. poliocephalus* and *T. laotum*, respectively.

For the crested gibbons (genus *Nomascus*), we propose that *N. hainanus*, *N. nasutus*, *N. concolor*, *N. leucogenys* and *N. gabriellae* be recognized as distinct species. The subspecies of *N. concolor* are downgraded as synonyms of the nominate form, and *N. siki* is provisionally classified as subspecies of *N. leucogenys*, although further research is needed on this question.

Hệ thống phân loại học phân tử các loài linh trưởng Đông dương

Tóm tắt

Hệ thống phân loại học các loài linh trưởng phân bố ở Đông dương vẫn còn là vấn đề đang được tranh luận. Trên cơ sở nghiên cứu cấu trúc phân tử, chúng tôi đã thiết lập một nền tảng vững chắc để phân loại toàn bộ các loài linh trưởng ở Đông dương. Đầu tiên là phân bộ tiền linh trưởng, ở Đông dương có hai loài culi gồm (*N. pygmaeus* và *N. bengalensis*). Tiếp đó là giống Macaca thuộc họ

Cercopithecines phân bố ở Châu Á. Giống này có năm loài được tìm thấy ở Đông dương (*M. arctoides*, *M. assamensis*, *M. fascicularis*, *M. mulatta* và *M. leonina*). Cả năm loài này được xác định là các loài riêng biệt. Riêng loài *M. fascicularis* có hai phân loài được tạm thời xác nhận.

Khỉ ăn lá ở Đông dương có ba giống *Pygathrix*, *Rhinopithecus* và *Trachypithecus*. Giống voọc chà vá (*Pygathrix*) đại diện bởi ba loài riêng biệt *P. cinerea*, *P. nemaeus* và *P. nigripes*. Giống voọc mũi hếch (*Rhinopithecus*), có bốn loài riêng biệt gồm (*R. avunculus*, *R. bieti*, *R. brelichi*, và *R. roxellana*). Riêng với loài *R. roxellana* cần có thêm những nghiên cứu để giải thích vị trí phân loại của ba phân loài thuộc loài này. Giống *Trachypithecus* được biết đến với ba nhóm loài gồm [*T. obscurus*], [*T. cristatus*] và [*T. francoisi*]. Nghiên cứu cho thấy, nhóm loài [*T. obscurus*] chỉ có một đại diện là loài *T. crepusculus* có yếu tố di truyền ty thể quan hệ gần với nhóm loài [*T. francoisi*]. Tuy nhiên, số liệu về yếu tố di truyền trong nhân của nhiễm sắc thể Y lại chỉ ra rằng loài này là con lai của hai nhóm loài trên. Đối với nhóm loài [*T. cristatus*] có hai loài *T. margarita* và *T. germaini* phân bố biệt lập bên hai bờ sông Mekong. Nhóm loài [*T. francoisi*], có bốn loài phân biệt gồm *T. delacouri*, *T. francoisi*, *T. poliocephalus*, và *T. laotum*. Loài *poliocephalus* có phân loài là *leucocephalus* và loài *T. laotum* có phân loài là *T. hatinhensis*.

Đối với vượn (giống *Nomascus*), chúng tôi đề xuất việc thừa nhận các loài *N. hainanus*, *N. nasutus*, *N. concolor*, *N. leucogenys* và *N. gabriellae*. Phân loài của *N. concolor* không nên công nhận, và *N. siki* tạm thời xác định là phân loài của *N. leucogenys*. Tuy nhiên những nghiên cứu tiếp theo trên hai đối tượng này là cần thiết.

Introduction

The Indochinese bioregion harbours a large number of endemic animal and plant species and is well known for its different primate species including slow lorises, macaques, doucs, snub-nosed monkeys, leaf monkeys and gibbons. However, the Indochina ecosystem and its inhabitants are endangered because of the negative impacts of poaching, logging, and habitat destruction. Especially for primates, hunting for traditional medicine and food as well as habitat loss significantly lowered the populations over the last decades, so that today five species of the region are included in the 25 most endangered primate species of the world (Mittermeier *et al*., 2006). One of the major issues facing those working on the conservation of Indochinese primates is the taxonomy of these creatures which continues to be debated. Several classification schemes based on morphology, fur colouration or genetics are at hand (e.g. Brandon-Jones *et al*., 2004; Groves, 2001; Roos, 2004), but currently no consensus exists. A clear definition of how many taxa exist and knowledge about their exact distribution however is urgently required to establish efficient conservation action plans.

To elucidate the phylogenetic relationships among Indochinese primates and their systematic classification, samples of a large number of all Indochinese primates and their relatives in other countries were collected. From these samples, we sequenced a fragment or the complete coding region of the mitochondrial cytochrome b gene for a number of lorises (*Nycticebus*), colobines (*Trachypithecus*, *Rhinopithecus*, *Pygathrix*) and gibbons (*Nomascus*). For macaques (*Macaca*), a region spanning the mitochondrial 12S-16S rRNA was selected. From some representatives, also nuclear DNA, e.g. Y-chromosomal loci, were analysed. Based on pair-wise genetic differences between and among taxa, we established a solid platform for the systematic classification of the primates distributed in the Indochinese bioregion. Moreover, we reconstructed phylogenetic trees, allowing detailed insights into the evolutionary and phylogeographic history of these species.

Materials and Methods

Hair, blood, fresh, dried or smoked tissue, museum skins and fecal samples were collected in primate keeping facilities, museums or during field surveys. Samples were stored until further processing in plastic or paper bags (hair, dried or smoked skin), or in 80% ethanol (all other sample types). DNA from the samples was extracted using methods as outlined in Sambrook *et al*. (1989), Walsh *et al*. (1991), or by applying the Qiagen DNA Mini Kit or Qiagen DNA Stool Mini Kit. Depending on genera, a fragment or the complete mitochondrial cytochrome b gene or a region spanning the 12S-16S rRNA was amplified via PCR using methods and oligonucleotide primers as described earlier (Geissmann *et al*., 2004; Nadler *et al*., 2005; Roos 2003, 2004; Roos & Nadler,

2001; Roos *et al.*, 2001, 2003, 2004; Tosi *et al.*, 2002; Ziegler *et al.*, 2007). From some representatives, also nuclear DNA, e.g. Y-chromosomal or autosomal loci, were analysed. The resulting PCR products were separated on 1% agarose gels, subsequently excised and the DNA extracted using the Qiagen Gel Extraction Kit. Direct sequencing reactions were performed with the BigDye Terminator Cycle Sequencing Kit following the manufacturer's recommendations. Sequence determination was performed on an automated ABI377 gel or an ABI3100-Avant capillary sequencer. Further details about laboratory procedures are available upon request.

To expand the different data sets (mainly those for macaques), further sequences deposited at GenBank were included. Sequences were checked for their potential to be correctly transcribed to exclude pseudogene contaminations of the data sets. Sequence alignments were carried out with ClustalW (Thompson *et al.*, 1994) and subsequently checked by eye. In the 12S-16S rDNA alignment, several indels were detected, which were removed with the Gblocks software (Castresana, 2000). Pairwise genetic differences were calculated with PAUP 4.0b10 (Swofford, 2002). Phylogenetic tree reconstructions were carried out using the maximum-parsimony (MP), and neighbor-joining algorithms (NJ) as implemented in PAUP. Maximum-likelihood (ML) analyses were performed with TREEPUZZLE 5.0 (Strimmer & von Haeseler, 1996). For MP analyses, all characters were treated as unordered and equally weighted throughout. A heuristic search was performed with the maximum number of trees set to 100. For NJ and ML reconstructions, different models of sequence evolution as well as the best-fitting model, estimated by MODELTEST 3.06 (Posada & Crandall, 1998), were applied. Support of internal branches was either determined by bootstrap analyses (MP and NJ) on the basis of 1,000 replications or indicated by the ML quartet puzzling support values (10,000 puzzling steps).

Results and Discussion

Lorises (*Nycticebus*)

The complete (1,140 bp) mitochondrial cytochrome b gene was sequenced for 40 slow loris individuals as well as from one slender loris (*Loris tardigradus*), which was used as outgroup for phylogenetic tree reconstructions. Among the 40 slow lorises studied, 27 different haplotypes were detected. Based on pairwise difference analyses, the genus can be divided into four major groups (*N. pygmaeus*, *N. bengalensis*, *N. coucang* and *N. menagensis*), which differ in 4.3-12.8% from each other (Table 1). Largest differences were detected between *N. pygmaeus* and the remaining groups (11.1-12.8%), whereas smallest differences between major groups can be found between *N. menagensis* and *N. bengalensis* (4.3-4.9%). Variations within the four major groups are comparatively low and do not exceed 2.0%. The pairwise differences between the type specimen of *N. intermedius* and *N. pygmaeus* individuals fall within this range (data not shown).

Table 1. Pairwise differences (in %) within and between *Nycticebus* taxa

	1	2	3	4
(1) *N. pygmaeus*	0.2-1.7			
(2) *N. bengalensis*	11.4-12.2	0.1-2.0		
(3) *N. coucan*g	12.2-12.8	7.2-8.0	0.3-0.4	
(4) *N. menagensis*	11.1-11.5	4.3-4.9	7.9-8.5	0.4-0.9

The phylogenetic relationships obtained from the data set are completely resolved and the branching patterns are significantly supported (Fig. 1), so that the depicted relationships most likely represent the real evolutionary relationships of the genus *Nycticebus*, although samples of *N. javanicus* are necessary to definitively explain the complete evolutionary history of the genus. According to the data, *N. pygmaeus* was the first to split off, followed by *N. coucang*, whereas *N. menagensis* and *N. bengalensis* were the last to diverge. The type specimen of *N. intermedius* forms a clade together with the *N. pygmaeus* representatives.

Based on the data, it is justified to recognise at least four distinct species (*N. pygmaeus*, *N. coucang*,

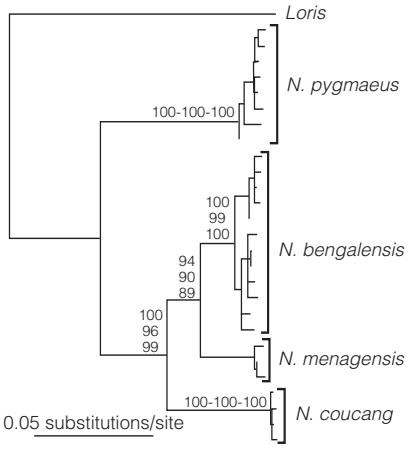

Fig. 1. Phylogenetic relationships among slow loris (*Nycticebus*) haplotypes as obtained from complete mitochondrial cytochrome b sequence data. Branch lengths are based on the NJ tree with numbers on branches indicating internal support (first: ML, second: NJ, third: MP).

N. menagensis and *N. bengalensis*) within the genus with two of them, *N. pygmaeus* and *N. bengalensis*, distributed in the Indochinese bioregion. *N. intermedius* should be regarded as synonym of *N. pygmaeus*. This opinion is supported by recent observations of seasonal weight and colour changes in pygmy lorises (Streicher, 2004).

Macaques (*Macaca*)

A 1,506 bp long fragment of the mitochondrial genome spanning the 3' end of the 12S rDNA, tRNA-Val and the 5' end of the 16S rDNA was analysed for one representative of all currently known macaque species with the exception of the recently described *M. munzala*. *Papio hamadryas* was used as the outgroup. Indels in the data set were removed, so that the final alignment comprises 1,467 bp. Variation between macaque species ranges from 0.6-7.6% (Table 2). Largest differences with at least 3.7% were detected between the four species groups [*M. sylvanus*], [*M. silenus*], [*M. sinica*] and [*M. fascicularis*] (including *M. arctoides*), which are comparable with those observed within the [*M. silenus*] group between the Sulawesi macaques and the remaining members of the species group (3.7-5.9%). Within the [*M. silenus*] group (excluding the Sulawesi macaques), five major lineages were detected, which differ in 1.6-3.1%, with the lower distance observed between *M. leonina* and *M. silenus*. Among the four analysed members of the [*M. sinica*] group, variation of 0.6-4.3% was detected. Within the [*M. fascicularis*] group, the five species vary in 1.5-3.5%, with lowest differences observed between *M. mulatta*, *M. cyclopis* and *M. fuscata*.

Table 2. Pairwise differences (in %) within and between *Macaca* taxa

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) M. sylvanus	-															
(2) Sulawesi macaques	5.0-6.1	0.9-3.3														
(3) M. silenus	6.0	4.6-5.6	-													
(4) M. leonina	5.9	4.2-5.2	1.6	-												
(5) M. nemestrina	6.4	4.8-5.8	2.5	2.2	-											
(6) M. siberu	6.1	4.9-5.9	2.5	2.5	2.5	-										
(7) M. pagensis	4.8	3.7-4.6	2.8	2.3	3.1	3.0	-									
(8) M. radiata	5.8	5.4-6.3	6.1	5.8	6.1	5.9	5.5	-								
(9) M. sinica	6.7	6.2-7.6	7.0	6.5	6.7	6.9	6.1	4.3	-							
(10) M. thibetana	7.0	6.0-7.2	6.5	6.4	6.5	6.7	5.9	3.8	4.1	-						
(11) M. assamensis	6.9	6.1-7.3	6.5	6.3	6.5	6.6	6.1	3.9	4.2	0.6	-					
(12) M. mulatta	5.5	5.3-6.5	6.0	5.7	6.1	5.8	5.3	4.2	4.6	5.0	5.1	-				
(13) M. fascicularis	5.2	4.8-6.1	5.6	5.0	5.6	5.4	4.5	4.6	5.0	5.2	5.3	3.5	-			
(14) M. fuscata	6.0	5.5-6.7	6.1	5.7	6.3	6.0	5.5	4.3	4.8	5.5	5.5	2.0	3.1	-		
(15) M. cyclopis	5.7	5.1-6.5	5.7	5.1	5.7	5.2	4.9	3.7	4.7	5.0	5.1	1.8	2.9	1.5	-	
(16) M. arctoides	5.5	5.7-6.9	5.9	5.7	5.9	5.9	5.2	3.7	4.7	5.2	5.4	3.3	3.4	3.3	2.7	-

The evolutionary relationships obtained from the different phylogenetic tree reconstruction methods are completely resolved and for most branching patterns significantly supported (supports not shown, Fig. 2). Based on the tree topology, the distinction of the macaque genus into the four species groups can be confirmed, with the sole African species *M. sylvanus* representing a sister clade to the Asian representatives. Among Asian macaques, the [*M. silenus*] group split off first, while the [*M. sinica*] and [*M. fascicularis*] groups diverged later from each other. Within the [*M. silenus*] group, the Sulawesi macaques form a monophyletic sister clade to the remaining species. Among the latter, *M. pagensis* split of first, before the other four species diverged during a radiation-like splitting event. Although not significantly supported, the closest relative of *M. leonina* is *M. silenus* and not the other pig-tailed

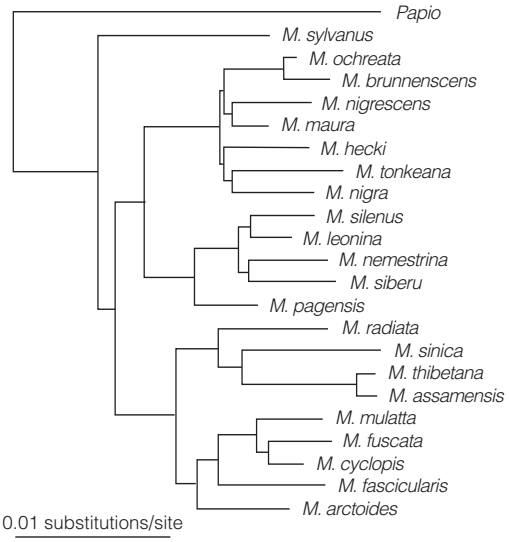

Fig. 2. Phylogenetic relationships among macaque (*Macaca*) species as obtained from the 12S-16S rRNA sequence data. Branch lengths are based on the NJ tree.

macaques. Within the [*M. sinica*] group, *M. radiata* represents the first splitting event, followed by *M. sinica*. In contrast, *M. thibetana* and *M. assamensis* diverged relative recently. The [*M. fascicularis*] group comprises five species. Among them, *M. arctoides* was the first species to be separated, before *M. fascicularis* diverged. This result however represents only the mitochondrial gene tree. In contrast, in Y chromosomal based trees, *M. arctoides* forms a sister clade to *M. assamensis*/*M. thibetana*, suggesting a hybrid origin of *M. arctoides* from progenitors of *M. fascicularis* and *M. assamensis*/ *M. thibetana* (Tosi *et al.*, 2000). The split between *M. mulatta*, *M. cyclopis* and *M. fuscata* occurred relative recently, with ongoing hybridisation between *M. fascicularis* and *M. mulatta* in overlapping regions (Tosi *et al.*, 2002). The relationships based on mitochondrial data confirm earlier results and are in agreement with other classification schemes (e.g. Deinard & Smith, 2001; Delson, 1980; Fooden, 1975; Groves, 2001; Hayasaka *et al.*, 1996; Morales & Melnick, 1998; Roos *et al.*, 2003; Tosi *et al.*, 2003; Ziegler *et al.*, 2007).

Based on our data, we recognise five macaque species for Indochina (*M. arctoides*, *M. assamensis*, *M. fascicularis*, *M. mulatta* and *M. leonina*). However, several subspecies are described and variation among populations is great, so that further studies are required to verify the taxonomy within species. E.g. for rhesus macaques, it is well know that individuals from India and China differ significantly in their response to SIV infections, although all these populations are recognised as *M. m. mulatta*. For *M. fascicularis*, two subspecies are described for the Indochinese bioregion, with one occurring on the mainland (*M. f. fascicularis*) and one on Con Dao Island (*M. f. condorensis*). Our preliminary data, indicate distinct subspecies status, however further studies are necessary.

Leaf monkeys (*Trachypithecus*)

A 573 bp long fragment of the cytochrome b gene was sequenced from 123 individuals representing all recognised species of the genus *Trachypithecus* and one *Presbytis fluviatilis*, which was used as the outgroup. *T. geei*, *T. pileatus*, *T. johnii* and *T. vetulus* were excluded from the data set, since the four species are mitochondrially closer related to *Semnopithecus* than they are to *Trachypithecus* (Geissmann *et al.*, 2004), with *T. vetulus* and *T. johnii* being members of

Table 3. Pairwise differences (in %) within and between *Trachypithecus* taxa

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) T. auratus	0.3-1.5													
(2) T. cristatus	2.4-4.3	0.5-1.7												
(3) T. germaini	3.3-4.7	3.1-4.2	0.2-1.0											
(4) T. margarita	2.8-4.0	2.4-3.5	2.6-3.1	0.2										
(5) T. p. poliocephalus	8.5-9.4	8.7-9.4	8.9-9.5	8.0-8.5	0.2-0.3									
(6) T. p. leucocephalus	9.2-10.1	9.4-10.4	9.7-10.4	9.2-9.7	1.8-2.1	0.2-0.5								
(7) T. francoisi	8.7-9.9	8.7-9.9	9.0-9.7	8.9-9.4	2.4-2.6	2.3-2.6	0.2-0.7							
(8) T. delacouri	8.3-10.1	8.0-9.4	9.0-9.9	8.9-9.5	4.3-5.2	4.2-4.9	3.3-4.3	0.2-1.0						
(9) T. l. laotum	8.2-9.0	8.2-8.9	9.2-9.5	9.0-9.2	5.2-5.6	5.7-5.9	5.0-5.4	3.1-3.8	-					
(10) T. l. hatinhensis	8.5-10.4	8.7-10.1	9.2-10.1	9.5-10.4	5.4-6.4	5.9-6.6	5.2-6.2	3.3-4.7	1.2-1.9	0.2-1.2				
(11) T. crepusculus	8.2-9.9	8.0-9.9	8.7-10.1	8.2-9.4	7.6-8.7	7.3-8.5	7.1-8.5	6.4-8.2	6.2-7.1	7.1-8.7	0.3-2.1			
(12) T. obscurus	6.6-8.3	6.6-8.0	7.5-8.5	6.2-7.1	8.9-9.7	9.7-11.1	9.0-10.4	8.3-9.4	8.2-8.9	8.3-9.4	7.6-9.9	0.3-1.7		
(13) T. phayrei	7.5-8.7	6.9-8.2	7.6-8.0	6.8-7.1	8.7-9.0	9.7-10.2	8.9-9.5	8.3-9.4	8.9-9.0	9.0-9.9	7.3-9.2	3.8-4.5	0.5	
(14) T. barbei	6.9-8.0	6.6-7.1	7.1-7.5	6.6-6.8	9.9-10.4	9.9-10.9	9.9-10.6	8.9-9.0	8.3	8.7-9.4	8.9-10.2	4.3-5.2	4.3-4.5	-

Semnopithecus, and *T. geei* and *T. pileatus* being the result of ancestral hybridization between the two genera (data not shown). Among the 123 analysed individuals, 66 haplotypes were detected. Variation within taxa range from 0.2-2.1%, whereas between taxa, the maximum variation detected was 11.1% (Table 3). Accordingly, the analysed taxa can be divided into four major groups [*T. cristatus*] group, [*T. obscurus*] group, [*T. francoisi*] group and *T. crepusculus*, which differ by 6.6–11.1%. Within the *T. cristatus* group, *T. auratus*, *T. cristatus*, *T. germaini* and *T. margarita* are different by 2.4–4.7%. The members of the [*T. obscurus*] group, *T. obscurus*, *T. phayrei* and *T. barbei* differ by 3.8–5.2%. Within the [*T. francoisi*] group, the highest differences of 5.0-6.6% were detected between the northern members (*T. francoisi*, *T. p. policephalus* and *T. p. leucocephalus*) and the southern taxa (*T. l. laotum* and *T. l. hatinhensis*). *T. delacouri* differs from all other members of the group by 3.1–5.2%. Within the northern clade, *T. francoisi* and *T. p. poliocephalus*/*T. p. leucocephalus* are different by 2.3-2.6%. The latter two taxa show pairwise differences of 1.8-2.1%, which are only slightly higher than those observed between *T. l. laotum* and *T. l. hantinhensis* (1.2-1.9%). The two analysed black langurs, representing the recently described *T. auratus ebenus*, are identical with one *T. l. hatinhensis* haplotype or differ only in 0.2% from other haplotypes. *T. crepusculus* differs from all other species groups in 6.2-10.2%.

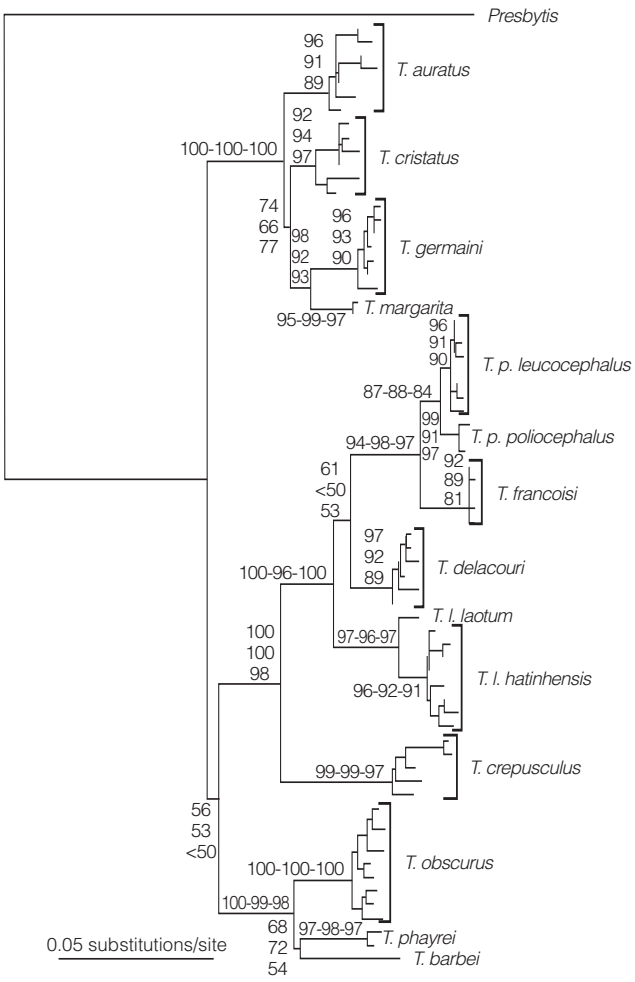

Fig. 3. Phylogenetic relationships among leaf monkey (*Trachypithecus*) haplotypes as obtaind from 573bp long sequences of the mitochondrial cytochrome b gene. Branch lengths are drawn according to the NJ tree with numbers on branches indicating internal support (first: ML, second: NJ, third: MP).

The evolutionary relationships as obtained from the phylogenetic tree reconstructions are completely resolved and significantly supported for most branching patterns (Fig. 3). Accordingly, the genus can be divided into the [*T. cristatus*] group, the [*T. obscurus*] group and the *T. francoisi* group, which significantly clusters together with *T. crepusculus*. The relationships among these three major groups however are not well resolved. Within the [*T. cristatus*] group, four reciprocal monophyletic clades were detected, which represent *T. auratus* (Java), *T. cristatus* (Sumatra, Borneo, Malaysian peninsular) and the mainland populations, which can be divided into two subgroups. These are most likely separated by the Mekong River and were recently classified as distinct species (Nadler *et al*., 2005). Although a monophyletic origin of the two mainland species *T. germaini* and *T. margarita* is confirmed by the data, the relationship among those and *T. auratus* and *T. cristatus* is not settled yet. Although the relationships are not well resolved, the [*T. obscurus*] group can be divided into three major groups, representing the species *T. obscurus*, *T. phayrei* and *T. barbei*. The last major group includes *T. crepusculus* and the members of the “limestone langurs”. This significantly supported relationship is based on a maternal inherited marker, however, molecular data based on paternal

inherited marker systems (data not shown) show that *T. crepusculus* is more closely related to the *T. obscurus* group. These findings indicate that *T. crepusculus* is the result of introgression or ancestral hybridization between the two species groups. Within the *T. francoisi* group, a northern, a central and a southern group can be distinguished, although the relationships among them are not well resolved and contradict with earlier results (Roos, 2004). The northern group is divided into three monophyletic clades, which represent *T. francoisi*, *T. p. poliocephalus* and *T. p. leucocephalus*, whereas the latter two form a sister clade to *T. francoisi*. The central group consists only of *T. delacouri*, and the southern clade comprises *T. l. laotum*, *T. l. hatinhensis* and *T. a. ebenus*, whereas the two analysed *T. a. ebenus* specimens cluster within the *T. l. hatinhensis* clade.

Based on the pairwise differences and phylogenetic relationships, we propose to recognise *T. poliocephalus, T. francoisi, T. delacouri, T. laotum, T. crepusculus, T. barbei, T. phayrei, T. obscurus, T. germaini, T. margarita, T. cristatus* and *T. auratus* as distinct species. Because of the low differences between *T. leucocephalus* and *T. poliocephalus* and between *T. laotum* and *T. hatinhensis*, *T. leucocephalus* and *T. hatinhensis* should be recognised only as subspecies of *T. poliocephalus* and *T. laotum*, respectively. Since the studied black langurs (*T. a. ebenus*) are not separated from *T. l. hatinhensis*, the taxon is here classified as synonym of *T. l. hatinhensis*. Moreover, there is information that both forms occur sympatrically (Ruggieri & Timmins, 1995), which led us to the conclusion that the black langur may be a melanistic morphe of *T. l. hatinhensis*. However, recent field studies indicate that both forms may occur allopatrically (Le Khac Quyet, 2004), doubting the synonymy of the black langur with *T. l. hatinhensis*. Although provisionally downgraded as synonym of the Hatinh langur, further research is needed to definitively solve the taxonomic position of the black langur.

Douc langurs (*Pygathrix*)

To analyse pairwise differences and phylogenetic relationships among douc langurs, a 573 bp long fragment of the mitochondrial cytochrome b gene was sequenced for 83 individuals, as well as one *Rhinopithecus avunculus* used as the outgroup. Among the 83 douc langurs sequences, 42 different haplotypes were detected. Based on pairwise differences (Table 4), douc langurs can be classified into three major groups, which represent the three recognised taxa *P. nemaeus*, *P. nigripes* and *P. cinerea*. The lowest differences among them were detected between *P. nemaeus* and *P. cinerea* (2.8–3.4%) and the largest between the latter two and *P. nigripes* (7.6–8.9%). Within groups, variation is comparatively low, ranging from 0.2-1.6%. One individual sampled at the Lang Bian Peak (Lam Dong Province, Vietnam), the type locality of *P. moi* shows 0.4–1.6% difference to *P. nigripes*, which is typical for intra-species variety.

Phylogenetic trees derived from the dataset reveal three statistically supported clades, which represent the three different taxa (Fig. 4). The relationships among them are also significantly supported. Accordingly, *P. nigripes* represents the first splitting event whereas *P. cinerea* and *P. nemaeus* diverged later from each other. *P. moi* clusters within the *P. nigripes* clade.

Based on these results, we conclude that *P. nemaeus*, *P.cinerea* and *P. nigripes* should be

Table 4. Pairwise differences (in %) within and between *Pygathrix* taxa

	1	2	3
(1) P. nemaeus	0.2-1.4		
(2) P. cinerea	2.8-3.4	0.2-0.9	
(3) P. nigripes	7.6-8.9	7.7-8.6	0.2-1.6

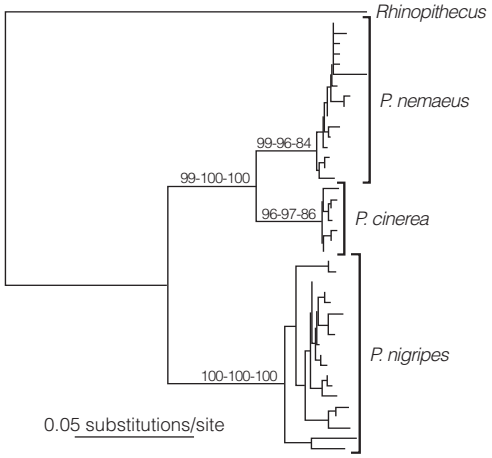

Fig. 4. Phylogenetic relationships among douc langur (*Pygathrix*) haplotypes as obtained from 573bp long sequences of the mitochondrial cytochrome b gene. Branch lengths are based on the NJ tree with numbers on branches indicating internal support (first: ML, second: NJ, third: MP).

recognised as distinct species. The taxon *P. moi* is not phylogenetically separated from *P. nigripes* and hence should be regarded only as synonym of *P. nigripes*.

Snub-nosed monkeys (*Rhinopithecus*)

573 bp long sequences of the mitochondrial cytochrome b gene were generated from 21 snub-nosed monkey individuals representing all four recognised species and one red-shanked douc langur (*Pygathrix nemaeus*) used as the outgroup. Among them, only eleven haplotypes were detected. Pairwise differences show that the analysed individuals can be divided into the four traditionally recognised species, which differ in 5.7–7.5% from each other (Table 5). Within species only low differences of a maximum of 0.9% were observed, with the exception of *R. bieti*, were two major subgroups were detected, which differ in 3.4-3.6%.

Phylogenetic tree reconstructions (Fig. 5) confirm the monophyly of each of the four taxa and indicate a basal position of *R. bieti*. After *R. bieti* split off, *R. brelichi* diverged as next, while the split between *R. roxellana* and *R. avunculus* represents the most recent divergence. Although the splitting events among the four species are resolved in the tree, the statistical support is not significant, so that the depicted scenario may not reflect the real relationships and are even in contrast to earlier results (Li Ming *et al.*, 2004; Roos, 2004).

Table 5. Pairwise differences (in %) within and between *Rhinopithecus* taxa

	1	2	3	4
(1) R. roxellana	0.9			
(2) R. brelichi	5.7-6.2	-		
(3) R. bieti	6.2-7.1	5.9-6.2	0.3-3.6	
(4) R. avunculus	6.4-6.9	6.2-6.6	6.8-7.5	0.2-0.3

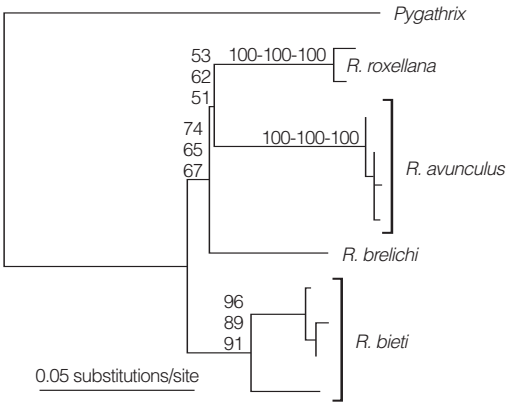

Fig. 5. Phylogenetic relationships among snub-nosed monkey (*Rhinopithecus*) haplotypes as obtained from 573bp long sequences of the mitochondrial cytochrome b gene. Branch lengths are based on the NJ tree with numbers on branches indicating internal support (first: ML, second: NJ, third: MP).

Based on these findings, we propose to recognise all four taxa as distinct species. The proposed subgenus *Presbyticus* for *R. avunculus* (Jablonski & Peng Yanzhang, 1993) does not resemble the evolutionary relationships among snub-nosed monkey and hence, should not be used. Further studies focusing on the phylogenetic relationships among the four snub-nosed monkey species are needed. The classification of the three *R. roxellana* subspecies (*R. r. roxellana*, *R. r. hubeiensis* and *R. r. qinlingensis*) needs also further molecular investigations.

Crested gibbons (*Nomascus*)

The complete mitochondrial cytochrome b gene was sequenced for 64 crested gibbons as well as from one individual of *Hylobates* lar used as the outgroup. Among the studied crested gibbons, 44 different haplotypes were detected. Pairwise differences (Table 6) among them range from 0.1-8.2%, with the lowest differences observed within taxa (0.1-1.1%). Between taxa, differences range from 1.2-8.2%. Largest differences within the genus ranging from 6.7-8.2% were detected between *N. nasutus*/*N. hainanus* and the remaining taxa, as well as between *N. nasutus* and *N. hainanus* (6.8%). *N. concolor* differs from the southern taxa in 4.5-6.2%, whereas *N. leucogenys* and *N. siki* vary from *N. gabriellae* only in 3.0-4.6%. Lowest differences between taxa

Table 6. Pairwise differences (in %) within and between *Nomascus* taxa

	1	2	3	4	5	6
(1) N. nasutus	0.2-0.5					
(2) N. hainanus	6.8	-				
(3) N. concolor	7.2-8.2	6.8-7.7	0.2-1.1			
(4) N. l. leucogenys	6.9-8.0	7.4-8.2	4.5-6.2	0.1-1.1		
(5) N. l. siki	6.7-7.4	7.4-7.7	4.6-5.8	1.2-1.8	0.2-0.8	
(6) N. gabriellae	7.1-7.8	7.4-7.9	4.8-6.0	3.3-4.6	3.0-3.9	0.1-1.1

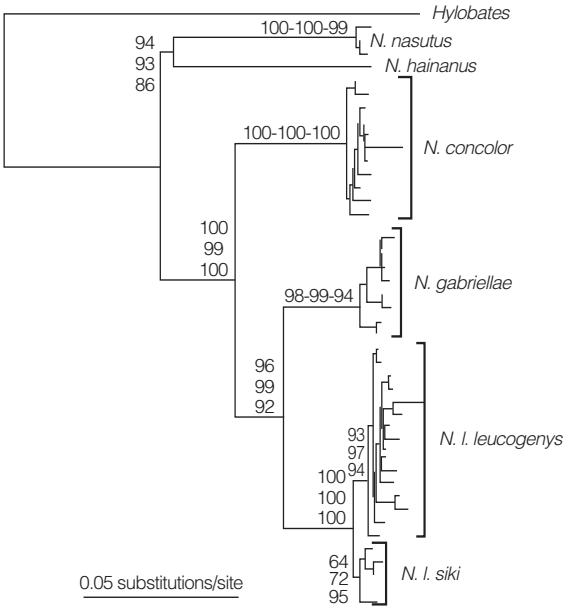

Fig. 6. Phylogenetic relationships among crested gibbon (*Nomascus*) haplotypes as obtained from complete mitochondrial cytochrome b sequence data. Branch lengths are based on the NJ tree with numbers on branches indicating internal support (first: ML, second: NJ, third: MP).

were observed between the northern and southern white-cheeked gibbon (1.2-1.8%), which is only slightly higher than intra-taxon variability.

The phylogenetic relationships among the different crested gibbon taxa are completely resolved and significantly supported (Fig. 6). With the exception of the *siki* clade, the monophyly of all the taxa is highly supported. Based on the tree topology, the two northernmost taxa *nasutus* and *hainanus* form a sister clade to the remaining taxa. Later, *N. concolor* split off, while *leucogenys* and *gabriellae* diverged later from each other. All *siki* representatives form a monophyletic sister clade to *leucogenys*. Within the *N. concolor* clade no subdivision was detected, and moreover the representatives of the different subspecies are not monophyletic. In principal, these results confirm earlier results (Roos, 2004; Takacs *et al.*, 2005), although those have not included the Hainan gibbon. Roos (2004) showed that *siki* representatives form two paraphyletic clades, with one related to *leucogenys* and the other to *gabriellae*. However, in contrast to this earlier study, in the recent analyses only karyotyped specimens were included, indicating that in the earlier study, incorrectly identified specimens may have been used.

Based on pairwise differences and phylogenetic relationships, *N. nasutus*, *N. hainanus*, *N. concolor*, *N. leucogenys* and *N. gabriellae* should be recognised as distinct species. The southern white-cheeked crested gibbon is closely related to *N. leucogenys* and hence should be classified as subspecies *N. l. siki*. The occurrence of possibly further taxa within the *gabriellae-leucogenys* complex as stated recently by Konrad & Geissmann (2006) has to be evaluated by further field and laboratory work. The different subspecies of *N. concolor* form no distinct clades in the tree and the pairwise differences among them fall in the range typical for within-taxon variability. Hence, *N. concolor* is regarded as monotypic here.

Conclusions

In the following, a summary on the genetically based systematic classification and distribution of Indochinese primates is given. Taxa with uncertain classification or which are recognised only as synonyms are mentioned in the text as well.

Pygmy loris *Nycticebus pygmaeus*

Distinct species status is supported. Distributed east of the Mekong River in Vietnam, Cambodia, Laos and in southernmost China. *N. intermedius* is recognised as synonym.

Bengal slow loris *Nycticebus bengalensis*

Genetic data support separation from all other slow loris forms on species level; distributed from north-eastern India into Indochina, and south to the northern parts of peninsular Thailand.

Long-tailed macaque *Macaca fascicularis fascicularis*

M. fascicularis is genetically distinct from all other macaque species. Hybridisation or introgression with/from *M. mulatta* however is common, so that the morphological based classification is sometimes contradicting with genetic data. Hence, further research is needed to definitively resolve the systematics of the different *M. fascicularis* subspecies. Distributed over wide ranges of Sunda land (Java, Borneo, Sumatra), north to Thailand, Cambodia and southern Vietnam.

Con Dao long-tailed macaque *Macaca fascicularis condorensis*

See also *M. f. fascicularis*. Based on genetic data, *M. f. condorensis* is distinct from *M. f. fascicularis*, hence a provisional subspecies status is supported. Further studies however are necessary to definitively settle the taxonomic position. Occurs only on some islands of the Con Dao Archipelago, Vietnam.

Rhesus macaque *Macaca mulatta mulatta*

Distinct species status proposed. Hybridisation or introgression with/from *M. fascicularis* however is common, so that the morphological based classification is sometimes contradicting with genetic data. In the response to SIV/HIV, rhesus macaques from India and China differ from each other. Hence, further research is needed to definitively resolve the systematics of the different *M. mulatta* subspecies. Distributed from India to China and Vietnam.

Assamese macaque *Macaca assamensis assamensis*

Distinct species status proposed. Distributed from Assam (India) throughout mainland Southeast Asia.

Stump-tailed macaque *Macaca arctoides*

Genetic data support distinct species status. This species is the result of ancient hybridisation between progenitors of *M. fascicularis* and *M. assamensis-M. thibetana*. Distributed from India throughout mainland Southeast Asia.

Northern pig-tailed macaque *Macaca leonina*

Distinct species status supported. Distributed from India through Bangladesh, Myanmar to Thailand and Indochina.

Indochinese grey langur *Trachypithecus crepusculus*

Genetic data support distinct species status. The species is the result of hybridisation or introgression of progenitors of the two species groups [*T. francoisi*] and [*T. obscurus*]. Distributed in northern Vietnam, southernmost China, Laos and northern Thailand.

Annamese silvered langur *Trachypithecus margarita*

Distinct species status is proposed. Distributed in Vietnam, Cambodia and southernmost Laos, with most likely the Mekong River as western barrier. The taxonomic status of *T. germaini caudalis* has to be evaluated by further studies.

Indochinese silvered langur *Trachypithecus germaini*

Genetic data support distinct species status. Distributed in southernmost Vietnam, Cambodia, Thailand and eastern Myanmar, with most likely the Mekong River as eastern barrier. The taxonomic status of *T. germaini caudalis* has to be evaluated by further studies.

Francois' langur *Trachypithecus francoisi*

Distinct species status supported. Distributed in northernmost Vietnam and southernmost China. More data are necessary to determine if the different populations form distinct "significant evolutionary units".

Cat Ba langur *Trachypithecus poliocephalus poliocephalus*

Genetic data support distinct subspecies status. Restricted to Cat Ba Island, Vietnam.

White-headed langur *Trachypithecus poliocephalus leucocephalus*

The closest relative of the white-headed langur is *T. p. poliocephalus* and hence a classification as subspecies of this taxon is proposed. Restricted to a small range in Guangxi Province, southernmost China.

Delacour's langur *Trachypithecus delacouri*

Genetic data support distinct species status; endemic to a restricted range in northern Vietnam.

Laos langur *Trachypithecus laotum laotum*

Genetic data indicate close relationship with the Hatinh langur and hence both are classified as subspecies of *T. laotum*; endemic to a small range in Laos.

Hatinh langur *Trachypithecus laotum hatinhensis*

Genetic data indicate close relationship with the Laos langur and hence classification as subspecies of *T. laotum*. Distributed in a restricted range in Vietnam and Laos. *T. auratus ebenus* is provisionally recognised as synonym of this subspecies, however further studies are necessary to definitively settle its taxonomic status.

Red-shanked douc langur *Pygathrix nemaeus*

A distinct species status is supported. Distributed in Vietnam and Laos.

Grey-shanked douc langur *Pygathrix cinerea*

Genetically distinct from *P. nemaeus* and *P. nigripes* and hence classified as distinct species. Distributed in the Central Highlands of Vietnam. Most likely also present in a small range in north-eastern Cambodia and south-eastern Laos.

Black-shanked douc langur *Pygathrix nigripes*

Genetic data support distinct species status. Distributed in southern Vietnam and Cambodia.

Tonkin snub-nosed monkey *Rhinopithecus avunculus*

Genetic data support species status; restricted to small patches in northern Vietnam.

Yunnan snub-nosed monkey *Rhinopithecus bieti*

Distinct species status supported; endemic to Yunnan Province, China.

Guizhou snub-nosed monkey *Rhinopithecus brelichi*

Genetically distinct on species level; occurs only in Fanjingshan National Nature Reserve, Guizhou Province, China.

Sichuan snub-nosed monkey *Rhinopithecus roxellana*

Distinct species status supported. The classification of the three subspecies *R. r. roxellana*, *R. r. hubeiensis* and *R. r. qinlingensis* however needs further investigations. Distributed in central and western China.

Hainan gibbon *Nomasus hainanus*

Genetically separated from all other crested gibbons and hence a distinct species status is proposed; endemic to Hainan Island, China.

Eastern black gibbon *Nomascus nasutus*

Distinct species status proposed. Currently only known from two locations one in north-east Vietnam, and another in the adjacent area in China.

Western black gibbon *Nomascus concolor*

Genetically distinct on species level. The described subspecies *N. c. lu*, *N. c. furvogaster* and *N. c. jingdongensis* are downgraded as synonyms of the nominate form here; distributed in northern Vietnam, south-western China and north-western Laos.

Northern white-cheeked gibbon *Nomascus leucogenys leucogenys*

Genetically separated from all other crested gibbons and hence a distinct species status is proposed. However, further studies are necessary to discriminate between *N. l. leucogenys* and *N. l. siki* and to elucidate the exact distribution area. Distributed in Vietnam and Laos.

Southern white-cheeked gibbon *Nomascus leucogenys siki*

The taxonomic status of this taxon is unclear and needs more research. Karyotyped specimens in captivity (with unknown origin) form a sister clade to *N. l. leucogenys* and hence a subspecies status of *N. leucogenys* is proposed. Distributed in Laos and Vietnam.

Yellow-cheeked gibbon *Nomascus gabriellae*

Distinct species status proposed. However, further studies are necessary to elucidate the exact distribution area. Distributed in Vietnam, Cambodia and possibly also southernmost Laos.

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Distribution, population and conservation status of the grey-shanked douc (*Pygathrix cinerea*) in Gia Lai Province, Central Highlands of Vietnam

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Key words: Grey-shanked douc, *Pygathrix cinerea*, distribution, Central Highlands Vietnam

Summary

Field surveys to investigate the grey-shanked doucs (*Pygathrix cinerea*) in Kon Cha Rang Nature Reserve, and Kon Ka Kinh National Park, Gia Lai Province were conducted in 2004 and 2006. The results indicate that only grey-shanked doucs exist in these protected forests and in their buffer zones. 10 groups were observed in these surveys with about 139-150 individuals. The main habitat of the species is primary montane evergreen forest (900-1300 m asl). The southern distribution of the species was confirmed to the latitude 14°13'N. The DNA analysis documents that the Kon Cha Rang population of grey-shanked douc is genetically close to the population in Ba To, Quang Ngai Province. Main threats to the species are hunting, logging and the wildlife trade. A forest corridor between these two protected forests should be immediately established in order to maintain a sustainable population of grey-shanked doucs in this area.

Phân bố, quần thể và tình trạng bảo tồn của loài chà vá chân xám (*Pygathrix cinerea*) ở tỉnh Gia Lai, Tây Nguyên, Việt Nam

Tóm tắt

Nghiên cứu điều tra về phân bố, quần thể và tình trạng bảo tồn của loài chà vá chân xám (*Pygathrix cinerea*)được tiến hành tại Vườn Quốc gia Kon Ka Kinh, và Khu bảo tồn Thiên nhiên Kon Cha Rang, tỉnh Gia Lai trong năm 2004 và năm 2006. Kết quả nghiên cứu cho thấy chỉ có duy nhất loài chà vá chân xám phân bố tại hai khu rừng đặc dụng trên và khu vực lân cận. 10 đàn chà vá chân xám đã được quan sát với khoảng 139-150 cá thể. Nơi sống chính của loài là rừng nguyên sinh. Kiểu rừng đặc trưng cho khu vực này là rừng thường xanh nhiệt đới ẩm tại độ cao 900 m đến 1,300 m. Phạm vi phân bố của loài được xác định đến vĩ tuyến 14°13'N. Kết quả nghiên cứu ADN đã chỉ ra rằng, quần thể chà vá chân xám tại Kon Cha Rang có quan hệ di truyền gần gũi với quần thể chà vá chân xám tại Ba Tơ, tỉnh Quảng Ngãi. Những mối đe doạ chính đối với loài này là săn bắt, khai thác gỗ và buôn bán động vật hoang dã. Một khu hành lang sinh thái cần được thiết lập giữa hai khu rừng đặc dụng trên nhằm giúp sự tồn tại và phát triển bền vững của loài chà vá chân xám trong khu vực.

Introduction

The grey-shanked douc was described as a new taxon of doucs (Nadler, 1997) and is endemic to Vietnam. Not only is the species newly discovered, but it's global population size is critically low, estimated to be less than 1000 individuals (Ha Thang Long, 2004). In 2002, 2004, 2006 the species was listed as one of "The World's 25 Most Endangered Primates" (Mittermeier *et al*., 2006).

Planning conservation solutions to protect a species requires a sufficient knowledge of its distribution and population status in the wild (Cowlishaw & Dunbar, 2000). Nadler *et al*. (2003) pointed out that the grey-shanked douc is restricted to the central coastal area and the Central Highlands of Vietnam (from 14°30'N to 15°38'N). The regions consist from the north to the south of five provinces: Quang Nam, Quang Ngai, Kon Tum, Binh Dinh, Gia Lai.

However, there were two points of uncertainty about the distribution of grey-shanked doucs in Gia Lai Province in the report. First, it is indicated that surveys conducted by Lippold & Vu Ngoc Thanh (1995) in Kon Ha Nung area, Gia Lai Province found both the red-shanked douc and black-shanked douc to be present and no evidence of the grey-shanked douc (Nadler *et al.*, 2003). Second, survey conducted by Le Trong Trai (2000) in Kon Cha Rang Nature Reserve, Gia Lai Province found two specimens of grey-shanked douc in a local village, but no observation on the species was made in the forest.

The questions addressed here are: (1) How many taxa of doucs really exist in Gia Lai Province; (2) what is the distribution pattern of grey-shanked douc and other douc species in Gia Lai Province; (3) what is the population and conservation status of the grey-shanked douc in Gia Lai Province. To answer these questions, field surveys were carried out in Gia Lai Province in two periods: from August to November 2004 and from February to May, 2006.

Study sites

Field surveys were made in Kon Cha Rang Nature Reserve and Kon Ka Kinh National Park. The two protected forest areas are located in the north of Gia Lai Province. The areas were chosen to conduct field surveys because the information about doucs in this area is unclear.

Kon Cha Rang Nature Reserve (14^{o}25' to 14^{o}35' N; 108^{o}30' to 108^{o}39' E)

The nature reserve is located in the north-east of Gia Lai Province about 70 km to K'Bang town. The area is 15.900 ha with 8,746 ha as strict protection zone, and has a buffer zone of about 56.000 ha.

Kon Cha Rang is situated on the upper part of Kon River. The terrain in Kon Cha Rang includes both mountains and highland plateau. Most of the reserve is between 900-1,200 m asl altitude with the highest point at 1,452 m asl and the lowest point at 800 m asl. The main forest type is mountain evergreen forest, distributed between the altitudes of 900 and 1,300 m asl in the north-west of the nature reserve. The flora system is dominated by a number of species from Fagaceae, Lauraceae and Magnoliaceae, mixed with gymnosperms, such as *Podocapus imbricatus* and *Dacrydium elatum*. Lowland evergreen forest occurs at the elevation below 900 m asl. The canopy cover is 80% (Tordoff *et al.,* 2004).

Kon Ka Kinh National Park (14^{o}09' to 14^{o}30' N; 108^{o}16' to 108^{o}28' E)

The national park is located in the north of Gia Lai Province on the Kon Tum Plateau and has a surface area of 41,710 ha. The terrain of the park is characterized by high, steep mountains in the north-east and flatter area in the south-west (Fig. 1). The highest point is the Kon Ka Kinh Mountain at 1,748 m asl. The south-west area is below 700 m asl.

Kon Ka Kinh National Park contains 33,565 ha of forest, equivalent to 80% of the total area. The national park has a large range of mountain evergreen forest across 700 m asl to 1,784 m asl (Tordoff *et al*., 2004).

Materials and Methods

Interviews

Interviewing using a pre-designed questionnaire pack based on the instructions of Peterson (2000) was conducted in this study. Interviewing begun with staffs of forest protection departments (FPD), and staff at the park and the nature reserve. The interviewers asked questions regarding occurrence of different primate species in the areas, forest condition, hunting pressure and wildlife trading in the area. In the villages, the interviewing focussed on hunters, collectors of forest products, and traders. Questions mostly concerned diversity of primate fauna in the area, diversity of doucs in the area, distribution and population status of doucs.

Field surveys

The "species presence/absence records"-method was used to collect the data on geographic

Fig. 1. Habitat of the grey-shanked doucs in Kon Ka Kinh National Park, Gia Lai Province. Photo: Ha Thang Long.

range and the habitat requirements of grey-shanked doucs (Ross *et al.,* 2003). During the survey, existing trails and newly cut transects were walked during daylight. Field observations usually began at 6.00 am and finished at 18.00 pm. During the survey, the surveyor was accompanied by a staff from the park, the nature reserve and one local field guide familiar with the terrain and wildlife. Field sites were chosen based on the best opportunity of finding grey-shanked doucs using the knowledge of the FPD personnel, local guides and our previous experience in the field.

Group structure was determined whenever the doucs were encountered. The number of animals, their sex and age class were recorded (Brockelman & Ali, 1987). The time of observation was noted and location was marked with the GPS. The habitat of the animal, such as habitat type and forest condition was noted. Specimens from hunted monkeys such as: skull, skin, and bones were collected. Localities and dates of monkey sightings were asked. Faeces sample were collected in the field and kept in 90% alcohol.

DNA analysis

Samples collected in the field were sent to the German Primate Centre for molecular genetic analysis.

Results

Interview results

About 80 people including hunters, collectors of forest products, traders and rangers were interviewed in Kon Cha Rang Nature Reserve and Kon Ka Kinh National Park. All local people were able to easily describe and recognize the grey-shanked douc. Many recent sightings of grey-shanked doucs were reported by local people. Two locations, in Kon Cha Rang Nature Reserve (Thac 50 and Kon River) have the most sightings of the species. In addition, many sightings of grey-shanked doucs in Kon Ka Kinh National Park were made around Ha Ngoi Stream and Ngut Mountain. Occurrence of grey-shanked doucs was also reported in Dak Roong Forest Enterprise. This area is a connecting forest between Kon Ka Kinh National Park and Kon Cha Rang Nature Reserve.

An important question focused on the number of different douc taxa that occur in the area. 95%

Fig. 2. Grey-shanked doucs in their natural habitat. Photo: Ha Thang Long.

of interviewees answered that there is only one type of douc, the grey-shanked douc. Five percent of interviewees claimed that there is another type of douc but they could not describe clearly how it differ from the grey-shanked douc.

According to local hunters the species is quite easy to hunt. They estimated some hundreds of the monkeys have been killed or captured during the last fifteen years. The group size has decreased from 50 individuals in a group to less than 20.

Distribution and population status of grey-shanked doucs in the study areas

The survey team has investigated 37 transects and trails in the forest with an accumulated length of about 185 km in Kon Ka Kinh National Park and Kon Cha Rang Nature Reserve. Ten groups of grey-shanked doucs were observed in the field. In total, 139-150 individuals of grey-shanked douc were counted. 70% of the observed groups have a group size less than 20 individuals, thus only 30% of observed groups exceed 20 individuals.

Only grey-shanked doucs were seen in Kon Ka Kinh and Kon Cha Rang (Fig. 2). There were no sightings of black-shanked or red-shanked doucs.

Three hair samples and 12 faeces samples were collected in the field, and a skull from a hunted douc was collected from Ngut mountain. The molecular genetic analysis confirmed the occurance of grey-shanked doucs. These populations are genetically closely related to populations in the neighbouring Ba To District, Quang Ngai Province (Roos, pers. comm.).

Habitat

Grey-shanked doucs were found at the altitude from 900 m to 1400 m asl. The vast majority of observations were made in primary forest. The habitat is characterized by mountain evergreen forest. The canopy cover is about 80% - 95%. The density of trees with DBH >10 cm is about 720 trees/ha. Almost of the groups were seen in big trees with DBH ≥ 40-120 cm and heights of 25 to 35 m.

Hunting and wildlife trade

The hunting season begins annually in September in Kon Cha Rang Nature Reserve and in June in Kon Ka Kinh National Park, when the rainy season starts. This activity is a tradition of the Ba Na minority people who live around the national park and the nature reserve. During the rainy season there is no other work in the fields or in the villages.

The survey team removed about a 400 m trap line in Trai Dam-Song Kon area and 2,000 m trap line in Thac 50 area. Several trap types, including 70 snare traps were collected. 16 hunter camps were found inside the nature reserve. A hunter with a gun coming out from forest was also seen in Kon Cha Rang Nature Reserve.

Logging activities and shifting agriculture

There is no logging activity inside the nature reserve and the national park. But two forest enterprises (Tram Lap Forest Enterprise and Dak Roong Forest Enterprise) are exploiting about 10,000 m^3 of timber per year in surrounding areas close to the north-west boundary of Kon Cha Rang Nature Reserve. The logging activities destroy the habitat in the corridor between Kon Ka Kinh National Park and Kon Cha Rang Nature Reserve.

Traditionally the Ba Na minority people use shifting cultivation and it was found in Ha Dong Village, Dak Doa District. The demand of agricultural lead to conversion of secondary and primary forest.

Discussion

Distribution of the grey-shanked doucs in Gia Lai Province

Lippold and Vu Ngoc Thanh (Lippold, 1995; Lippold & Vu Ngoc Thanh, 1995) conducted surveys on the doucs in Vietnam. These surveys aimed to find out the distribution of the taxa. There were two important conclusions on their research. First, sympatric occurrence of the red-shanked douc and the black-shanked douc was found in Kon Cha Rang Nature Reserve, Gia Lai Province. Second, the area between 14°00'-14°45'N/107°45'-108°35'E was suggested as the centre of origin for all taxa of doucs (Lippold & Vu Ngoc Thanh, 1995; Lippold, 1998).

Our study in Kon Cha Rang Nature Reserve and Kon Ka Kinh National Park yielded no observation or information about the occurrence of black - or red - shanked doucs in the area, and there is no hint about a sympatric occurrence between the different douc species.

Grey- and black-shanked doucs are difficult to distinguish in the field. A key character is the color of the face. Adult grey-shanked doucs have a bright orange face while adult black-shanked douc charaterized a dark blue face with cream or yellow eye rings. But infants and juvenile of grey-shanked doucs have also dark bluish-grey face. A photo from a grey-shanked douc taken by *T. Nadler* at the Endangered Primate Rescue Center is also misidentified from Lippold (1998) as black-shanked douc.

Many of the reported douc observation in the past before the grey-shanked douc has been decribed (Nadler, 1997) can not considered as reliable. The reliable records of black-shanked doucs by Nadler *et al.* (2003) are limited by about 13°N.

Potential of a habitat corridor between Kon Ka Kinh National Park and Kon Cha Rang Nature Reserve

Kon Ka Kinh National Park is situated about 20 km west of Kon Cha Rang Nature Reserve. They are linked by a forest area. A habitat corridor between the protected areas would bring a great benefit to grey-shanked doucs and wildlife in general.

This is already recommended in the Biodiversity Action Plan for Vietnam (Government of SRV/GEF, 1994), and the investment plan for Kon Ka Kinh Nature reserve (Le Trong Trai *et al.*, 2000). But if the logging of the forest enterprises continue, the chance of the establishment of a habitat corridor is dwindling. Tram Lap Forest Enterprise exploited in 2004 4,800 m^3 timber from 20,000 ha forest, and Dak Roong Forest Enterprise 5,000 m^3 from 35,000 ha forest.

Conclusions

- In Kon Cha Rang Nature Reserve, and Kon Ka Kinh National Park only the grey-shanked doucs are confirmed. There is no evidence or information of the occurrence of other douc species.
- The population of the grey-shanked doucs in Kon Cha Rang, Kon Ka Kinh and buffer zone areas comprises at least 139 individuals and is one of the largest grey-shanked douc populations. The main habitat of the species is primary and secondary evergreen mountain forest (900 m-1,300 m asl.).
- The population is genetically very closely related to the population in Ba To District, Quang Ngai Province.
- Main threats to the species are hunting, logging and wildlife trade. Hunting is the greatest threat and the doucs are still used for food by the Ba Na minority. Doucs are also used for the production of traditional medicine the "monkey balm". Logging activities have a high impact to the habitat to the forest in the buffer zones and to the corridor area between the two protected areas.
- A forest corridor between Kon Ka Kinh National Park and Kon Cha Rang Nature Reserve area is of extreme importance for the conservation of a sustainable population of the grey-shanked doucs.

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Survey for southern white-cheeked gibbons (*Nomascus leucogenys siki*) in Dak Rong Nature Reserve, Quang Tri Province, Vietnam

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Key words: Dak Rong Nature Reserve, *Nomascus* spec., gibbon, conservation, habitat, hunting, war material

Summary

Dak Rong is the only protected area in Quang Tri Province. The reserve is identified as an important stronghold for a number of endangered mammals including the Indochinese tiger (*Panthera tigris*), gaur (*Bos gaurus*), saola (*Pseudoryx nghetinhensis*), and red-shanked douc (*Pygathrix nemaeus*). Results of our gibbon survey in 2003, 2004, and 2006 showed that the nature reserve is one of the most important distribution sites of the southern-white checked gibbon (*Nomascus leucogenys siki*) and red shanked douc. Gibbon distributes in Dakrong is concentrate particularly in two areas of the nature reserve: 1. A Cho1-A Cho2-Ba Le-A Pong area and 2. the forest are of Ta Long, Trieu Nguyen, Ba Long, Hai Phuc communes. In addition, Dakrong and Phong Dien Nature Reserves together form an important conservation area especially for gibbon and douc in the north central region of Vietnam.

Hunting and snare trapping poses a serious threat to terrestrial mammals and also to some macaque species in the area. Habitat degradation and disturbance by human activities such as hunting and logging also poses a serious threat to the nature reserve and primate habitat in the area. There is still discussion on the taxonomy of gibbons in Dakrong, therefore, further studies are crucial to clarify which gibbon taxon occurs in the nature reserve and this information will aid in developing an effective conservation action for gibbons in this important nature reserve.

Điều tra vượn đen má trắng siki (*Nomascus leucogenys siki*) ở Khu bảo tồn Thiên nhiên Đak Rông, tỉnh Quảng Trị, Việt Nam

Tóm tắt

Đak Rông là Khu bảo tồn Thiên nhiên duy nhất hiện này được thành lập ở tỉnh Quảng Trị. Đak Rông cũng được đánh giá là một trong những khu vực phân bố quan trọng của nhiều loài động vật nguy cấp như hổ đông dương (*Panthera tigris*), bò tót (*Bos gaurus*), sao la (*Pseudoryx nghetinhensis*) và chá vá chân nâu (*Pygathrix nemaeus*). Kết quả điều tra vượn và linh trưởng trong các năm 2003, 2004 và 2006 của chúng tôi đã cho thấy Đak Rông là một trong những vùng phân bố quan trọng nhất của hai loài vượn đen má trắng (*Nomascus leucogenys siki*) và chá vá chân đỏ ở Việt Nam. Phân bố của vượn ở Đak Rông chủ yếu tập trung ở hai khu vực chính là (i) khu vực A Cho1-A Cho2-Ba Lê-A Pông và (ii) khu vực rừng nằm giữa các xã Ta Long, Triệu Nguyễn, Ba Long và Hai Phúc.

Săn bắn và bẫy bắt bất hợp pháp là những nguyên nhân chính ảnh hưởng đến quần thể các loài động vật ở Đak Rông, bên cạnh đó suy thoái sinh cảnh sống và sinh cảnh sống bị quấy rầy là những ảnh hưởng chính tác động đến sự tồn tại của vượn và các loài linh trưởng ở khu vực. Hiện nay, vẫn còn một số tranh luận về phân loại học của loài vượn đang tồn tại ở Đak Rông, vì thế, các nghiên cứu nhằm khẳng định về phân loại học của loài vượn ở đây là rất cần thiết và sẽ giúp ích to lớn cho việc bảo tồn loài vượn ở Khu bảo tồn quan trọng này.

Introduction

Dak Rong Nature Reserve (NR) is not only the newest nature reserve of Vietnam, but also the

only protected area in Quang Tri Province. The protected area covers 40,253 hectares of natural forest. The nature reserve connects with Phong Dien Nature Reserve (Thua Thien Hue Province), making the area a large block of protected natural forest, as well as an important conservation site for Truong Son Mountains within the two provinces. Dak Rong NR is located on a low mountainous area of the Truong Son range. This nature reserve is also the boundary of Quang Tri and Thua Thien Hue Provinces (CRES, 2005). The average elevation for the mountains of the reserve ranges from 500 m to 1,102 m asl from Ba Le Mountain to Ba Long area (Anon., 2000; CRES, 2005). The general terrain is strongly influenced by mountains, valleys, and streams. Dak Rong forest is a watershed forest for the Dak Rong and Thanh Han Rivers and other important streams in the area which provide irrigation for 6 communes and the Dak Rong District surrounding the nature reserve.

At present, there are confirmed to occur in the nature reserve: 1,053 species of plants, 17 species of amphibians, 32 species of reptiles, 72 species of fish, 193 species of birds and 67 species of mammals (excluding bats and some rodents). Among the mammals, there are several globally endangered species, including the gaur (*Bos gaurus*), saola (*Pseudoryx nghetinhensis*), giant muntjak (*Muntiacus vuquangensis*), tiger (*Panthera tigris*), red shanked douc (*Pygathrix nemaeus*) and white-cheeked gibbon (*Nomascus leucogenys siki*) (Anon., 2000; CRES, 2005; Nguyen Manh Ha, 2005).

The white-cheeked gibbon is identified as one of the most endangered primates in Vietnam (Geismann *et al*., 2000; Government of Vietnam, 2006). In Vietnam, the distribution of this gibbon is limited to the western part of the Da River and the southern most distribution of this species is Bach Ma National Park, Thua Thien Hue province (Dao Van Tien, 1983; Pham Nhat, 2002). In a gibbon survey in the north-central region identified, Dak Rong as the most important distribution stronghold for this gibbon taxa for its entire range in Vietnam (Nguyen Manh Ha, 2005). This gibbon is seriously threatened in Vietnam due to accelerated deforestation, illegal hunting, and trade throughout all of its range (Nguyen Manh Ha, 2005; Geissmann *et al*., 2000; Ministry of Science, Technology and Environment, 2000). Nevertheless, information on this endangered primate is lacking, with uncertain population numbers and distribution, and there are no estimated population sizes at national or even local level.

Hence, in this 2nd survey, we wish to collect more information on the population status and distribution of the white-cheeked crested gibbon in Dak Rong NR. This survey yields a clearer view of the gibbon's status in the nature reserve, with recommendations for follow-up conservation work for this endangered species in the nature reserve and the north-central region of Vietnam.

Field surveys were carried out in Dak Rong from January 12 to January 23, 2006 and additional field surveys were conducted from June 11 to June 18, 2006. The survey team was a combination of one researcher from CRES, and two rangers from the Dak Rong NR. Surveys focused on two major areas in the nature reserve: one in the south-west part (Hong Thuy, A Bung, Ta Long and Huc Nghi communes) and one in the north-east part (Trieu Nguyen, Ba Long, Hai Phuc communes). These two areas were identified as the most concentrated distribution areas for gibbons in the nature reserve previously (Nguyen Manh Ha, 2005).

Methods

Methods used in this survey followed the primate training manual (Long *et al*., 2004). However, the most important methods are briefly described below:

Interviewing survey

Rapid interviewing trips were made to 9 villages in Hong Thuy, A Bung, Huc Nghi, Ta Long, Trieu Nguyen, Ba Long and Hai Phuc Communes. The purpose of the interviews was to collect updated information on gibbon presence in the area and to identify the local consumption or hunting of wildlife products to provide the survey team better information on the human impact on the fauna (including gibbons) in the nature reserve. In addition, these interviews provided reliable information allowing the team to make an effective survey schedule in areas where gibbons appeared the most frequently in the nature reserve.

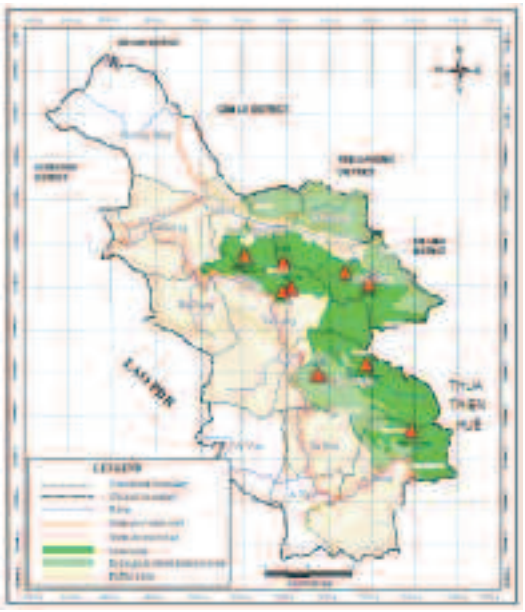

Fig. 1. Gibbon records in Dak Rong Nature Reserve, Quang Tri Province.

Transect survey

Nine random transect surveys were made. The length of transects were approximately 2 to 4 km, for a total of about 26 km during the surveys. The regular time of the transect walks were 09:00 to 11:00 and 14:00 to 16:00. In general, transect surveys were made after the survey team finished at listening posts. However, due to the extreme isolation of the mountainous terrain and the very dense and closed tropical forest canopy which limited observation distance (limited 10 to 15 metres), consequently, no gibbons were observed during the transects.

Listening post survey

Six listening posts were set up on mountain peaks and ridge tops for gibbon surveys. Each listening post was spaced 1 to 1.5 km apart to avoid duplicating the survey for the same gibbon group. Gibbon records were marked daily on a topographic map for gibbon census in the survey area.

The times spent at the listening posts were from 05:00 to 11:00. Survey team (three people) arrived at the listening post before 05:00. The compass and recording equipment were ready to go, and at 09:00 two people left the post for transect surveys. One ranger remained in the post for listening surveys until 11:00. Each listening post was surveyed for three days continuously (three listening posts were surveyed for four days due to bad weather).

Six groups of gibbons were tape recorded for future sonographic analysis and other conservation purposes.

Ranger Training

The survey provided field training for gibbon and primate survey skills for two rangers in the nature reserve. The rangers had good opportunities to learn and practice field survey skills and using field equipment such as unidirectional microphones and field recording equipment for gibbon survey, gibbon census techniques, and primate species identification. In addition, other field survey skills including using a GPS, reading a map, and using acompass were transferred to the rangers. These essential field survey skills will help the rangers in the protection of biodiversity of the Dak Rong NR.

Results

Gibbon records

During our survey, a minimum of 12 gibbon groups were confirmed by sound (Fig. 1). Bad weather and continuous raining during this survey may have limited the number of gibbon groups recorded as well as difficulties for the team while moving from camps within the survey area. However, results of the interview surveys suggested that the local population of gibbons had likely increase during the past few years as a consequence of improved forest protection activities and no gibbon hunting in the area.

In addition, information from our previous gibbon and mammal surveys in 2003 and 2004, (Nguyen Manh Ha, 2004; Nguyen Manh Ha, 2005) combined with this survey suggests that the forest complex A Cho1-A Cho2-Ba Le-A Pong (within Hong Thuy, A Bung, Ta Long and Huc Nghi communes) and forest complex within Ta Long, Trieu Nguyen, Ba Long, Hai Phuc communes are the two main gibbon distribution areas in Dak Rong (CRES, 2005; Nguyen Manh Ha, 2004; Nguyen Manh Ha, 2005).

Fig. 2. Habitat in Dak Rong Nature Reserve, Quang Tri Province. Photo: Nguyen Manh Ha.

The reasons for the gibbon concentration in these areas include the following: the areas include a major portion of the primary forest in the nature reserve; and these forest complexes are located away from local villages which may limit the impact from human activities to these forest resources (Fig. 2).

Among the 12 groups of gibbons recorded, most singing bouts range from 05:32 to 07:07 with the longest song bout being 17 minutes and the shortest bout being 05 minutes. The effects of weather on the singing behaviour of gibbons was clearly shown during the survey, e.g. in at least 3 listening posts, the gibbons did not sing until the third day of the survey due to raining and heavy fog. Conversely, the gibbons sang all morning when it was sunny (at least 3 posts had gibbons sing the entire three morning of surveying).

In comparison within the range of white-checked gibbons in the north-central region, Dak Rong is likely the most important area for this taxon (Nguyen Manh Ha, 2005). The reason that makes this area a stronghold for the white-cheeked gibbon is that Dak Rong and its neighbour Phong Dien NR combin to form a large block of natural forest (more than 80,000 ha of natural forest). Hence, this significant forest area probably forms a favourable habitat for the development of a sustain gibbon population in Dak Rong and Phong Dien.

Threats to gibbons and other conservation issues

Deforestation remains the most serious threat to wildlife (including gibbons) in Dak Rong NR. Evidence of deforestation in the forest area surrounding Dak Rong is clearly present, and this nature reserve now only connects to Phong Dien NR. These two nature reserves connect to form a green island.

Forest degradation by illegal logging is also a common phenomenon that occurs in the north and north-eastern part of the nature reserve. During our survey, at least 4 illegal logging places were recorded in the area of Ba Long and Trieu Nguyen Communes, and two others were recorded at Ta Lao and Huc Nghi. Local residents log for local consumption (housing and furniture) and a large part of logging is used for commercial purpose. Logging activity not only degrades the forest quality but also causes disturbance to the ecosystem.

Hunting and snare trapping are serious conservation problems in Dak Rong. Snare traps were

Fig. 3. Confiscated snare traps in a hunter camp. Photo: Nguyen Manh Ha.

Fig. 4. Ammunition collected in Dak Rong Nature Reserve. Photo: Nguyen Manh Ha.

recorded in the forest area of Hong Thuy, Ta Long, and Trieu Nguyen Communes (Fig. 3). Additionally, 100 snare traps were found in A Cho forest (Hong Thuy commune) and a hundred more were set in lesser concentrations in Ta Long and Trieu Nguyen. In addition, according to local information, there were hundreds more set up along the border of Dak Rong and Thua Thien Hue Province (Phong Dien NR). According to the nature reserve management board, snare trapping poses a serious threat to the mammals of Dak Rong, especially ungulates, cats, macaques, civets, as well as other animals. Hunting, using military gun, is also a critical threat to animals in the area. We met one group of two hunters using SKS military rifles (7.62x39 mm) in Dak Rong (Ba Le, Hong Thuy). The hunters informed us that they would hunt whatever mammals they found in the forest; however ungulates, large cats, bears, and primates are preferred! They confirmed that there are no exclusions for gibbons or any other endangered mammals during their hunting trip. Nevertheless, there were recent records of gibbons being killed by hunters in Dak Rong; however, we do not know if gibbons are a targeted species for hunting in the area.

War materials and unexploded ordinance collection is also common in the nature reserve (Fig. 4). Three groups of collectors were observed in the forest of Hong Thuy. The collectors travel in groups of 3-5 people to collect various types of war materials such as steel, bullets, un-exploded bombs, and other ordinance. Many people travel in search of material in the forest and probably cause a significant amount of disturbance to the natural habitat. In addition, the collectors sometimes burn collected materials causing explosions, this activity yields extreme disturbance in the forest and can lead to forest fires.

Discussion

Dak Rong NR is located between the natural range of two gibbon taxa: the yellow-checked gibbon (*Nomascus gabriellae*) and southern white-cheeked gibbon (*Nomascus leucogenys siki*). Because of this there has been recent discussion about the taxonomy of gibbons in Dak Rong. Are these yellow-cheeked gibbons, southern white-cheeked gibbons, hybrids or a third taxon? Therefore, additional taxonomic attention needs to be focused on these gibbons to help direct future conservation action in this area.

A comprehensive gibbon and endangered primate survey needs to be carried our for the forest complex that encompasses Phong Dien-Dak Rong Nature Reserves in order to provide further information about the status of gibbons and other endangered primates in this important area. In addition, a gibbon and endangered primate monitoring program is crucial to understand how populations of these species are changing.

Hunting and trapping are still big challenges to conservation in the area; therefore, effective enforcement of the law to control hunting and trapping is a crucial need in these nature reserves to ensure the survival and development of wildlife in this area.

During this survey only 12 gibbon groups were recorded. This record is lower than the record of a minimum of 25 groups in 2004 and 2005 (Nguyen Manh Ha, 2004 and Nguyen Manh Ha, 2005). Bad weather including rain may have influenced the survey results as well. There are two main distribution areas for gibbon in the nature reserve. These areas are A Cho1-A Cho2-Ba Le-A Pong area and the forest of Ta Long, Trieu Nguyen, Ba Long, Hai Phuc Communes. Dak Rong combines with Phong Dien Nature Reserve (Thua Thien Hue Province) to form a large forest complex in the north-central region of Vietnam providing suitable habitat for survival and development of gibbon populations in Quang Tri and Thua Thien Hue Provinces. Deforestation and nature forest degradation are continue to be major threats to gibbons in the area. In addition, hunting and snare traps pose serious threats to the mammals in Dak Rong NR.

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Morphological data of pygmy lorises (*Nycticebus pygmaeus*)

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Key words: Pygmy loris, *Nycticebus pygmaeus*, species identification, body measurements, sexual dimorphism.

Summary

The identification of the pygmy lorises *Nycticebus pygmaeus* appears to be still problematic. Sympatric occurrence and overlapping body mass ranges in obese or underweight individuals suggests that body mass data alone do not allow for species identification. Fur coloration has been found to be subject to seasonal changes and thus can also be misinterpreted. The paper looks into body measurements, potential sexual dimorphism of these measurements and their suitability for species identification.

Pygmy lorises can be best identified by taking a set of body measurements. Head-body length, taken from the top of the head to the base of the tail, of *Nycticebus pygmaeus* measures between 195 and 230 mm in adult animals. The average ear length for the pygmy loris is 23 mm and the average tail length is 18 mm. Ear length and tail length are not species specific and can only be assessed relative to the head-body length. Foot length should always be measured, since it is very consistent for the species and on average is 45 mm. Foot span, hand span and hand length should also be included.

Một số kết quả nghiên cứu hình thái của loài Culi nhỏ (*Nycticebus pygmaeus*)

Tóm tắt

Việc nhận dạng loài culi nhỏ *Nycticebus pygmaeus* vẫn là một vấn đề khó khăn và cần được nghiên cứu. Do loài culi nhỏ có một số khu vực phân bố trùng lặp với loài culi lớn, đồng thời trọng lượng của những cá thể riêng biệt của 2 loài có thể bằng nhau phụ thuộc vào thể trạng và từng giai đoạn phát triển của chúng. Do đó không thể chỉ dùng yếu tố trọng lượng để nhận dạng loài. Mặt khác, màu sắc lông của loài cũng thay đổi theo mùa dẫn đến những nhầm lẫn khi nhận dạng. Nghiên cứu này tìm hiểu về những số đo đặc trưng trên cơ thể loài culi, sự khác nhau do giới tính và khả năng dùng để nhận dạng loài.

Đối với loài culi nhỏ, phương pháp dùng các số đo này có thể là phương pháp tốt nhất. Chiều dài thân được đo từ đỉnh đầu đến gốc đuôi. Số đo chuẩn của cá thể trưởng thành từ 195 mm đến 230 mm. Trung bình chiều dài tai là 23 mm và dài đuôi là 18 mm. Tuy chiều dài tai và đuôi không phải là chỉ số đặc trưng của loài tuy nhiên có thể xem xét trong tương quan với chiều dài thân. Chiều dài của chi sau rất đặc trưng cho loài với kích thước trung bình là 45 mm. Độ rộng của chi sau, chi trước và chiều dài của chi trước cũng cần được xác định.

Introduction

As the name suggests the pygmy loris *Nycticebus pygmaeus* is distinguished from other Southeast Asian loris species mainly by its small size. The type specimen is described as weighing 377 g with a head-body length of 286 mm (Bonhote, 1907).

However, identification of the species can be problematic, as throughout its range east of the Mekong River in Vietnam, eastern Cambodia, Laos, and southernmost China (Streicher, 2004) the pygmy loris occurs sympatrically with the Bengal slow loris (*Nycticebus bengalensis*).

There is still uncertainty how to differentiate the two species, which is further complicated by the claimed existence of a third loris species *Nycticebus intermedius* (Dao Van Tien, 1960). But the latter species appears to be based on a misidentified *Nycticebus pygmaeus* (Groves, 1971; 1998; 2001; Streicher, 2004).

Discussions about the size of lorises are often primarily based on body mass and not actually on size, especially for live animals. Size and body mass usually are related with larger animals also having higher body masses. In the field it is obviously easier to estimate the body mass than the head-body length of the animals. Consequently, reports often use body mass as the characteristic to distinguish the pygmy loris from other loris' species.

Average body mass values for pygmy lorises are currently given as 420 g for males and 428 g for females (Streicher, 2005), whereas body mass values of Bengal slow lorises range between 1,100 and 1,400 g (Nekaris *et al*., 2006) and can in exceptions be as high as 2,000 g (Pro Wildlife unpubl., 2006).

Lorises of this size are unlikely to be mistaken for individuals of *Nycticebus pygmaeus*. The bodyweight values of the pygmy lorises in such cases differ to a degree, which allows easy species identification. But in the majority of cases distinction is less straightforward.

First of all, bodyweight has been found to be very variable in pygmy lorises and appears to be subject to a significant seasonal change, as in certain times of the year pygmy lorises might weigh up to 700 g (Streicher, 2004). On the other hand, trade confiscated individuals of the larger loris' species might be considerably emaciated, and weigh as little as 500-700 g (Streicher, pers. observ.).

Due to this variability bodyweight cannot serve as a reliable source of information for the taxonomic identification of the animals (Streicher, 2004).

To determine phenotypic characteristics suitable to distinguish the pygmy loris from other loris' taxa, a study on the fur colouration of pygmy lorises was conducted at the EPRC between 1999 and 2002. This study showed that the fur colouration also undergoes seasonal changes and thus cannot serve as a readily identifiable trait for the species' identification (Streicher, 2003).

So neither bodyweight nor fur colouration alone are sufficiently distinctive characteristics for species identification and field researchers often either misidentify species or indicate uncertainty about the actual loris species encountered (Vu Ngoc Thanh, pers. com). And until now, field researchers indicate uncertainty about the actual loris species encountered, and there is still widespread confusion on the identification of lorises in the field (Vu Ngoc Thanh, pers. com).

Exact species identification is essential for taxonomic classification as well as conservation efforts. Lack of accurate data makes it impossible to assess the conservation status of the species correctly.

It has been suggested that standard measuring methods should be followed (Streicher *et al*., in print, Streicher, 2004, Nekaris, 2006) to allow comparison between the gathered data and thus clarify the taxonomy of the species.

Until recently only few data were available on pygmy lorises actual body size (Groves, in litt.; Corbet & Hill, 1992; Bonhote, 1907) and these data were surprisingly variable and partly overlapping with size ranges for other loris species, in particular the sympatric Bengal slow loris. Also sexual dimorphism has been suggested for bodyweight and size (Groves, 2004; Kappeler, 1991; Nekaris *et al*., 2006).

The following data represent the first comprehensive overview about the body measurements of the pygmy lorises and provide standard values to facilitate further species identification.

Materials and Methods

27 adult pygmy lorises have been measured of which 15 were female and 12 were male. Lorises usually reach the bodyweight of an adult individual within less than a year, but under unfavourable conditions might not develop full body size for a considerably longer time (Ratajszczak, 1998). Therefore animals were only measured once they were at least two years of age. Pygmy lorises are strictly seasonal and all infants are born in February and March (Streicher, 2004) which facilitates age estimates.

The measurements were taken under anaesthesia. Ketamine has been used at an average

dosage of 27 mg/kg bodyweight. After intramuscular injection an anaesthetic effect is achieved after about 5 minutes, and anaesthesia lasts on average about 32 minutes (Streicher, 2004).

The measurements were taken as suggested by Streicher *et al.* (in print): Head-body length, upper arm length, forearm length, thigh length, knee height, hand length, hand span, foot length, foot span, tail length, maximum head length and ear length.

Head-body length was measured from the top of the head to the base of the tail.

Females and males were compared for each of the measurements, and statistical comparisons involved the use of both nonparametric and parametric analyses. These include Student's t and Mann-Whitney U tests, both analysed at P=0.05. Based on personal observations, it was hypothesised that there are no significant differences between the sexes, however all tests were two-tailed. Similarly, parametric analyses do not assume equal variances between the sexes. Nonparametric tests were performed because a general lack of morphometric data for *N. pygmaeus* cautions against assuming a normal distribution in measurement variables. Descriptive and comparative statistics were analysed with SPSS 11.0.

Results

A descriptive statistical summary for all variables measured is presented in Table 1. A few selective variables, which are supposed to be of importance in species identification are further explored and illustrated in the figures below.

Table 1. Student's *t*-test and Mann-Whitney U summary for thigh length of pygmy lorises.
The comparisons use P=0.05. Student's *t*-tests present degree of freedom, t_{crit} = critical values, and t_{obt} = obtained values. Values for t_{crit} are directional or one-tailed, and degrees of freedom do not assume equal variances. Mann-Whitney U tests present N_1 and N_2, the Z critical value for one-tailed tests and the obtained Z values.

Measurement Variable	Statistical comparison				
	Student's t-test summary				
				P-value	
	Degrees of Freedom	t_{crit}	t_{obt}	One-tail	Two-tail
Thigh length	25	1.71	2.55	0.03	0.05
	Mann-Whitney U summary				
	N1	N2	$Z_{crit.}$	$Z_{obt.}$	
Thigh length	15	12	1.65	2.22	

Table 2. Descriptive statistics for body measurements in *Nycticebus pygmaeus*.
All measures reported in mm, and sex is not differentiated.

Measurement variable	N of cases	Mean	Median	Standard Deviation	Coefficient of Variation
Head-body length	26	217	220	9.2	23.5
Upper arm length	27	61.2	62	4.6	13.3
Foream length	27	63.5	63	3.7	17.2
Thigh length	27	65.0	65	3.8	16.9
Knee height	27	74.9	75	4.7	16.0
Hand length	27	36.9	36	3.3	11.2
Hand span	27	53.1	53	3.5	15.1
Foot length	27	45.1	44	5.4	8.4
Foot span	27	64.7	65	3.5	18.3
Ear length	26	23.1	23	3.2	7.2
Maximum head length	25	50.6	50	4.3	11.8
Tail length	26	18.0	18	2.7	6.8

Head-body length

The average head-body length for adult female and male pygmy lorises is 216.3 and 217.9 mm, respectively. The standard deviation for females is 9.9 mm and for males 8.5 mm. The value range for females is between 195 and 230mm and for males between 200 and 230 mm. There is no significant difference between the sexes, and the mean head-body length for all animals averages 217.0 mm with a standard deviation of only 9.2 mm (Fig. 1 and 2).

Ear length

The average ear length for adult pygmy lorises is 23.8 mm in females and 22.2 mm in males. There is no significant difference between the sexes and the mean for all sexes is 23.1 mm with a standard deviation of 3.2 mm. Ear length varies from 14-32 mm in this sample (Fig. 3).

Fig. 1. Head-body length bar graph for the total *N. pygmaeus* samples, illustrating the frequency of occurrence based on set bin lengths. X-axis shows the highest value in the bin, with a set length of 5 mm. Each individual measure within the 5mm bin range contributes to the frequency of the Y-axis.

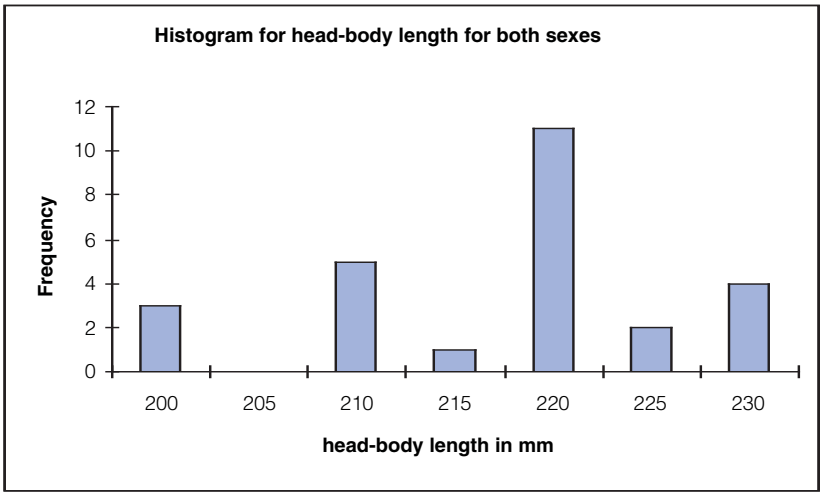
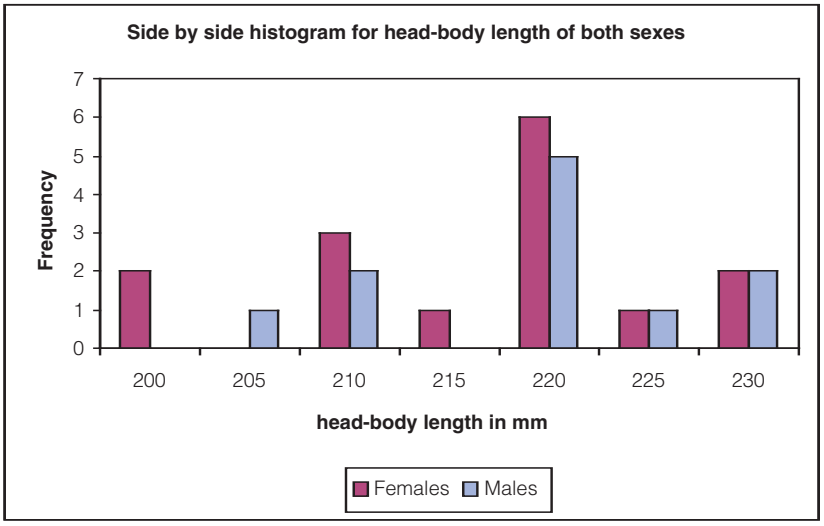


Fig. 2. Head-body length bar graph for both sexes, illustrating the frequency of occurrence based on set bin lengths. X-axis shows the highest value in the bin, with a set length of 5 mm. Each individual measure within the 5 mm bin range contributes to the frequency of the Y-axis.



Tail length

The mean values for tail length in female pygmy lorises are 18.0 mm and 17.4 mm in males. There is no significant difference between sexes and the mean for all sexes is 18.0 mm with a standard deviation of 2.7 mm. The tail length varies between 14 and 26 mm (Fig. 4).

Intermembral index

The intermembral index for the pygmy loris does not differ significantly between males and females, and is 89.3 for both sexes with a standard deviation of 5.0. The lowest value is only 76.0 and the highest value 99.2. The intermembral index was calculated with knee height, thigh length, forearm and upper arm length. The average is comparable to other members of Lorisidae, which general show little difference in intermembral index.

Fig. 3. Ear length bar graph for the total *N. pygmaeus* samples, illustrating the frequency of occurrence based on set bin lengths. X-axis shows the highest value in the bin, with a set length of 2 mm. Each individual measure within the 2 mm bin range contributes to the frequency of the Y-axis.

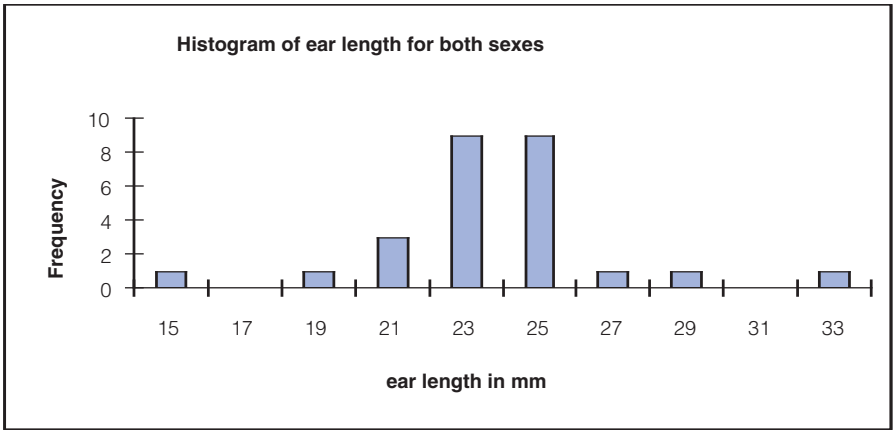


Fig. 4. Tail length bar graph of histogram for the total *N. pygmaeus* sample, illustrating the frequency of occurrence based on set bin lengths. X-axis shows the highest value in the bin, with a set length of 2 mm. Each individual measure within the 2 mm bin range contributes to the frequency of the Y-axis.

Comparative statistics

Significant differences were not anticipated between the sexes. And indeed statistical analyses, both parametric and nonparametric, reveal that all of the measurement variables were statistically insignificant in comparison, with the exception of thigh length. Females were found to have significantly longer thigh length than males using Student's t-test and Mann-Whitney U. The obtained t-value of 2.55 at 25 degrees of freedom, and z-value of 2.22, exceed the critical values for significance at P=0.05. However, this does not affect the intermembral index values between the sexes, which cautions against the significance of this difference. For females, thigh length averaged 66.2 mm with a standard deviation of 4.1 mm. In males the mean thigh length was 63.4 mm with a standard deviation of 2.9 mm. The difference is created by a few high outliers in the female data set, which suggests rather a measuring mistake than a valid difference. In general females and males do not differ significantly in this study.

Discussion

The main focus of the paper is to give a set of standard mean values for measurements for the pygmy loris, which can facilitate identification of species. Furthermore this paper aims to identify measurements, which are relatively consistent for the species and can easily be reproduced by different observers and can therefore serve as a species specific characteristic.

Probably the most important measurement is the head-body length. It is not only the measurement most often used for taxonomic descriptions, but also the measurement, which is most readily taken. Unfortunately it is also a measurement, where there is no general agreement how it has to be taken. I have earlier described, how it was measured in the course of these data collection, but it might be assessed different by different researchers. Head-body length might be measured in a fully stretched out animal from the root of the tail to the tip of the nose. This is commonly done on museum specimen and when skins are measured. However head-body length of living specimen is often taken from the top of the head to the root of the tail. The two values differ of course considerably, in adult pygmy lorises by about 50 mm. Consequently head-body length values can not be compared as long as the measuring method is not known. Currently available measurements for pygmy lorises head-body length are given as follows. 286 +/-18 mm (Bonhote, 1907), 230-287 mm (Groves, in litt.), 210-290 mm (Corbet & Hill, 1992). The high values can easily be explained under the assumption, that these data are based predominantly on dead individuals or skins, which have been measured fully stretched out.

If a measuring standard for head-body length can be generally accepted for this taxon, this measure has a high descriptive value. However in the study head-body length has been found to be the least consistent of all measurements taken with a high coefficient of variation. But still it appears sufficiently suitable as species specific characteristic in particular in its exclusivity. Animals with a head-body length of more than 230 mm are most likely not *Nycticebus pygmaeus*. However animals measuring 230 mm head-body length or less are not necessarily *Nycticebus pygmaeus* but could also be subadult representatives of another loris species. It is important to assess the age of the animal by other ways for example by dentition or vocalization (Lorises in the first two years of their life do also often utter a chirp or chitter, when being handled. Chirping or chittering animals should not be considered adult. (Streicher, pers. observ.)

Ear length and tail length are additional measurements, which are readily noted by researchers because they are obvious, visible characters. They are both very consistent for the species and have a low coefficient of variation. But preliminary data suggest that both ear and tail length values for adult *Nycticebus bengalensis* are nearly equal in range than for pygmy lorises and can therefore not serve as species specific characteristics. Ear length and tail length can only serve for species identification in combination with head-body length.

One more measure appears remarkable. Next to the ear and tail length foot length appears to be the measurement, with the lowest coefficient of variation. Foot length is also a measurement, where there is little chance for variation by different observers and a high consistency can be expected if data are collected. Foot length should therefore been generally measured if lorises are to be identified. A foot length of 45 mm suggests that the measured animal is a pygmy loris.

Foot span, hand length and hand span are as well easily measurable values. The coefficients of variation are higher than for foot length but variation was limited to a very narrow range.

Other measures are less useful for general species identification, because they are more difficult to take and there might be considerable differences between researcher's methods. And they can not be taken from skins or museum specimen.

However all morphometric data might give insights into the species' ecology. Is there any particular meaning for example to the hand and foot span of the species? Does this reflect in any way the living environment of the pygmy lorises? Is there any correlation between these measures and the diameter of branches preferably used for locomotion? And if so how different is it from the sympatric Bengal slow loris? After all these two loris species are the only lorisids that live in sympatry. So they must occupy different ecological niches. An obvious one would be the preferred tree level for foraging. Is this reflected in their morphology?

Within the lorisidae the pygmy lorises have the highest intermembral index and are the least hindlimb dominant species. This identifies them as active quadrupeds.

Conclusions

1. Pygmy lorises can be best identified by taking a set of body measurements.
2. Head-body length, taken from the top of the head to the base of the tail, of *Nycticebus pygmaeus* measures between 195 and 230 mm in adult animals.
3. The average ear length for the pygmy loris is 23 mm and the average tail length is 18 mm. Ear length and tail length are not species specific and can only be assessed relative to the head-body length.
4. Foot length should always be measured, since it is very consistent for the species and on average is 45 mm. Foot span, hand span and hand length should also be included.

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Diet of the Tonkin snub-nosed monkey (*Rhinopithecus avunculus*) in the Khau Ca area, Ha Giang Province, Northeastern Vietnam

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Key words: Tonkin snub-nosed monkey, Rhinopithecus avunculus, endemic, dietary ecology, Vietnam.

Summary

The Tonkin sub-nosed (TSN) monkey (*Rhinopithecus avunculus*) is both critically endangered and endemic to northeastern Vietnam. This species is one of the world's top 25 endangered primates. *Rhinopithecus avunculus* is known only from three isolated populations that are located in Ha Giang, Tuyen Quang and Bac Kan Provinces. The remaining population is estimated to consist of approximately 150 individuals. The two largest populations are found in Na Hang Nature Reserve (Tuyen Quang Province) and Khau Ca area (Ha Giang Province).

The diet of the TSN monkeys consists of a broad range of plants and plant parts. Since 2004, 31 food species have been identified belonging to 21 families. Leaf stems and fruits are the most common part of the TSN monkeys' diet (27.78%), followed by young leaves (flush leaves) (11.11%), unripe fruit (22.22%), inflorescences and flowers (8.33%) and seeds (2.78%). The plant foods most frequently consumed by the TSN monkeys are *Iodes seguini* (leaf stems and ripe fruits), *Garcinia fagraeoides* (leaf stems), *Acer tonkinensis* (leaf stems), *Excentrodendron tonkinensis* (flowers), and *Brassaiopsis stellata*. The toughness of the diet of the TSN monkey was also found to exceed that of other SE Asian colobines at the Endangered Primate Rescue Center, Cuc Phuong, Vietnam.

These dietary findings, when coupled with preliminary data on masticatory morphology, reveal unexpected ecomorphological relationships among members of the genus *Rhinopithecus* that we are examining in greater detail.

Thành phần thức ăn của Voọc mũi hếch (*Rhinopithecus avunculus*) ở khu vực Khau Ca, tỉnh Hà Giang, Đông Bắc Việt Nam

Tóm tắt

Voọc mũi hếch (*Rhinopithecus avunculus*) là loài linh trưởng đặc hữu của khu vực Đông Bắc Việt Nam và đang bị đe dọa tuyệt chủng. Loài này được xếp là một trong số 25 loài linh trưởng nguy cấp nhất trên thế giới. Voọc mũi hếch hiện chỉ được biết với 3 quần thể ở các tỉnh Tuyên Quang, Hà Giang và Bắc Kạn. Số lượng ước tính của loài hiện chỉ còn khoảng 150 cá thể. Hai quần thể lớn nhất có ở Khu bảo tồn Thiên nhiên Na Hang (tỉnh Tuyên Quang) và khu vực Khau Ca (tỉnh Hà Giang).

Thức ăn của voọc mũi hếch gồm nhiều loại loại thực vật. Kể từ năm 2004 đến nay, kết quả nghiên cứu đã ghi nhận 31 loài thực vật, thuộc 21 họ, là thức ăn của voọc mũi hếch. Thành phần thức ăn của voọc mũi hếch gồm có quả xanh (25%), quả chín (22,2%), cuống lá (22,2%) còn lại là hoa, lá non, lá trưởng thành và hạt. Một số là thức ăn ưa thích của voọc mũi hếch là: *Iodes seguin*i (cuống lá và quả chín), *Garcinia fagraeoides* (cuống lá), *Acer tonkinensis* (cuống lá), *Excentrodendron tonkinensis* (hoa) và *Brassaiopsis stellata* (quả chín). Độ bền của một số loại thức ăn của voọc mũi hếch cũng đã được nghiên cứu và cho thấy hơn hẳn các loài khỉ ăn lá của vùng Đông Nam Á đang được nuôi nhốt tại Trung tâm Cứu hộ Thú Linh trưởng Nguy cấp, Cúc Phương, Việt Nam.

Các kết quả nghiên cứu về thức ăn này, cùng với các số liệu về hình thái hàm, cho thấy mối quan hệ hình thái-sinh thái không mong muốn trong các loài thuộc giống *Rhinopithecus*. Những mối quan hệ này đang được chúng tôi tiếp tục nghiên cứu chi tiết.

Introduction

The Tonkin snub-nosed monkey (*Rhinopithecus avunculus*) is restricted to a small area in northern Vietnam where it is endemic. This species was named by Dollman (1912), but very few sightings of it occurred in the following decades, leading Mittermeier & Cheney (1986) to state "the Vietnamese snub-nosed monkey (*Rhinopithecus avunculus*) from Tonkin may already be extinct. It is known from only a handful of museum specimens collected earlier in this century, and there are no recent reports of it from the wild."

While not extinct, it is critically endangered with Nadler *et al*. (2003) and Mittermeier *et al*. (2005) reporting that only three small populations of Tonkin snub-nosed (TSN) monkeys are now known, consisting of less than 300 individuals. In fact, Cowlishaw & Dunbar (2000), in their influential *Primate Conservation Biology* text, use the snub-nosed monkeys as the first example of primates in peril of extinction, stating that of the four *Rhinopithecus* species, the TSN monkey is the most endangered. Populations in Na Hang and Cham Chu Nature Reserves identified in the early 1990's are severely threatened by human activities. The third population, which occurs in Khau Ca adjacent to the Du Gia Nature Reserve, Ha Giang Province was initially confirmed to exist at this site in 2002 (Le Khac Quyet, 2002; 2004) (Fig. 1).

Fig. 1. Tonkin snub-nosed monkey (*Rhinopithecus avunculus*) in Khau Ca area, Ha Giang Province. Photo: Le Khac Quyet.

Only one long-term study of the Tonkin snub-nosed monkey was conducted (Boonratana & Le Xuan Canh, 1998a, b) prior to the present project. This study collected valuable information on the social behavior and ecology of this rare species, and our results complement those of this earlier research.

Although conservation efforts have led to better protection for the monkeys and their habitat in Khau Ca, hunting, habitat loss and disturbance remain considerable threats, particularly in Nha Hang and Cham Chu (Le Xuan Canh & Boonratana, 2006). In fact, recent surveys in these areas indicate that populations have declined significantly in the past few years. Studies of this species' behavior and ecology are still limited, but are necessary to develop sustainable and effective conservations strategies. This report presents information on the diet of TSN monkey in the Khau Ca area based on a long term study from December 2004 – May 2006.

Material and Methods

Study site

The present study was conducted between December 2004 and May 2006 in a limestone forest in the Khau Ca area (22°51'N; 105°08'E) of Ha Giang Province, northeastern Vietnam (Fig. 2). This small patch of limestone forest is located in three communes of Ha Giang Province: Tung Ba (Vi Xuyen District), Yen Dinh and Minh Son (Bac Me District). Its total area is approximately 1,000 ha (Fig. 3).

This region is situated in the northern tropics, the climate is hot and wet, and includes a dry

Fig. 2. Habitat of the Tonkin snub-nosed monkey in Khau Ca area in Ha Giang Province, northeastern Vietnam. Photo: Le Khac Quyet.

season. Total rainfall is around 2,300 mm/year. The mean annual temperature is around 23.3°C. The lowest mean relative humidity occurs during October and December (35.5%) and the highest during February and March (87% and up to 100%). The dry season (<100 mm rain/month) extends from October to March and the rainy season from April to September (≥100 mm rain/month) (Fig. 4).

Fig. 3. Study site in northeastern Vietnam.

Fig. 4. Climate diagram of January 2004 – September 2005.

The forest may be generally labeled lower montane evergreen limestone forest. In the study site, the tree community is dominated by *Excentrodendron tonkinense* (Tiliaceae), *Garcinia* spp. (Clusiaceae), *Pometia pinnata* (Sapindaceae), *Diospyros* spp. (Ebenaceae), *Dendrocnide urentissima* (Urticaceae), *Bridelia balansae* (Euphorbiaceae), *Rhododendron* spp. (Ericaceae), *Illicium* spp. (Illiciaceae), *Vernicia* spp. (Euphorbiaceae), *Acer* spp. (Aceraceae), *Schefflera* spp. (Araliaceae), and *Quecus* sp (Fagaceae) (Nguyen Anh Duc *et al.*, 2006).

Methods

The methods presented in this section are on going, however the data used for this study were collected between December 2004 and May 2006. Plants observed to be consumed by the Tonkin snub-nosed monkey were collected throughout the study period. The samples were pressed and dried and are housed in the Botanical Museum of Hanoi University of Science - Vietnam National University. Data on feeding bouts are obtained, both opportunistically and systematically, by observers collecting foods processed by the TSN monkey. A tissue feeding bout is scored when a monkey processes a plant tissue. Regardless of the number of times a tissue from a single food type is processed a day, it is counted as a single tissue bout. This collection technique insures that tissue bouts can be treated as independent data points. These data are used to calculate the percent contribution of foods and food parts in the diet. Additional data on dietary mechanics were collected in June and October (2005) using a mechanical tester designed by Lucas *et al.* (2001) (also see http://www.gwu.edu/~hebdp/fieldtech/ for further details on these methods and equipment).

Four one kilometer by two meter phenology transects were established in order to evaluate tree composition and permit us to assess food selectivity relative to food availability in the TSN monkey population at Khau Ca. By establishing transects we reduced additional cutting, permit phenology to be tracked immediately, and allowed census walks and phenology tracking to be conducted simultaneously.

For each tree captured by the transects, we established the taxon to at least the family level. We also measured DBH, bole height, tree height, canopy shape, canopy diameters (both long and short), % leaf flush, % flower/inflorescence, % fruit, and identified associated climbers and epiphytes.

Eight 20x50 m plots are being established in different eco-regions throughout the site. The data from these plots will be compared to those from the transects. The sampling method to be employed for these plots has been long established by botanists at the Vietnam National University, Hanoi and will provide a data set that can be directly compared to other studies conducted by VNU researchers.

Results

Dietary preference

The diet of *R. avunculus* consists of a broad range of plants and plant parts. Since 2004, 31 food species have been identified belonging to 21 families. Unripe fruits (25.0%), ripe fruits (22.2%) and leaf petioles (22.2%) are the most common part of the TSN monkeys' diet, followed by young leaves (flush leaves) (11.11%), inflorescences and flowers (8.33%), seeds (5.56%) and piths (2.78%) (Table 1).

The plant foods most frequently consumed by *R. avunculus* are *Iodes seguini* (leaf stems and ripe fruits), *Garcinia fagraeoides* (leaf stems), *Acer tonkinensis* (leaf stems), *Excentrodendron tonkinensis* (flowers) and *Brassaiopsis stellata* (ripe fruits).

Toughness for foods processed by *R. avunculus*

Among items tested for toughness, cambium (1577.5 Jm^{-2}), leaf lamina (1370.6 Jm^{-2}) and leaf stems (1230.9 Jm^{-2}) are the toughest tissues ingested by the *R. avunculus*, followed by whole fruit (1147.53 Jm^{-2}), seed coats (1129.6 Jm^{-2}), bark (981.6 Jm^{-2}), mesocarp (382.9 Jm^{-2}), endosperms (351.9 Jm^{-2}), and exocarps (231.4 Jm^{-2}). B. Wright, L. Ulibarri and J. O'Brien (pers. observ.) have found that the toughness of the cambium, stems, and leaf lamina ingested by the *R. avunculus* is greater than that of tissues selected by two *Pygathrix* and two *Trachypithecus* species studied at the Endangered Primate Rescue Center in Cuc Phuong National Park (Table 2 and 3) (Covert *et al.*, in press).

Plant food selectivity

Of the 48 tree families captured by the transects, 21 (46%) were in the diet of the TSN mokeys. The total number of trees on the transects, which were in the families that the TSN monkeys fed, were 738 (67%) out of 1103 total trees. When analyzing selected foods by family, the TSN monkeys appear to be quite liberal in their selection of food items. However, the analysis by genus suggests greater discrimination. Of the 93 identified tree genera, 12 (13%) were eaten by the TSN monkeys. This represents 301 (28%) out of a total of 1093 trees identified to genus. Thus, the TSN monkeys appear to be quite dietarily selective when more exclusive taxonomic categories are used for the analysis.

Discussion

In their 1999 report on the Guizhou snub-nosed monkey (*R. brelichi*), Sun Dun Yuan *et al*. (1999) state that "the snub-nosed monkeys represent an ecological array whereby shared characteristics show modification based on differing environments – from the tropical limestone forest of the Tonkin golden [snub-nosed] monkey to the Himalayan temperate forest of the Yunnan golden [snub-nosed] monkey [*R. bieti*]" (p.14). They further state that this environmental gradation has produced a "step-wise gradation of morphology and behavior." The findings from our and other studies, when coupled with preliminary data on the craniofacial morphology of *R. avunculus* and *R. roxellana*, suggest a more complex set of relationships among environment and morphology than identified by Sun Dun Yuan *et al.* (1999).

Fruits, seeds, and leaves were reported by Sun Dun Yuan *et al*. (1999) to be the primary resources consumed by the Tonkin-snub nosed monkey. These findings were based on the previous study of Boonratana and Le Xuan Canh (1998a) in Na Hang. The findings from our longer term study at Khau Ca reveal that stems, young leaves, and unripe fruit are the major contributors to the diet of *R. avunculus* at Khau Ca. These disparate findings may represent a difference between available plant species at these two sites, seasonal dietary differences, or cultural differences in food preference between populations. The percentage of food types consumed by both *R. roxellana* and *R. bieti* also has been found to vary from those reported by Sun Dun Yuan *et al*. (1999). Where the diet of *R. roxellana* was reported to consist primarily of leaves, leafbuds, and

Table 1. List of plant species consumed by Tonkin snub-nosed monkey (Rhinopithecus avunculus) in Khau Ca area, Ha Giang Province.

No.	Latin name	Consumed items
	Aceraceae	
1	*Acer tonkinensis* Lec.	St
	Apocynaceae	
2	*Melodinus tourneri* Pierre ex Spire	unFr
3	*Apocynaceae* sp.	St
	Araliaceae	
4	*Brassaiopsis* stellata Fang	rFr
5	*Brassaioopsis* sp.	rFr
6	*Schefflera aff. velunosa* (W. & Arn.) Harms.	P
7	*Schefflera palmiformis* Grushv	St
	Asclepiadaceae	
8	*Goniostemma punctatum* Tsiang & P. T. Li	St
	Bignoniaceae	
9	*Rhadermachera* sp.	Flo
	Clusiaceae	
10	*Garcinia bracteata*	St, rFr
11	*Garcinia fagraeoides*	rFr
	Ebenaceae	
12	*Diospyros* sp.	Fl, Flo
	Euphorbiaceae	
13	*Antidesma* sp.	Fl
14	*Bridelia retusa* (L.) Spreng.	rFr
15	*Sapium rotundifolium* Hemsl.	Sd
	Fabaceae	
16	*Dalbergia tonkinensis* Prain	rFr
	Lauraceae	
17	*Litsea baviensis* Lecomte	unFr
18	*Litsea* sp.	unFr
19	Lauraceae sp.	unFr
	Icacinaceae	
20	*Iodes seguini* (Lévl.) Rehd.	St, rFr
	Mimosaceae	
21	*Archidendron* sp.	Sd
	Moraceae	
22	*Ficus* sp.	Fl
	Oleaceae	
23	Olea sp.	unFr
	Orchidaceae	
24	*Bulbophyllum affine* Lindl.	L
	Sabiaceae	
25	*Meliosma fordii* Hemsl.	St
	Sapindaceae	
26	*Pometia pinnata* J.R et G.Forst.	rFr, unFr
	Sapotaceae	
27	*Sinosideroxylon wrightianum*	St
	Tiliaceae	
28	*Excentrodendron tonkinensis* (Chev.) Ching & Miav.	unFr, Flo
	Vitaceae	
29	*Tetrastigma oliviforme* Pl. in DC.	unFr
30	*Tetrastigma* sp.	unFr
	Urticaceae	
31	*Debregeasia squamata* f. *etuberculata* Wilmot - Dear	Fl

Notes: St - Leaf stems; Fl – flush leaves; rFr - Ripe fruit; unFr - Unripe fruit; Flo - Flowers; Sd – Seeds; P – Piths

Table 2. Average toughness (J m^{-2}) for foods processed by *R. avunculus*.

Items	Average toughness
whole fruit	1147.53
exocarp	231.40
mesocarp	382.90
seed coat	1129.60
endosperm	351.90
stems	1230.93
lamina	1370.56
bark	981.60
cambium	1577.50
flower	257.88

Table 3. Average toughness (J m^{-2}) for foods processed by *R. avunculus* and two representative species of *Pygathrix* (*P. nemaeus* and *P. cinerea*) and *Trachypithecus* (*T. laotum hatinhensis* and *T. delacouri*).

	Average toughness
Trachypithecus	1,156
Pygathrix	1,238
Rhinopithecus	1,393

fruit/seeds, Li Baoguo *et al*. (2002) found a marked seasonal shift in the diet of this primate species from consumption of a majority of fruits (38%), arboreal lichen (21%), and buds (17%) to a winter diet consisting of primarily lichens (41%), bark (23%), and buds (22%). In turn, lichens and leaves were reported to make up the majority of the diet of *R. bieti* (Sun Dun Yuan *et al*., 1999) and while other studies have found lichen to be the primary component of the diet of *R. bieti*, the contribution of this food item can vary between 60 and 95% (Wei Ding & Qi-Kun Zhao, 2004). Furthermore, another group of *R. bieti* at lower altitudes at this same site subsisted primarily on bamboo leaves >50% (Wei Ding & Qi-Kun Zhao, 2004).

The seasonal variation among the diets of *R. avunculus*, *R. roxellana*, and *R. bieti* brings into question the way in which these primate species partition foods mechanically. Wright (2004) has shown that the diets of primates that differ markedly in the percent contribution of different foods types may have diets that are comparable in toughness. The presence of *R. avunculus* in lower altitude evergreen tropical rain forest, and the initial findings of Boonratana & Le Xuan Canh (1998a) that fruit was the major contributor to this species diet, suggests a diet that is relatively mechanically weak. In turn, it may be predicted that these ecological and dietary attributes may be reflected in a more gracile mandible. However, preliminary data collected by Wright & Prodhan (in prep.) reveals that the width of the mandibular corpus (Fig. 5) and depth of the mandibular symphysis (Fig. 6) exceeds that of *R. roxellana* and greatly exceed those of a range of Asian and African colobines. These morphological findings suggest that tougher foods, such as stems and leaves, may be the primary contributors to the diet of the Tonkin snub-nose monkey, as our findings show, and that the diet of this low tropical rainforest dweller may exceed that of its more temperate forest dwelling congeners.

Conclusions

Rhinopithecus avunculus consumes a broad range of plants and plant parts. From a long term study at Khau Ca, 31 food species have been identified belonging to 21 families. Leaf stems, young leaves and unripe fruits are primary resources consumed by *R. avunculus*. Among items tested for toughness, cambium, leaf lamina and leaf stems are the toughest tissues ingested by the *R. avunculus*. The toughness of the cambium, stems, and leaf lamina ingested by the *R. avunculus* is greater than that of tissues selected by two *Pygathrix* and two *Trachypithecus* species studied at the Endangered Primate Rescue Center in Cuc Phuong National Park. The TSN monkey also appears to be quite dietarily selective, although its dietary breadth is still unclear. The morphological findings suggest that the dietary toughness for *R. avunculus* – a low tropical rainforest dweller, may exceed that of its more temperate forest dwelling congeners.

We plan on continuing data collection on the ecology of the TSN monkey at Khau Ca for the

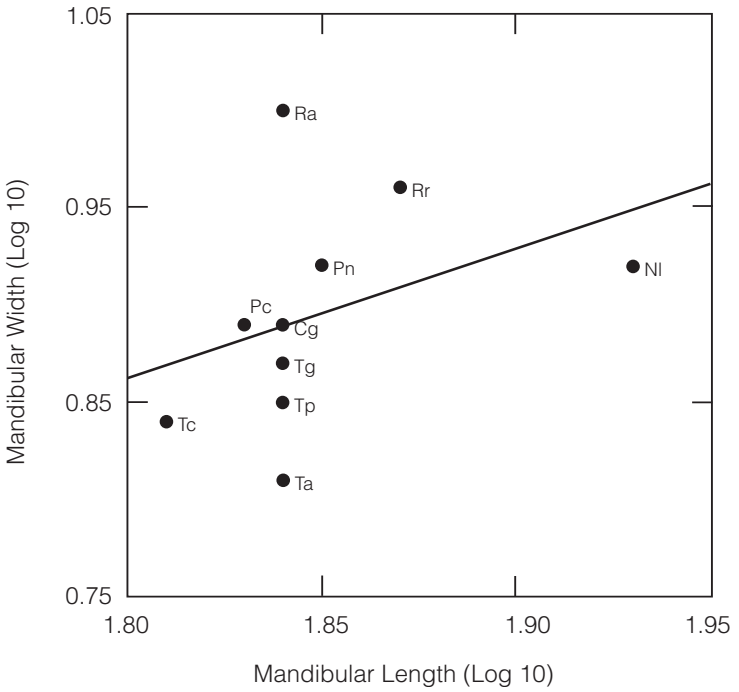

Fig. 5. Comparison of the mediolateral width of the mandibular corpus to mandibular length among a sample of colobines from Southeast Asia and Africa. Cg = *Colobus guereza*, Nl = *Nasalis larvatus*, Pc = *Pygathrix cinerea*, Pn = *P. nemaeus*, Ra = *Rhinopithecus avunculus*, Rr = *R. roxellana*, Ta = *Trachypithecus auratus*, Tc = *T. cristatus*, Tg = *T. germaini*, Tp = *T. phayrei.*

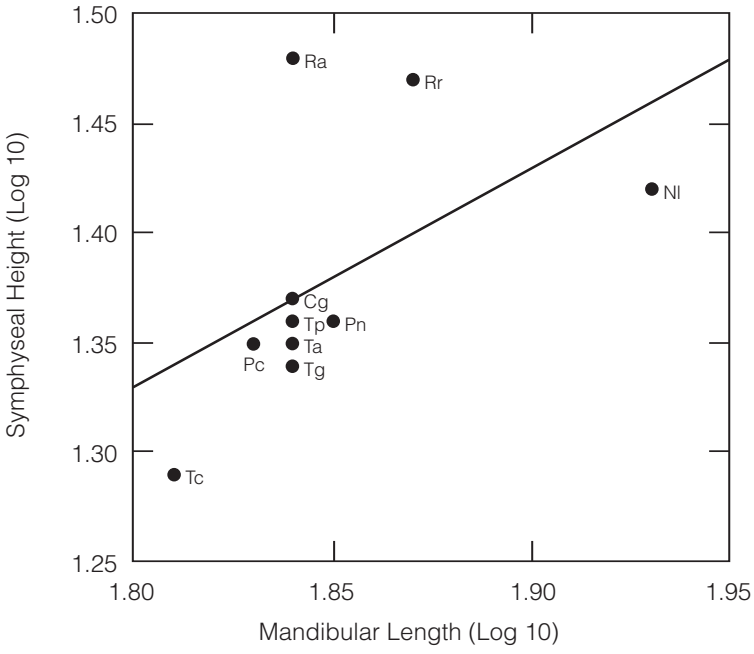

Fig. 6. Comparison of symphyseal height to mandibular length among a sample of colobines from Southeast Asia and Africa (see species key for Fig. 4). Cg = *Colobus guereza*, Nl = *Nasalis larvatus*, Pc = *Pygathrix cinerea*, Pn = *P. nemaeus*, Ra = *Rhinopithecus avunculus*, Rr = *R. roxellana*, Ta = *Trachypithecus auratus*, Tc = *T. cristatus*, Tg = *T. germaini*, Tp = *T. phayrei.*

foreseeable future. Forthcoming data should allow us to better understand the effects of seasonality on the diet of this extremely rare primate.

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Establishment of a Primate Data Base at the Endangered Primate Rescue Center, Vietnam

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Key words: Primates, Vietnam, Primate Data Base

Summary

The fast development of Vietnam has had a substantial impact on natural resources of the country. All primate species in Vietnam are under high pressure, some of them on the brink of extinction. In particular, the Vietnamese endemic species are highly threatened. The nation of Vietnam is responsible for the guarantee of their preservation and survival. To support the biodiversity conservation a documentation of the historical and current changes of the fauna is necessary. A comprehensive data set for primates should support statements about the status of populations, threats, decisions about land use and protected areas.

The Endangered Primate Rescue Center at Cuc Phuong National Park has been involved in primate conservation work for more than ten years, and is also a center for the collection of information regarding to primates. The center purchased the special computer program "Bio-Office" and is going to establish a "Primate Data Base" which should contain relevant data about Vietnamese primates. This data base should be comprised of new results of surveys and research as well as historical information.

The EPRC would like to invite institutions, organizations, and scientists who are working on primate related fields to contribute publications, reports, and information. In exchange the information in the data base will be freely accessible in the future through a browser on the internet.

Thiết lập cơ sở dữ liệu về thú linh trưởng tại Trung tâm Cứu hộ Thú Linh trưởng Nguy cấp, Việt Nam

Tóm Tắt

Sự phát triển nhanh chóng ở Việt Nam đã dẫn đến những tác động nghiêm trọng lên nguồn tài nguyên thiên nhiên của quốc gia. Tất cả các loài thú linh trưởng có ở Việt Nam đều trong tình trạng bị đe doạ nghiêm trọng, một số loài đang đứng trước nguy cơ tuyệt chủng. Đặc biệt là đối với các loài thú linh trưởng đặc hữu của Việt Nam. Chính phủ Việt Nam cần có biện pháp đảm bảo sự tồn tại và phát triển của các loài thú linh trưởng này. Nhằm thúc đẩy công cuộc bảo tồn đa dạng sinh học ở Việt Nam, dữ liệu về những thay đổi trong quá khứ và hiện tại của hệ động vật là rất cần thiết. Một dữ liệu hoàn chỉnh sẽ giúp thấy rõ tình trạng bảo tồn, các mối đe doạ đối với thú linh trưởng ở Việt Nam, trên cơ sở đó những quyết định đúng đắn về các khu vực bảo vệ và sử dụng tài nguyên đất sẽ được đề xuất.

Trung tâm Cứu hộ Thú Linh trưởng Nguy cấp Việt Nam (TTCHTLTNC) tại Vườn Quốc gia Cúc Phương đã tham gia vào công cuộc bảo tồn các loài thú linh trưởng Việt Nam hơn 10 năm nay và nơi đây cũng là Trung tâm thu thập nhiều dữ liệu về các loài thú linh trưởng. Hiện tại, Trung tâm đang xây dựng "Cơ sở dữ liệu về linh trưởng Việt Nam" dựa trên phần mềm "Bio-Office". Cơ sở dữ liệu này sẽ cung cấp đầy đủ thông tin về những kết quả nghiên cứu và khảo sát gần đây cũng như cung cấp những thông tin nghiên cứu trước đây.

Trung tâm Cứu hộ Thú Linh trưởng Nguy cấp kính mong các viện nghiên cứu, các tổ chức và các nhà khoa học có nghiên cứu về linh trưởng đóng góp tài liệu, báo cáo và thông tin khoa học để

cơ sở dữ liệu được hoàn thiện. Sau khi hoàn thành cơ sở dữ liệu này sẽ giúp các nhà nghiên cứu cung cấp, trao đổi thông tin một cách tự do trên mạng Internet.

Introduction

Vietnam is the country with the fastest economic growth in Southeast Asia. This rapid growth has brought dramatic reduction in poverty and improvements in the material standard of living for most of its people. With development and continuously human population growth has also come expansion of urban areas, rapid land use changes, growing exploitation of natural resources, and intense pressure on the nature (Ministry of Natural Resources and Environment *et al.,* 2005).

In the 19th century, Vietnam was richly endowed with high-quality forest, covering nearly the whole country probably 30 Mha of the country's 33 Mha. By 1943, the forest cover had been reduced to only 14 Mha. From then on, forest area decreased very rapidly, in particular during the war, and in the period following the war, from 1976 to 1985. In 1990, the government estimated a decline to 11 Mha. Major national reforestation programs have turned around these negative trends, and in 2004 the forest cover increased to 12.3 Mha. But only 7 percent of the remaining forests are considered "primary" forests, and nearly 70 percent of remaining forests are considered to be poor quality and secondary forests (Ministry of Natural Resources and Environment *et al*., 2005).

The decrease of forest and forest fragmentation set a high pressure to forest dwelling animal species. Many, in particular larger mammal species, are additionally threaten through increasing poaching. Poaching is one of the most significant threats to many animal species. In 2002, the trade in wildlife within and from Vietnam amounted to approximately 3,050 tons and was worth over US$66 million (Ministry of Natural Resources and Environment et al., 2005)! A not negligible part is the primates. Nearly all 25 primate taxa in Vietnam are threatened with extinction, 7 listed as "Critically Endangered", 9 as "Endangered", 7 as "Vulnerable" and only two species fall into the category "Least Concern" (Southeast Asia Mammal Data Bank, 2006).

Quickly changing primate habitats – a result of various factors including population growth, deforestation and economic development – and the impact of poaching on primate populations make documentation, that will contribute to the conservation of the country's biodiversity, necessary.

This documentation allows for the monitoring of population development and status, aid decisions about conservation activities, land use planning and proper use of resources which avoid or minimize negative impacts to the threatened species.

The fast changing primate habitats trough various reasons and the impact on primate populations through poaching make a documentation necessary which allowed following up the development of populations, support decisions about conservation, land use planning and resource use to avoid or to minimize the impact to the threatened species, and to contribute to the conservation of the country's biodiversity.

In 2006 the Endangered Primate Rescue Center established a data base for Vietnam's primates.

Content of the "Primate Data Base"

The Primate Data Base strives to provide a comprehensive overview of all primate related data that belongs to the country's primate fauna. This should include:

- description of the taxa
- systematics, molecular genetics, anatomy
- distribution, population density, population dynamics
- ecology, habitat structures, feeding ecology, resources use
- behavior, social structures, ranging behavior, dispersal and inter group relations
- threats, habitat disturbance, poaching
- land use planning in the distribution area
- recommendations for conservation actions
- photo archive from primate species and primate habitats

The data base should also contain all information from historical time regarding previous distribution and population densities. Historical publications and documents should be available in a scanned version.

Publications and documents, including reports of organizations which are available in an electronic version should be available in PDF-Format.

"BioOffice" program of the Primate Data Base

BioOffice is *the* software solution for the management of biological distribution data, for cartographic presentation, spatial analysis and interchange of data from field surveys as well as data collection. The comprehensive data model which BioOffice is based on allows the integration of spatial and factual information. It features both GIS and database functionality in one product. The digital recording of biological data in their spatial context and the presentation in maps puts them in a new perspective.

BioOffice surpasses conventional software tools currently available for the management of biological data, because it combines an extensive data base module – used for the documentation of factual characteristics of objects – with an integrated GIS module, which enables the gathering, representation and evaluation of the spatial relation of these objects – without requiring sophisticated software expertise.

The program is a tool for the visualization, evaluation and utilization of area-related biological data, for use in working with taxon based information in projects such as field surveys, biodiversity issues, monitoring and a support for resources management and land use planning.

Organisation of the Primate Data Base

In the beginning of the project, a Primate Data Base manager will collect all primate relevant sources for a reference catalog. The reference catalog should contain the complete papers, articles, books, and also unpublished reports and information.

Information about primate taxa (systematics, genetics, anatomy, distribution, population dynamics, biology, ecology, threats etc.) and about primate habitats (forest type and structure, protection status, climate, forest use, land use planning etc.) should be extracted from the reference catalog.

In a second step, contributions to the Data Base can made from participants through internet directly to the program as provisional data until the information is reviewed and involved in the program.

In addition to the data collection, a photo catalog about the primate species, habitats and habitat changes are also considered. Images are not for use in commercial purposes and are managed under strict commitments of the authors.

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Endangered Primate Rescue Center, Vietnam - Report 2004 to 2006

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Key words: Primates, Vietnam, Endangered Primate Rescue Center

Summary

The Endangered Primate Rescue Center is both a part of and the operational base of the "Vietnam Primate Conservation Programme" of the Frankfurt Zoological Society.

Since its establishment in 1993, the Endangered Primate Rescue (EPRC) has published regularly the "EPRC-Newsletter." *The Vietnamese Journal of Primatology* creates a platform to make all the newsletter information accessible to a broader circle of readers. Reports from the EPRC should be regularly published in the journal.

The number of primates at the EPRC increased continuously from the end of 1993 (8 individuals) to the end of 2006 (145 individuals). The number of taxa has also increased from two to fifteen. By the end of 2006, 109 individuals from nine taxa had been born at the center. Among those born were four species born for the first time ever in captivity: the Delacour's langur, Hatinh langur, Cat Ba langur, and grey-shanked douc langur.

The center has 43 cages for langurs and gibbons with a total surface area of 2,750 m^2, 6 indoor enclosures comprising 110 m^2, and 13 cages for lorises with a total surface area of 100 m^2.

The quarantine station has four outdoor enclosures (total 60 m^2), two indoor enclosures (total 50 m^2), a surgery room and a preparation room. Of particular significance are the two electrically-fenced semi-wild enclosures with primary forest (roughly 2 and 5 ha).

The staff at the center has grown to currently 20 Vietnamese workers, five Vietnamese biologists, one Vietnamese project assistant, two foreign animal keepers, and one foreign project leader. One foreign veterinarian has been working at the center from 1997 to autumn 2006.

In cooperation with Vietnamese and foreign institutions and universities, the EPRC has contributed immensely to knowledge of the systematics, molecular genetics, locomotion, nutrition and feeding ecology of Indochinese primates.

Van Long Nature Reserve is an important contribution to the protection of the largest and probably only viable population of the "Critically Endangered" Delacour's langur.

In 2005, preparations began for a long-term reintroduction program in Phong Nha - Ke Bang National Park. The first step is the construction of a 20 ha electrically-fenced semi-wild area. The first species selected for the reintroduction is the Hatinh langur.

The EPRC contributes in several ways to raising awareness about wildlife conservation, especially primate protection and education. Numerous publications and TV reports called attention to the highly endangered and endemic Vietnamese primates.

Besides a basic financial contribution to the EPRC provided by the Frankfurt Zoological Society, finances originate from numerous conservation organizations, zoos and private people who contribute to the "Vietnam Primate Conservation Programme". Without their ongoing support the EPRC would not be able to continue its work for primate conservation in Vietnam.

Trung tâm Cứu hộ Thú Linh trưởng Nguy cấp Việt Nam - Báo cáo 2004-2006

Tóm tắt

Trung tâm Cứu hộ Thú Linh trưởng Nguy cấp (TTCHTLTNC) là một phần của dự án "Bảo tồn Thú Linh trưởng Việt Nam" của Hội động vật - Frankfurt, CHLB Đức.

Kể từ khi thành lập năm 1993, Trung tâm đã thường xuyên phát hành ấn phẩm "Báo cáo hàng năm"/"EPRC-Newsletter". Sắp tới, "Chuyên đề Thú Linh trưởng Việt Nam" sẽ được xuất bản nhằm cung cấp đầy đủ thông tin cho bạn đọc với số lượng lớn hơn cả trong và ngoài nước. Ấn phẩm "EPRC-Newsletter" sẽ là một bài báo khoa học tiếp tục được phát hành trong tạp chí này.

Số lượng thú linh trưởng được cứu hộ tăng từ 8 cá thể cuối năm 1993 đến 145 cá thể cuối năm 2006. Số lượng loài cũng tăng từ 2 đến 15 loài và phân loài khác nhau. Tính đến cuối năm 2006, đã có 109 cá thể thuộc 9 loài được sinh sản, trong đó có những loài như voọc mông trắng, voọc Cát Bà, voọc Hà Tĩnh và voọc chà vá chân xám đã lần đầu tiên cho sinh sản thành công trong điều kiện nuôi nhốt tại Trung tâm.

Trung tâm hiện nay có 43 chuồng đôi với diện tích 2.750 m^2 và 6 nhà chuồng với diện tích 110 m^2 cho nuôi voọc và vượn, 13 chuồng nuôi culi với diện tích 100 m^2.

Trạm kiểm dịch có 4 chuồng đơn (tổng diện tích là 60 m^2) và 2 nhà chuồng (tổng diện tích là 50 m^2), một phòng mổ, một phòng thuốc và bếp. Trung tâm có 2 khu nuôi nhốt bán hoang dã với môi trường rừng nguyên sinh (có diện tích khoảng 2 ha và 5 ha).

Qua thời gian, nhân sự của Trung tâm cũng tăng lên đến nay là 20 nhân viên nuôi thú, năm cán bộ sinh học, một trợ lý dự án, hai chuyên gia nuôi thú và một chuyên gia là Giám đốc dự án. Một chuyên gia thú y đã làm việc tại Trung tâm từ năm 1997 đến 2006.

Trung tâm thường xuyên hợp tác khoa học với các trường đại học, các trung tâm nghiên cứu khoa học, các tổ chức bảo tồn trong và ngoài nước. Trung tâm đã đóng góp nhiều kiến thức về phân loại học, di truyền phân tử, tập tính vận động, chế độ dinh dưỡng và sinh thái của các loài thú linh trưởng Đông dương cho kho tàng kiến thức về động vật học.

Trung tâm hiện đang hỗ trợ Khu bảo tồn đất ngập nước Vân Long nhằm bảo vệ nguyên vị quần thể voọc mông trắng lớn nhất ở Việt Nam, một trong những loài đang có nguy cơ bị đe doạ tuyệt chủng cao nhất trên thế giới.

Từ năm 2005, Trung tâm đã hợp tác với Vườn Quốc gia Phong Nha-Kẻ Bàng thực hiện chương trình tái thả thú linh trưởng về tự nhiên. Một khu bán hoang dã khoảng 20 ha đã được xây dựng và nhóm động vật được chuẩn bị tái thả đầu tiên là loài voọc Hà Tĩnh.

Trung tâm cũng đã đóng góp rất nhiều cho chương trình nâng cao nhận thức bảo tồn trong cộng đồng, đặc biệt là bảo vệ và bảo tồn thú linh trưởng. Nhiều bài báo và ấn phẩm khoa học được đăng tải trên nhiều báo và tạp chí, nhiều phóng sự khoa học và phim tài liệu được phát trên truyền hình và đài phát thanh nhằm kêu gọi sự chú ý và đóng góp của công chúng với chương trình bảo vệ và tồn các loài thú loài linh trưởng nguy cấp và đặc hữu của Việt Nam.

Trung tâm đã nhận được sự tài trợ chính về kinh phí của Hội động vật-Frankfurt, bên cạnh đó là một phần không nhỏ của các tổ chức bảo tồn, các vườn thú và các cá nhân trong và ngoài nước đã ủng hộ chương trình bảo tồn linh trưởng của Việt Nam bằng nhiều hình thức. Trung tâm rất trân trọng và đánh giá cao tới những đóng góp quý báu của các tổ chức và cá nhân đã giúp đỡ để duy trì và phát triển các hoạt động bảo vệ và bảo tồn thú linh trưởng Việt Nam.

Introduction

The Endangered Primate Rescue Center is both a part of and the operational base for the "Vietnam Primate Conservation Programme" of the Frankfurt Zoological Society. The project partner is Cuc Phuong National Park, and the center belongs to the Department of Science and International Cooperation at the national park.

Since its establishment in 1993, the Endangered Primate Rescue (EPRC) has published regularly the "EPRC Newsletter." This newsletter was a report about the center's development, the

animals' status and the budget. Above all, it was a report to the donors of the EPRC apprising them of and thanking them for the conservation work they support.

In addition to the report, the newsletter also included an increasing number of scientific articles on the animals at the EPRC. Unfortunately, this information was mostly accessible only to a select circle of donors and a few primatologists who are in close contact with the center.

The last "EPRC Newsletter" was published in 2004 with the report from 2003. The *Vietnamese Journal of Primatology* creates a platform to make all the information from the newsletter accessible to a broader circle of readers. Reports from the EPRC should be regularly published in the journal.

Animals of the EPRC

The number of primates at the EPRC increased continuously from the end of 1993 (8 individuals) to the end of 2006 (145 individuals) (Fig. 1). The number of taxa also increased from two to fifteen. In total, 109 individuals from nine taxa were born at the center. The animals that were confiscated during the first years of the EPRC were either immature or single adults. It took a few years to establish mature breeding pairs. Four years after the establishment of the center, the first animals were born (Fig. 2).

On average, 13.4 animals have been confiscated per year. The large number of animals confiscated in 2006 was due to the total receipt of 13 pygmy lorises on several occasions. The confiscation of highly endangered primates very often requires negotiation with the forest departments of districts and provinces which are responsible for the law enforcement and also for the issue of transport permits to transport protected animals through the country.

The new law (Decision 139/2004/ND-CP, June 2004) allows the selling of confiscated animals back to the animal trader or hunter if the animals are not healthy and can not released immediately back to the wild. This regulation makes the law about the protection of rare and endangered animals completely useless. With the licensed purchase of confiscated but protected animals these animals return legally to the animal trade. The reselling of the confiscated animals – which can be very lucrative (for example, the reselling of a poached tiger) – is a good income for a ranger station. As

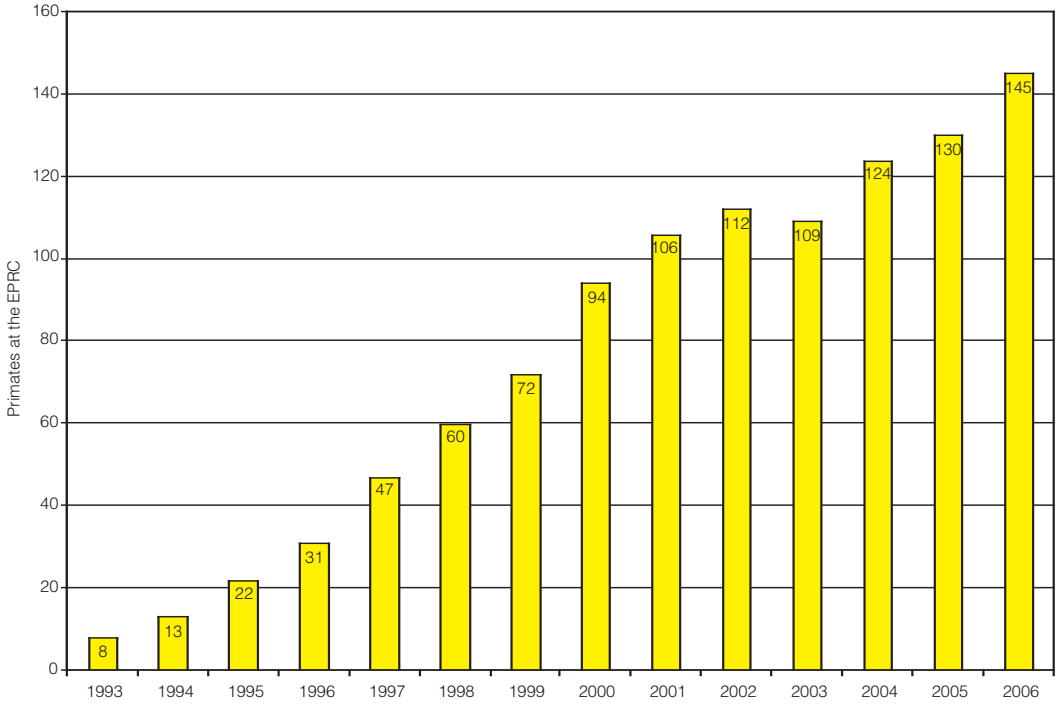

Fig. 1. Primates housed at the EPRC.

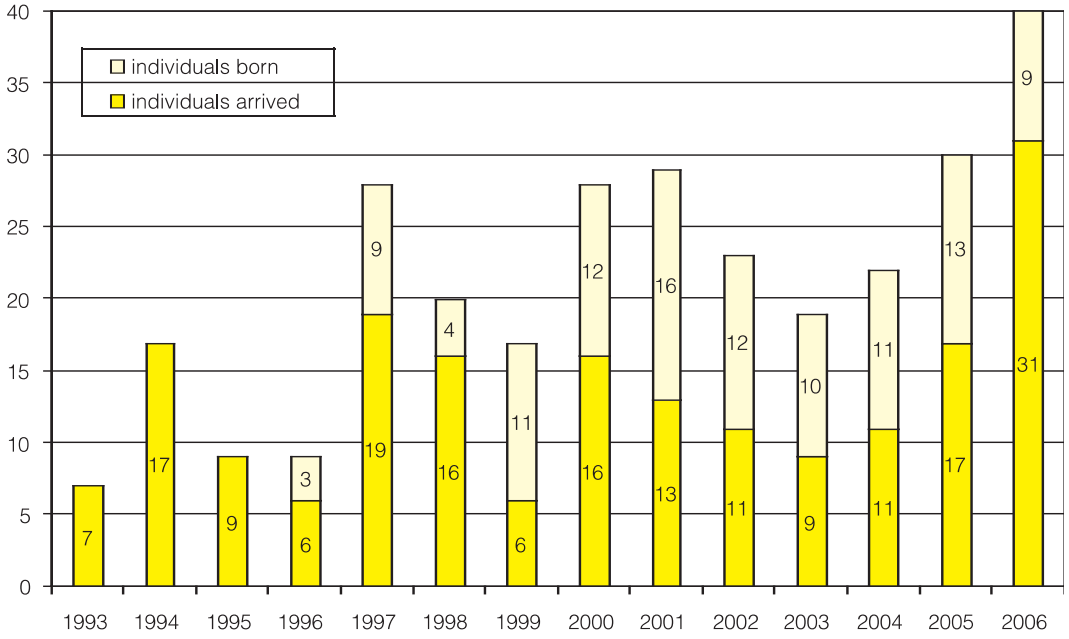

Fig. 2. Primates arrived and born at the EPRC.

a result, a confiscated animal is rarely declared as healthy, even it's confiscated on the forest edge and could be released without any problems. The Forest Protection Departments are often more interested to sell endangered animals for a high price back to the animal trader (which will likely sell the animal to a restaurant or a traditional medicine producer) than for free or a derisory reward to a rescue center. This law has an extremely negative impact on the conservation of wildlife. This law allows government and forest protection authorities to solve the problem of placing thousands of tons of confiscated wild animals without actually reducing the poaching and dramatic decline of wild animal populations.

The confiscated primates which arrive at the Endangered Primate Rescue Center are only a fraction of the total of poached primates. Based on information from hunters collected during several surveys, the number of poached "Endangered" and "Critically Endangered" primates could be more than ten times higher. Poaching has a dramatic impact on these already fragile and fragmented primate populations.

Housing capacity and construction activities

The increasing number of animals which arrived at the center required new housing space. In 2005, three double cage units were constructed for langurs and six cages for lorises. In 2006, the national park agreed to extend the center area by 3,600 m^2. This extension allowed the construction of eight more cages (Fig. 3) to house single animals or surplus males until they could be involved in species breeding programs. The center has 17 double cage units, and nine single cages for langurs and gibbons. In total, there are 43 cages with a surface area of 2,750 m^2, and six indoor enclosures with a total of 110 m^2. For lorises, the center has 13 cages with a total surface area of 100 m^2.

The quarantine station has four outdoor enclosures (60 m^2), two indoor enclosures (50 m^2), a surgery room and a preparation room.

Particularly worth mentioning are the two electrically-fenced semi-wild enclosures with primary forest. The two enclosures (roughly 2 and 5 ha) include two cages to allow animals to adjust to the facility.

A station house accommodates the project office, a working room for assistants, a room for hand rearing young animals, a food preparation room and a living room for a foreign animal keeper.

Fig. 3. The new area at the EPRC with eight cage complexes.

Staff

The extension of the center and the increasing number of animals has required the employment of additional workers. The staff has grown over the years to its current level of 20 workers (Fig. 4). All workers at the center are locals from villages close to the national park. This is not only advantageous for organization but is also a great support for local families, mostly minorities with a limited chance of employment somewhere else. The EPRC is therefore the department within the national park with the highest number of employees of minorities from surrounding villages. Several departments within the park, while employing more than 100 people, only employ few minorities from the surrounding villages.

After completing a Master's course in primate conservation at Oxford University, Vietnamese biologist Ha Thang Long began a PhD program at Cambridge University in January 2005 under the supervision of Professor David Chivers.

Since establishment of the EPRC, a trained and experienced foreign animal keeper has worked as the head animal keeper. Duties include organizing the work and training the Vietnamese workers in animal husbandry.

In 2002, Ms. Elke Schwierz started her work as the EPRC's head animal keeper. She is a trained animal keeper from Zoo Berlin, Germany. Mr. Jakob Kolleck is also a trained animal keeper from Zoo Berlin has shared the work with her since May 2005. Elke Schwierz worked in November/December 2005 at the Taronga Zoo, Sydney to engender cooperation with this zoo and to exchange experiences in the keeping of sensitive leaf-eating primates. From January to March 2006 she worked for the West African Primate Conservation Action (WAPCA) Project, Ghana to train the staff of a rescue center.

Dinh Van Vinh, the EPRC's Vietnamese head keeper, received an invitation from and attended a six week training course at the Melbourne Zoo in 2004.

Ulrike Streicher has worked as the EPRC's veterinarian since 1997. In September 2006 she moved to the Phnom Tamao Rescue Center and Zoo in Cambodia to work with a much larger collection of animals and a more diverse number of species.

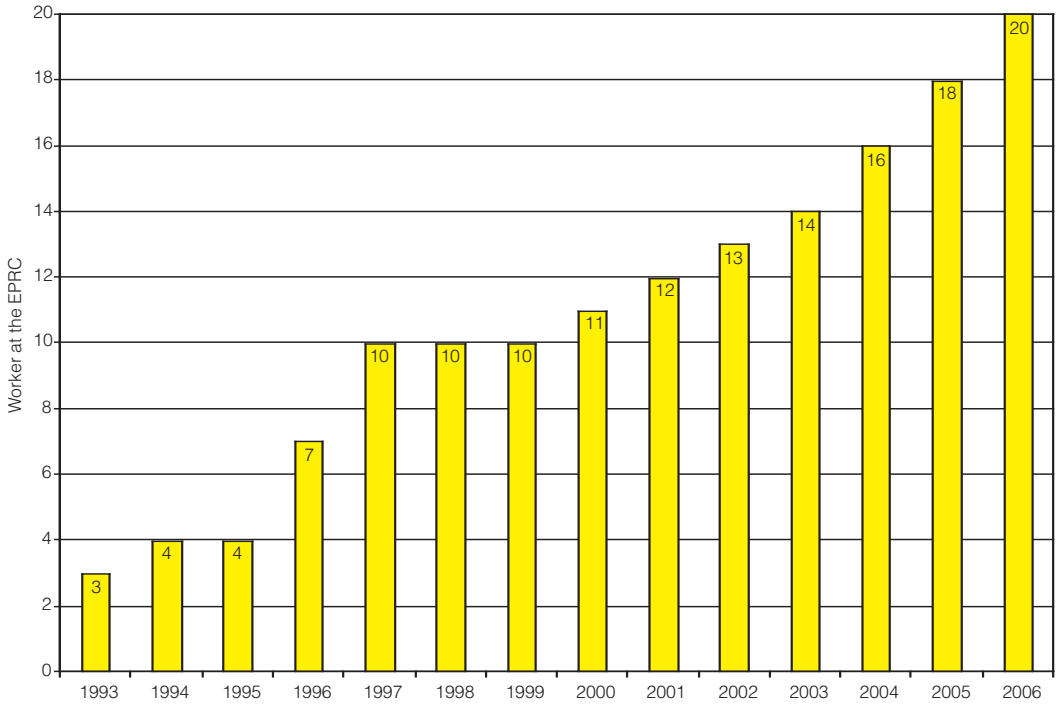

Fig. 4. Number of staff at the EPRC.

Scientific work

In cooperation with several institutions, the scientific output of the EPRC has increased immensely over the last years. Professor Herbert Covert of the University of Colorado at Boulder has been an instrumental player to the EPRC. Dr. Covert has been working with the EPRC since 2000 and has introduced the EPRC to a broader scientific community of U.S. scientists. Due to his efforts, the EPRC hosts many scientists studying various aspects of the center's unique primate collection.

For more than a decade, a very close cooperation has existed with the German Primate Center, especially on the field of molecular genetics and systematics. The cooperation has resulted in a number of revisions on Indochinese primate systematics as well as the discovery of new taxa.

Scientific cooperation started with the Center of Research on Endangered Species (CRES), San Diego to investigate the genetics of Vietnamese primates. The center provided material for Kurt Benirschke's studies on comparative placentation.

Ulrike Streicher, the former veterinarian of the EPRC, finished her PhD in 2004 on "Aspects of Ecology and Conservation of the Pygmy Loris *Nycticebus pygmaeus* in Vietnam," with a particular focus on the reintroduction of this species. Dr. Streicher's dissertation is the first PhD based on the EPRC's animals.

In 2003, Christelle Otto began a project on the nutrition and feeding ecology of the EPRC's douc langurs. She completed her PhD in 2005, titled "Food intake, nutritient intake, and food selection in captive and semi-free douc langurs".

Catherine Workman visited the EPRC in 2002 to study primate positional behavior and, in 2004, wrote a Master's thesis on the ontogeny of locomotion in three species of langurs housed at the center. Now at Duke University in the U.S., she will conduct PhD research on the foraging ecology of Delacour's langurs at Van Long Nature Reserve in 2007-2008.

In 2005, Vietnamese student Nguyen Van Thai at the Forestry University, Xuan Mai finished his Master's thesis on the husbandry of Delacour's langurs at the EPRC. In addition, Vietnamese student Nguyen Xuan Nghia from the National University, Hanoi started his Master's thesis on the keeping of gibbons at the EPRC.

Surveys

In 2004, Ha Thang Long and Tilo Nadler carried out two surveys on silvered langurs (*Trachypithecus germaini*) in Kien Giang Province, South Vietnam to find a solution for a population which is threatened by the limestone mining for cement production by the Swiss company HOLCIM.

In 2004, Ha Thang Long and Luu Tuong Bach, biologists of the EPRC, carried out primate field surveys on grey-shanked douc langurs in Kon Cha Rang Nature Reserve and Kon Ka Kinh National Park.

Also in 2004, two monitoring surveys were carried out in Pu Luong Nature Reserve and Cuc Phuong National Park, where two important populations of the Delacour's langur (*Trachypithecus delacouri*) occur. The results show that both populations have declined dramatically by about 20% over the last five years.

In March 2005, a short survey was carried out to monitor the Delacour's langur population in Ngoc Son Nature Reserve. No observations could be made and interviews confirmed the hunting of a complete group. Whether a population exists inside the nature reserve is questionable but there is obviously no chance for the long-term existence of a relict population, if one still exists there.

In 2005 and 2006 short surveys on the Delacour's langur population in Van Long Nature Reserve were carried out by Catherine Workman in preparation for her PhD study.

Habitat protection at Van Long Nature Reserve

The Delacour's langur was the impetus for the "Vietnam Primate Conservation Programme" of Frankfurt Zoological Society and has become the flagship species of the project. Since the discovery of a population in the Van Long area, close to Cuc Phuong National Park in 1993, this population became of special interest and a large reason for the establishment of the Van Long Nature Reserve in 2001. Van Long therefore is an important contribution to the protection of the largest and probably only viable population of this species. Since its establishment in 2001, Frankfurt Zoological Society has supported the nature reserve by financing the marking of the reserve's borders, the building of five ranger stations, the payment of equipment and salaries for 20 guards, training courses, education work in surrounding villages, and support of management work.

The fourth ranger station was completed in 2004 and the fifth ranger station in 2006.

Fig. 5. Fifth ranger station at Van Long Nature Reserve. Photo: Tilo Nadler.

Reintroduction project

A reintroduction project for Hatinh langurs as a pilot project for likely further reintroduction of primates bred at the EPRC was planned for Phong Nha-Ke Bang National Park. The park occurs in the distribution area of Hatinh langurs, red-shanked douc langurs and southern white-cheeked gibbons, all three species that are kept and bred at the EPRC. The project is co-financed by Cologne Zoo, Germany.

With the arrival of Bernhard Forster in 2005 as manager for this project part, preparations for the 20 ha semi-wild area began. After deciding the location of the field site, it was necessary to work with the park's management to incorporate the area into the national park's boundary. In 2006, construction of the fence and the electric fence surrounding the site was nearly finished (Fig. 6). The transfer of animals from the EPRC to the site is planned for the middle of 2007.

Fig. 6. Semi-wild area in Phong Nha – Ke Bang National Park, Central Vietnam. Photo: T. Nadler.

Education

The EPRC is a famous tourist attraction for visitors to Cuc Phuong National Park. The EPRC can be visited with trained tour guides from the national park who mediate information concerning problems about nature and primate conservation in Vietnam and about the center's work. About 7,000 to 9,000 people visit the center every year.

The center produces education and souvenir material, including post cards, brochures, T-shirts, and books which can purchased at the center.

In 2004, a new field guide for Vietnamese primates was produced in cooperation with the organization "Wildlife at Risk" (WAR).

In 2005, a guide book for primate field surveys was produced in cooperation with WWF "Mosaic-Project."

In 2005, a special brochure about primates and primate protection in Vietnam was produced in close cooperation with the Vietnamese organization "Education for Nature" (ENV) in the regularly

published Green Forest magazine. These magazines were distributed in high volume in Vietnam. The project managed the distribution of 12,000 magazines in about 30 schools around Van Long Nature Reserve.

In June 2006, a one week primate training course for students was organized in cooperation with Danang University and sponsored by the project. Courses are planned to be held regularly every year.

The project also contributed to a primate training course at Hanoi University, organized by Conservation International and the University of Colorado, Boulder.

Participation in conferences and congresses

April 2004: "Training Workshop and Preliminary Survey of Francois' langur" Guizhou, China. (T. Nadler).

August 2004: 20.Congress of the International Primatological Society. Torino, Italy (T. Nadler).

October 2004: Third annual joint meeting "IUCN Red List-Conservation Breeding Specialist Group" and IUCN Red List-Reintroduction Specialist Group." Taipei, Taiwan (T. Nadler).

July 2005: 19 Annual Conference of the Biological Conservation Society. Brasilia, Brasil (Ha Thang Long)

August 2005: 1. Congress of the European Federation for Primatology and 9. Tagung der Gesellschaft fuer Primatologie. Goettingen, Germany. (Ha Thang Long, T. Nadler).

October 2005: International Symposium on Southeast Asian Primate Research, Bangkok, Thailand. (T. Nadler).

December 2005: 5. Goettinger Freilandtage, German Primate Center. (T. Nadler)

February 2006: 21. Congress of the International Primatological Society. Entebbe, Uganda. (T. Nadler).

September 2006: Asian Primate Redlist Workshop – Global Mammal Assessment – IUCN Red List Primate Specialist Group. Phnom Penh, Cambodia. (T. Nadler).

September 2006: 15. Annual Conference of Southeast Asian Zoos. Ho Chi Minh City, Vietnam. (E. Schwierz, T. Nadler).

November 2006: Training Course: Biotechnology in Conservation of Animal Biodiversity and Development. Institute of Biotechnology, Vietnamese Academy of Science and Technology. Hanoi, Vietnam (Ha Thang Long, T. Nadler).

Budget

Finances for the EPRC come from numerous conservation organizations, zoos and private individuals. Without their ongoing support the EPRC would not be able to continue its work for primate conservation in Vietnam. The large fluctuation in the budget (Fig. 7) shows that there is no stable financial support of the EPRC. Besides a regular financial contribution from the Frankfurt Zoological Society and the Zoological Society for the Conservation of Species and Populations, Germany, the funds for the maintenance and development of the center have to be raised from several sources, especially zoos and conservation organizations. Since 2002 the Leipzig Zoo, Germany has supported the work of the center with a long term agreement for continuous financial contribution.

The instability of funding makes the management and long-term planning of the EPRC difficult. Necessary construction activities require special proposals, but funding is not guaranteed. Unforeseen and short-dated regulations by the Vietnamese government regarding workers' salaries exacerbate the challenges of managing the center's finances. The larger budget of the past several years is due to construction activities.

The EPRC would like to thank all the donors for their financial support. The donors are mentioned yearly on the EPRC's web site: www.primatecenter.org.

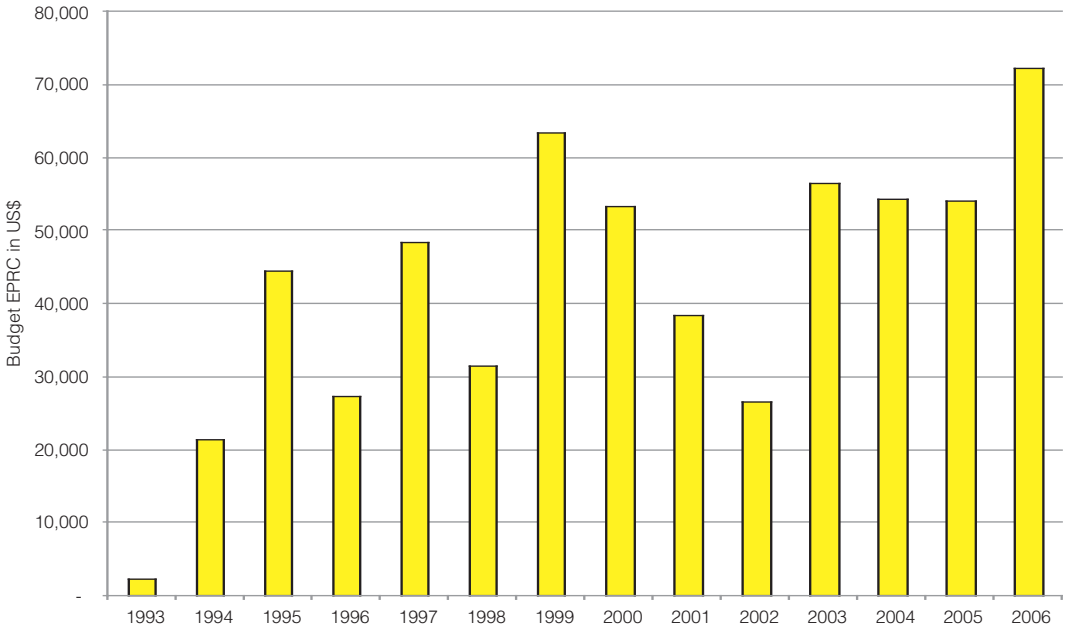

Fig. 7. Expenses of the EPRC in USD.

Publications, reports and presentations about the EPRC's work

In continuation of the *EPRC Newsletter* listed below are publications about the EPRC, publications based on scientific work at the EPRC, and presentations at scientific conferences and congresses.

Anonym (2006): IPPL Member's Meeting 2006: Conference Brings Primate Protectors Together in South Carolina. IPPL News 33 (1), 3-13.

Benirschke K, **Streicher U** & **Nadler T** (2004): The placenta of leaf monkeys. In: Nadler, Streicher & Ha Thang Long: Conservation of Primates in Vietnam. Frankfurt Zoological Society, Hanoi.

Benirschke K, **Houck M**, **Streicher U** & **Nadler T** (2004): Cytogenetic aspects of langurs. In: Nadler, Streicher & Ha Thang Long (eds.): Conservation of Primates in Vietnam. Frankfurt Zoological Society, Hanoi.

Bleisch WV, **Nadler T**, **Zhang Yingyi**, & **Insua-Cao P** (2006): Prioritization of Conservation Avtion for Primates of Indochina and South China. International Primatological Symposium Fusui, China. Proc. 1 (Abstract).

Covert HH, **Workman C** & **Byron C** (2004): The EPRC as an important research center: Ontogeny of locomotor differences among Vietnames colobines. In: Nadler, Streicher & Ha Thang Long (eds.): Conservation of Primates in Vietnam. Frankfurt Zoological Society, Hanoi.

Dang Huy Huynh (2004): The Endangered Primate Rescue Center at Cuc Phuong National Park - a refuge for confiscated primates. In: Nadler, Streicher & Ha Thang Long (eds.): Conservation of Primates in Vietnam. Frankfurt Zoological Society, Hanoi.

Ha Thang Long (2004): A field survey for the grey-shanked douc langur (*Pygathrix cinerea*) in Vietnam. Unpubl. report to Frankfurt Zoological Society.

Ha Thang Long (2004): Distribution and status of the grey-shanked douc langur (*Pygathrix cinerea*) in Vietnam. In: Nadler, Streicher & Ha Thang Long (eds.): Conservation of Primates in Vietnam. Frankfurt Zoological Society, Hanoi.

Ha Thang Long & **Nadler T** (2004): Primate Survey in Bai Voi Limestone Hill and Recommendations for the Conservation of the Silvered Langur population (Kien Luong District, Kien Giang Province. Unpubl. report to Frankfurt Zoological Society.

Kim Hoa (2006): Chuyen Tinh duoi tan rung Cuc Phuong. Phunu 2006, 12. (In Vietnamese).

Nadler T (2004): The Primates of Vietnam – an overview. Presentation on the 20th Congress of the International Primatological Society, Torino, Italy.

Nadler T (2004): Distribution and status of the Delacour's langur (Trachypithecus delacouri) and recommendations for its long-term conservation. In: Nadler, Streicher & Ha Thang Long (eds.): Conservation of Primates in Vietnam. Frankfurt Zoological Society, Hanoi.

Nadler T (2006): Why do several langur species occur in karst habitats? International Primatological Symposium Fusui, China. Proc. 21 (Abstract).

Nadler T (2006): Conservation of non-human primate species. Presentation at the Training Course: Biotechnology in Conservation of Animal Biodiversity and Development. Institute of Biotechnology, Vietnamese Academy of Science and Technology.

Nadler T & **Schwierz E** (2006): A Primate Reintroduction Project for the Endangered Hatinh Langur (*Trachypithecus laotum*

hatinhensis) in Vietnam. Presentation of the 15th Annual Conference of Southeast Asian Zoos. Ho Chi Minh City, Vietnam.

Nadler T & **Ha Thang Long** (2004): Primate Survey in Bai Voi Limestone Hill and Options for the Conservation of the Silvered Langur Population (Kien Luong District, Kien Giang Province). Unpubl. report to Frankfurt Zoological Society.

Nadler T, **Le Trong Dat** & **Luong Van Hao** (2004): A Primate field survey at Pu Luong Nature Reserve with the emphasis on Delacour's langur (*Trachypithecus delacouri*). Fauna & Flora International- Vietnam Conservation Support Ptogramme and the Forest Protection Department Hanoi, in association with Frankfurt Zoological Society-Vietnma Primate Conservation Programme.

Nadler T & **Streicher U** (2004): Conservation of primates in Vietnam. In: Nadler, Streicher & Ha Thang Long (eds.): Conservation of Primates in Vietnam. Frankfurt Zoological Society, Hanoi.

Nadler T, **Streicher U** & **Ha Thang Long** (eds. 2004): Conservation of Primates in Vietnam. Frankfurt Zoological Society, Hanoi.

Nadler T, **Walter L** & **Roos C** (2005): Molecular evolution, systematics and distribution of the taxa within the silvered langur species group (*Trachypithecus* [*cristatus*]) in Southeast Asia. Zool. Garten N.F. 75, 238-247.

Nadler T, **Walter L** & **Roos C** (2006): Systematics and distribution of the species within the silvered langur species group (*Trachypithecus cristatus*). Presentation of the 21st Congress of the International Primatological Society. Int. J. Primatol. 27, suppl. 1, abstract 95.

Roos C & **Nadler T** (2006): Molecular Evolution and Systematics of Indochinese Primates. International Primatological Symposium Fusui, China. Proc. 23 (Abstract).

Roos C & **Nadler T** (2005): Molecular Evolution and Systematics of Indochinese Primates. 5. Goeetinger Freilandtage. Primate Report, Special Issue 72-1, 38-39.

Stevens NJ, **Wright KA**, **Covert HH** & **Nadler T** (2006): A comparison of vertebral kinematics of Hatinh and Delacour's langurs in the Cuc Phuong National Park, Vietnam. Poster. Department of Biomedical Sciences, Ohio University, Athens, Ohio.

Streicher U & **Nadler T** (2005): Das Endangered Primate Rescue Center – die Entwicklung in den letzten drei Jahren. ZGAP Mitteilungen 21, 5-7.

Streicher U (2004): Seasonal changes in colouration and fur patterns in the pygmy loris (*Nycticebus pygmaeus*). In: Nadler, Streicher & Ha Thang Long (eds.): Conservation of Primates in Vietnam. Frankfurt Zoological Society, Hanoi.

Streicher U (2004): Confiscated primates – health aspects and long-term placement options. In: Nadler, Streicher & Ha Thang Long (eds.): Conservation of Primates in Vietnam. Frankfurt Zoological Society, Hanoi.

Wright BW, **Ulibarri L**, **O'Brien J**, **Covert HH** & **Nadler T** (2006): It's tough out there: Variation in the toughness of ingested leaves among four colobines in Vietnam. Presentation of the 21st Congress of the International Primatological Society. Int. J. Primatol. 27, suppl. 1, abstract 321.

Wright BW, **Stevens NJ**, **Covert HH** & **Nadler T** (2006): Hanging around: A comparisonof suspensory posture in langurs and gibbons at the Endangered Primate Research Center, Cuc Phuong National Park, Vietnam. Presentation of the 21st Congress of the International Primatological Society. Int. J. Primatol. 27, suppl. 1, abstract 322.

Wright BW, **Le Khac Quyet**, **Prodhan R**, **Cover HH** & **Nadler T** (2007): Does craniofacial variation among *Rhinopithecus* species follow an altitudinal cline? Poster. Kansas City University of Medicine and Biosciences.

Wright KA, **Ruff CB**, **Stevens NJ**, **Covert HH** & **Nadler T** (2007): Long Bone Articular and Diaphyseal Structure in Doucs (*Pygathrix*): Evidence of Suspensoty Adaptations. Poster. Kansas City University of Medicine and Biosciences.

TV reports

Several TV stations reported about the work of the "Vietnam Primate Conservation Programme" and the EPRC's work.

2004

- Japanese TV: report about the EPRC's work.
- Bayrischer Rundfunk, Germany: report about the Cat Ba langur.
- BBC TV "Really Wild Show": report about the EPRC's work.
- Vietnamese TV "VTV1": report about the EPRC's work.

2005

- Vietnamese TV: production of two documentaries about the EPRC's work. One was honored with the Vietnamese golden medal for documentary reports.
- In cooperation with Vietnam TV and WWF: report for TV about douc langur protection.
- BBC "Planet Earth": report about the Delacour's langurs at the EPRC and Van Long Nature Reserve.
- Japanese TV: report at the EPRC for a Japanese nature series.

2006

- German TV-ZDF: report about the EPRC and conservation problems in Vietnam.
- German TV-ZDF: report about the planned reintroduction project in Phong Nha - Ke Bang National Park, and the cooperation with Cologne Zoo.
- Bayrischer Rundfunk, Germany: report about the EPRC's work and the reintroduction project.
- German-TV-MdR: report about the EPRC's work, especially about the problems of primate confiscation.
- Vietnam-TV-VTV 1: report about the EPRC's work.

Appendix

Register of primates by the EPRC 2006 - (up to date 31. 12. 2006)
(*species or subspecies only held in EPRC anywhere in the world)

No.	Date of arrival	Sex	Date born or estimated	Sire	Dam	Source	Current status
Delacour's langur *Trachypithecus delacouri* (*)							
1-01	Jan.93	M	1990	wild	wild	confiscated	EPRC
1-02	Jan.93	M	1990	wild	wild	confiscated	EPRC
1-03	17.5.94	F	ad.	wild	wild	confiscated	EPRC
1-04	17.5.94	M	1993	wild	wild	confiscated	EPRC
1-06	28.7.96	F	28.7.96	1-01	1-03	born EPRC	EPRC
1-07	21.2.98	M	21.2.98	1-01	1-03	born EPRC	EPRC
1-08	16.8.99	F	16.8.99	1-01	1-03	born EPRC	EPRC
1-09	3.4.01	F	3.4.01	1-01	1-03	born EPRC	EPRC
1-10	4.6.01	M	4.6.01	1-02	1-05	born EPRC	EPRC
1-12	7.12.02	M	7.12.02	1-01	1-03	born EPRC	EPRC
1-13	9.7.03	F	9.7.03	1-02	1-06	born EPRC	EPRC
1-15	14.7.04	M	14.7.04	1-01	1-03	born EPRC	EPRC
1-16	1.6.05	M	1.6.05	1-04	1-08	born EPRC	EPRC
1-17	27.10.05	F	27.10.05	1-02	1-06	born EPRC	EPRC
Hatinh langur *Trachypithecus laotum hatinhensis* (*)							
2-01	11.5.93	M	1990	wild	wild	confiscated	EPRC
2-03	13.1.94	F	1993	wild	2-02	confiscated	EPRC
2-05	9.4.94	F	1994	wild	2-04	confiscated	EPRC
2-09	14.1.96	F	ad.	wild	wild	confiscated	EPRC
2-10	6.2.96	M	6.2.96	2-01	2-08	born EPRC	EPRC
2-11	27.4.96	F	27.4.96	2-01	2-04	born EPRC	EPRC
2-12	27.11.96	M	1995	wild	wild	from private	EPRC
2-13	28.3.97	M	28.3.97	2-01	2-09	born EPRC	EPRC
2-14	22.5.97	F	22.5.97	2-01	2-08	born EPRC	EPRC
2-15	15.10.97	M	1995	wild	wild	from tourists	EPRC
2-17	11.12.97	F	1994	wild	wild	from tourists	EPRC
2-20	11.3.98	F	1995	wild	wild	from tourists	EPRC
2-21	11.3.98	M	11.3.98	2-01	2-04	born EPRC	EPRC
2-22	24.2.99	M	24.2.99	2-01	2-08	born EPRC	EPRC
2-23	9.4.99	M	9.4.99	2-01	2-09	born EPRC	EPRC
2-24	25.3.00	M	25.3.00	2-15	2-17	born EPRC	EPRC
2-25	13.8.00	F	13.8.00	2-12	2-05	born EPRC	EPRC
2-26	20.11.00	M	20.11.00	2-15	2-11	born EPRC	EPRC
2-27	7.1.01	F	7.1.01	2-15	2-20	born EPRC	EPRC
2-30	4.2.02	F	4.2.02	2-01	2-04	born EPRC	EPRC
2-32	4.4.02	F	4.4.02	2-15	2-17	born EPRC	EPRC
2-35	13.4.03	F	13.4.03	2-01	2-09	born EPRC	EPRC
2-36	14.11.03	F	14.11.03	2-12	2-05	born EPRC	EPRC
2-37	19.11.03	M	19.11.03	2-15	2-11	born EPRC	EPRC
2-38	3.12.03	M	3.12.03	2-15	2-20	born EPRC	EPRC
2-40	23.8.04	F	23.8.04	14-1	2-14	born EPRC	EPRC
2-41	28.11.04	M	28.11.04	2-01	2-09	born EPRC	EPRC
2-42	8.4.05	F	8.4.05	2-12	2-03	born EPRC	EPRC
2-45	3.7.05	F	3.7.05	2-15	2-17	born EPRC	EPRC
2-46	1.8.05	F	ca. 2004	wild	wild	confiscated	EPRC
2-47	27.11.05	M	27.11.05	2-12	2-05	born EPRC	EPRC
2-48	14.2.06	F	14.2.06	2-15	2-11	born EPRC	EPRC
2-49	29.6.06	F	29.6.06	14-1	2-14	born EPRC	EPRC
2-50	28.9.06	M	28.9.06	2-12	2-03?	born EPRC	EPRC
2-51	20.10.06	M	20.10.06	2-10	2-27	born EPRC	EPRC

2-52	31.10.06	F	31.10.06	2-10	2-32	born EPRC	EPRC
2-53	10.12.06	M	10.12.06	2-15	2-20	born EPRC	EPRC

Black langur *Trachypithecus laotum ebenus* morph "ebenus" (*)

14-01	12.1.98	M	1996	wild	wild	from tourists	EPRC

Laos langur *Trachypithecus laotum laotum* (*)

3-01	26.9.95	M	1995	wild	wild	confiscated	EPRC

Grey langur *Trachypithecus crepusculus*

4-04	22.1.97	F	1996	wild	wild	from private	EPRC
4-05	14.4.00	F	1999	wild	wild	confiscated	EPRC
4-07	24.1.02	F	24.1.02	4-06	4-04	born EPRC	EPRC

Cat Ba langur (Golden-headed langur) *Trachypithecus p. poliocephalus* (*)

15-01	8.11.98	F	1998	wild	wild	confiscated	EPRC
15-04	2.6.03	M	2.6.03	15-02	15-01	born EPRC	EPRC

Francois' langur *Trachypithecus francoisi*

17-01	8.1.02	F	1997	wild	wild	confiscated	EPRC
17-02	30.9.05	M	2003	wild	wild	confiscated	EPRC

Red-shanked douc langur x Hatinh langur *P. nemaeus x T. laotum hatinhensis*

18-01	14.10.03	F	14.10.03	6-9/12?	2-03	born EPRC	EPRC

Red-shanked douc langur *Pygathrix nemaeus*

6-02	17.3.96	F	1992	wild	wild	confiscated	EPRC
6-05	8.5.97	M	ad.	wild	wild	confiscated	EPRC
6-06	24.5.97	M	1994	wild	wild	from tourists	EPRC
6-09	10.7.97	M	1997	wild	wild	confiscated	EPRC
6-12	28.11.97	M	1997	wild	wild	from tourists	EPRC
6-13	6.1.98	F	ad.	wild	wild	confiscated	EPRC
6-14	12.1.98	M	1996	wild	wild	from tourists	EPRC
6-16	2.4.98	M	1994	wild	wild	from tourists	EPRC
6-21	30.12.98	F	30.12.98	6-05	6-02	born EPRC	EPRC
6-26	6.5.00	M	6.5.00	6-05	6-17	born EPRC	EPRC
6-28	19.8.00	M	1996	wild	wild	confiscated	EPRC
6-29	25.4.01	M	25.4.01	6-05	6-13	born EPRC	EPRC
6-30	6.6.01	F	6.6.01	6-06	6-02	born EPRC	EPRC
6-31	21.4.02	F	21.4.02	6-06	6-02	born EPRC	EPRC
6-32	24.2.03	F	24.2.03	6-06	6-02	born EPRC	EPRC
6-34	26.3.04	F	2001	wild	wild	confiscated	EPRC
6-35	17.4.04	W	17.4.04	6-05	6-13	born EPRC	EPRC
6-36	28.6.04	M	ad.	wild	wild	confiscated	EPRC
6-37	25.8.04	M	25.8.04	6-06	6-02	born EPRC	EPRC
6-38	13.12.04	F	ad.	wild	wild	confiscated	EPRC
6-39	13.4.05	M	ad.	wild	wild	confiscated	EPRC
6-41	9.5.05	F	9.5.05	6-12	6-21	born EPRC	EPRC
6-42	11.6.05	M	April 05	wild	wild	confiscated	EPRC
6-43	19.10.05	M	19.10.05	6-06	6-02	born EPRC	†3.6.06
6-44	27.5.06	M	ad.	wild	wild	confiscated	†27.5.06
6-45	31.5.06	F	Jan. 06	wild	wild	confiscated	EPRC
6-46	17.8.06	F	2001	wild	wild	confiscated	EPRC
6-47	17.8.06	F	ad.	wild	wild	confiscated	EPRC
6-48	21.11.06	F	21.11.06	6-06	6-02	born EPRC	EPRC

Grey-shanked douc langur *Pygathrix cinerea* (*)

7-01	31.8.95	M	1992	wild	wild	confiscated	EPRC
7-04	4.8.97	M	1994	wild	wild	confiscated	EPRC

7-09	13.2.01	M	ca.1996	wild	wild	confiscated	EPRC
7-11	15.12.01	F	ca. 1997	wild	wild	confiscated	EPRC
7-13	12.7.02	F	ad.	wild	wild	confiscated	EPRC
7-14	18.8.02	M	1998	wild	wild	confiscated	EPRC
7-16	11.12.02	M	ad.	wild	wild	confiscated	EPRC
7-19	13.3.03	M	subad.(1998)	wild	wild	confiscated	EPRC
7-24	15.1.04	W	15.1.04	7-04	7-13	born EPRC	EPRC
7-25	9.11.04	M	2000	wild	wild	confiscated	EPRC
7-28	6.6.05	F	6.6.05	7-01	7-11	born EPRC	EPRC
7-29	14.8.05	F	ca. 2005	wild	wild	confiscated	EPRC
7-30	9.11.05	F	ad.	wild	wild	confiscated	EPRC
7-31	5.3.06	M	5.3.06	7-04	7-13	born EPRC	EPRC
7-32	17.4.06	M	2002	wild	wild	confiscated	†23.4.06
7-33	12.7.06	M	ad.	wild	wild	confiscated	†7.11.06
7-34	19.10.06	F	2000	wild	wild	confiscated	EPRC
7-35	3.11.06	F	ad.	wild	wild	confiscated	EPRC
7-36	29.11.06	M	2002	wild	wild	confiscated	†10.12.06
7-37	24.12.06	M	2003	wild	wild	confiscated	EPRC

Black-shanked douc langur *Pygathrix nigripes*

13-05	15.3.01	M	1996	wild	wild	confiscated	EPRC

Red-shanked douc langur x Black-shanked douc langur *Pygathrix nemaeus x nigripes*

16-01	1.1.00	M	1.1.00	6-06	13-02	born EPRC	EPRC

White-cheeked gibbon *Nomascus leucogenys leucogenys*

8-01	30.9.94	F	1993	wild	wild	from foreigner	EPRC
8-02	30.9.94	F	1994	wild	wild	from foreigner	EPRC
8-03	28.5.02	M	1999	wild	wild	confiscated	EPRC
8-04	28.5.02	F	2001	wild	wild	confiscated	EPRC
8-05	28.5.02	F	2001	wild	wild	confiscated	EPRC
8-08	19.11.04	F	2001	wild	wild	confiscated	EPRC

Southern white-cheeked gibbon *Nomascus leucogenys siki*

9-02	18.9.93	F	1993	wild	wild	from foreigner	EPRC
9-05	10.11.94	M	1992	wild	wild	from foreigner	EPRC
9-06	24.2.95	F	1993	wild	wild	from tourists	EPRC
9-07	30.10.96	M	1996	wild	wild	from tourists	EPRC
9-08	1.12.98	F	1998	wild	wild	from tourists	EPRC
9-09	23.6.99	M	23.6.99	9-05	9-02	born EPRC	EPRC
9-10	10.3.00	M	1999	wild	wild	confiscated	EPRC
9-11	25.7.02	F	25.7.02	9-03	9-06	born EPRC	EPRC
9-12	17.12.02	M	17.12.02	9-05	9-02	born EPRC	EPRC
9-13	21.11.06	M	21.11.06	9-05	9-02	born EPRC	EPRC

Yellow-cheeked crested gibbon *Nomascus gabriellae*

10-01	26.2.95	F	1994	wild	wild	from tourists	EPRC
10-02	6.2.97	F	1994	wild	wild	confiscated	EPRC
10-04	3.6.01	F	1997	wild	wild	confiscated	EPRC
10-05	11.6.04	F	2001	wild	wild	confiscated	EPRC
10-06	21.5.04	F	2003	wild	wild	confiscated	EPRC
10-07	7.10.06	F	2005	wild	wild	confiscated	EPRC
10-08	7.10.06	F	2005	wild	wild	confiscated	EPRC

Slow loris *Nycticebus bengalensis*

11-05	5.4.01	M	ad.	wild	wild	confiscated	EPRC
11-06	26.4.01	M	26.4.01	11-04	11-02	born EPRC	7.6.06 released

Pygmy loris *Nycticebus pygmaeus*

12-02	15.9.93	F	ad.	wild	wild	from foreigner	June released
12-07	27.2.97	F	27.2.97	12-01	03?04?	born EPRC	†20.11.06
12-33	16.2.01	M	16.2.01	12-09	12-07	born EPRC	EPRC
12-36	22.2.01	F	22.2.01	12-09	12-04	born EPRC	EPRC
12-48	12.12.03	M	ad.	wild	wild	Uni Hanoi	EPRC
12-60	13.6.05	??	Febr.05	wild	12-59	confiscated	EPRC
12-62	27.7.05	M	ca. 2004	wild	wild	confiscated	EPRC
12-63	12.12.05	F	ad.	wild	wild	confiscated	EPRC
12-66	24.2.06	F	ad.	wild	wild	WAR	EPRC
12-67	24.2.06	M	ad.	wild	wild	WAR	EPRC
12-68	24.2.06	M	ad.	wild	wild	WAR	EPRC
12-69	24.2.06	F	2/2005	wild	wild	WAR	EPRC
12-70	24.2.06	F	ad.	wild	wild	WAR	EPRC
12-72	24.2.06	F	ad.	wild	wild	WAR	EPRC
12-78	15.3.06	F	ad.	wild	wild	WAR	EPRC
12-79	15.3.06	F	ad.	wild	wild	WAR	†6.4.06
12-80	15.3.06	M	ad.	wild	wild	WAR	†29.3.06
12-81	20.4.06	F	2003	wild	wild	ENV	†6.8.06
12-82	20.4.06	F	2005	wild	wild	ENV	†6.12.06
12-83	7.10.06	M	ad.	wild	wild	ENV	EPRC
12-84	3.11.06	M	ad.	wild	wild	confiscated	EPRC

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Books and Monographs

Groves CP (2001): Primate Taxonomy. Washington DC.

Edited books and book chapters

Groves CP 2004: Taxonomy and Biogeography of Primates in Vietnam and Neighbouring Regions. In: Nadler, Streicher, Ha Thang Long (eds.): Conservation of Primates in Vietnam; p 15-22. Hanoi, Frankfurt Zoological Society.

Dissertations

Otto C (2005): Food intake, nutrient intake, and food selection in captive and semi-free Douc langurs. PhD dissertation, University Cologne.

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