Gibbon Journal

Nr. 5 – May 2009

Gibbon Conservation Alliance

Impressum

Gibbon Journal 5, May 2009

ISSN 1661-707X

Publisher: Gibbon Conservation Alliance, Zürich, Switzerland

http://www.gibbonconservation.org

Editor: Thomas Geissmann, Anthropological Institute, University Zürich-Irchel, Universitätstrasse 190, CH–8057 Zürich, Switzerland. E-mail: thomas.geissmann@aim.uzh.ch

Editorial Assistants: Natasha Arora and Andrea von Allmen

Cover legend

Western hoolock gibbon (*Hoolock hoolock*), adult female, Yangon Zoo, Myanmar, 22 Nov. 2008. Photo: Thomas Geissmann. –

*Westlicher Hulock (*Hoolock hoolock*), erwachsenes Weibchen, Yangon Zoo, Myanmar, 22. Nov. 2008. Foto: Thomas Geissmann.*

GCA

Contents / Inhalt

Impressum i

Instructions for authors iv

Gabriella's gibbon
Simon M. Cutting 1

Hoolock gibbon and biodiversity survey and training in southern Rakhine Yoma, Myanmar
Thomas Geissmann, Mark Grindley, Frank Momberg, Ngwe Lwin, and Saw Moses 4

Status of the western black crested gibbon (*Nomascus concolor*) in the Nam Ha National Protected Area, Lao PDR
Jeff Brown 5

Crested gibbons in southeastern Yunnan, China: Status and conservation
Ni Qingyong and Jiang Xuelong 6

The northern white-cheeked gibbon (*Nomascus leucogenys*) is on the edge of extinction in China
Fan Peng-Fei and Huo Sheng 7

Door slamming: Tool-use by a captive white-handed gibbon (*Hylobates lar*)
Thomas Geissmann 8

Hormonal correlates of the ovarian cycle in the yellow-cheeked crested gibbon (*Nomascus gabriellae*), and a review of ovarian cycles in gibbons (Hylobatidae)
Thomas Geissmann and Gustl Anzenberger 9

Comparing the role of androgens in paternal care between gibbon species
Michelle Rafacz, Sue Margulis, Rachel Santymire 10

Longevity in gibbons (*Hylobatidae*)
Thomas Geissmann, Katja Geschke and Barbara J. Blanchard 11

New Media 2008 12

Theses 12

Books and special publications 12

Journal articles and book chapters 12

Congresses and workshops 13

What is the Gibbon Conservation Alliance? 14

How can I help the gibbons? 15

Instructions for authors

The Gibbon Journal publishes original papers in English or German on all aspects of gibbon natural history. It is distributed electronically and published annually by the Gibbon Conservation Alliance.

Das Gibbon Journal veröffentlicht Orignalarbeiten in englischer oder deutscher Sprache über alle Aspekte der Gibbon-Naturkunde. Es erscheint jährlich und wird elektronisch publiziert von der Gibbon Conservation Alliance.

An English abstract is to be provided, preferably no longer than 250 words.

Dem Manuskript soll eine englische Zusammenfassung von bis zu 250 Worten beiliegen.

Figures and tables should be numbered and referred to by number in the text. Each figure and table should have an accompanying caption. Colour figures are welcome, but should be understandable if printed in black-and-white.

Abbildungen und Tabellen sollten beide fortlaufend nummeriert sein und im Text genannt werden. Jede Abbildung und jede Tabelle sollte eine Legende haben. Farbabbildungen sind willkommen, sollten jedoch auch verständlich sein, wenn sie in schwarz-weiss gedruckt werden.

Citations in the text should include author name(s) and year in parentheses. Where there are three or more authors, only the first author's name is given in the text, followed by "*et al.*".

Von zitierten Publikationen sollen im Text Autorennamen und Veröffentlichungsjahr in Klammern genannt werden. Bei mehr als zwei Autoren wird nur der erste genannt und die übrigen mit „*et al.*" abgekürzt.

List cited references alphabetically at the end of the paper.

Die zitierte Literatur sollte am Ende des Manuskripts in alphabetischer Reihenfolge gelistet werden.

Examples:

Beispiele:

Papers in journals:

Zeitschriftenartikel:

Traeholt, C., Bonthoeun, R., Virak, C., Samuth, M., and Vutthin, S. (2006). Song activity of the pileated gibbon, *Hylobates pileatus*, in Cambodia. *Primate Conservation* **21**: 139-144.

Books:

Bücher:

Groves, C. P. (2001). *Primate taxonomy*, Smithsonian Institution, Washington, D.C., viii+350 pp.

Papers in edited books:

Arbeiten in editierten Büchern:

Brockelman, W. Y., and Gittins, S. P. (1984). Natural hybridization in the *Hylobates lar* species group: Implications for speciation in gibbons. In Preuschoft, H., Chivers, D. J., Brockelman, W. Y., and Creel, N. (eds.), *The lesser apes. Evolutionary and behavioural biology*, Edinburgh University Press, Edinburgh, pp. 498-532.

Theses:

Dissertationen:

Whittaker, D. J. (2005). *Evolutionary genetics of Kloss's gibbons (*Hylobates klossii*): Systematics, phylogeography, and conservation*, PhD thesis, Faculty in Anthropology, The City University of New York, xiv+201 pp.

Manuscripts should be submitted as e-mail attachment (the preferred word-processing package is MS-Word) to the Editor:

Manuskripte sollten als E-mail-Beilage (bevorzugtes Format ist ein MS-Word-Dokument) an den Editor gesandt werden:

Thomas Geissmann, Anthropological Institute, University Zürich-Irchel, Universitätstrasse 190, CH–8057 Zürich, Switzerland.

E-mail: thomas.geissmann@aim.uzh.ch

Gabriella's gibbon

Simon M. Cutting

School of Biological Sciences, Royal Holloway,
University of London, Egham, Surrey TW20 OEX, UK.
E-mail: s.cutting@rhul.ac.uk

Nomascus gabriellae, the yellow-cheeked crested gibbon was identified and scientifically described 100 years ago from a specimen obtained in Vietnam. This paper provides a historical record of how this gibbon was discovered by a young Englishwoman, Gabrielle Maud Vassal, whose name the gibbon carries. Mrs Vassal lived in Nha Trang, Vietnam, with her husband, a scientist working at the Pasteur Institute of Nha Trang with the famous microbiologist Alexandre Yersin. Together they collected a number of important type specimens for the British Museum (Natural History).

Introduction

The yellow-cheeked crested gibbon (*Nomascus gabriellae*) is well known to the gibbon community. Crested gibbons are born with a yellowish natal coat, which begins to turn black near the end of the infant's first year of life. Males retain this colour while females, following sexual maturity, acquire a blond coat (Fig. 1). Now endangered (Geissmann, 2007), this gibbon is found only in the tropical forests of Vietnam, Cambodia and Laos and was first described, as *Hylobates gabriellae*, in 1909 (Thomas, 1909). Occasionally, it is referred to as Gabriella's gibbon, but what is the exact origin of the name? As a frequent visitor to Vietnam I have managed to decipher the stories behind the discovery of this animal just over one hundred years ago and of the woman whose name this gibbon carries.

Fig. 1. Adult pair (female left, male right) of the yellow-cheeked crested gibbon (*Nomascus gabriellae*) at Hannover Zoo, Germany. Photo: Robert Dallmann, April 2004. – *Gelbwangen-Schopfgibbons (*N. gabriellae*), erwachsenes Paar im Zoo von Hannover (links Weibchen, rechts Männchen)*.

Gabriella refers to Gabrielle Maud Vassal (1880-1959), an Englishwoman born in Uppingham in the county of Rutland (Fig. 2). Her father, Howard Candler, was a master at Uppingham School, then and now a prestigious English public school. As a young woman in late Victorian society she received minimal education, but was packed off to Switzerland to improve her French followed by two further years at Cheltenham Ladies College. At Cheltenham in 1898 she would attend a guest lecture given by the renowned African explorer, Mary Kingsley (1862-1900), the author of "*Travels in West Africa*". Possibly, as a young woman in a male-orientated world listening to Kingsley's travels in the Congo, Gabrielle acquired a taste for adventure and indeed from this point on her life would change forever. Gabrielle was fluent in French and on a school trip to Paris she fell in love with a handsome French military physician, Joseph Margeurite Jean Vassal (1867-1957). Joseph had chosen to move into scientific research and specialized in parasitology. He worked in Paris at the Pasteur Institute and was shortly assigned to the French colonial service (*Troupes Coloniales*). In 1904, just a few months after marrying Gabrielle, he accepted a posting in French Indochina. His destination was Nha Trang, a remote fishing village in Annam, one of the five protectorates of Indochina. Gabrielle dutifully followed her husband to Nha Trang, embarking on the twice-monthly mail boat from Saigon to Nha Trang in April 1904.

Less than thirty French lived in Nha Trang, mostly males who were in the civil service or on short-term contracts. Nha Trang was then reached only by sea; the Mandarin Road (now Highway No. 1) that connected Saigon to Hanoi and passed through Nha Trang was considered too perilous for regular travel, especially by foreigners. Gabrielle lived with Joseph in a three-roomed 'colonial' bungalow on the beach front (now Tran Phu Street).

Joseph worked alongside the great Swiss microbiologist, Dr. Alexandre Yersin (1863-1943), a protégé of Louis Pasteur, at an outstation of the

Fig. 2. Gabrielle Vassal (c.1910-1911). Photograph taken from *Le Tour du Monde* (Vassal, 1911). – *Gabrielle Vassal (c.1910-1911). Foto aus* Le Tour du Monde *(Vassal, 1911).*

Pasteur Institute (The Nha Trang Pasteur Institute) which he founded in 1904, and that remains there to this day on Tran Phu Street. Joseph was the first physician to work with Yersin and together they investigated the numerous tropical diseases that afflicted both livestock and humans in this densely forested region. Yersin was himself somewhat of an explorer and in 1893 was the first European to explore the Lang Bian plateau in the interior of Annam, recording both the topography as well as the native people who inhabited this region. At an altitude of 1500 m, the cool alpine climate of the plateau offered possibilities as a potential hill station for the French expatriates, and by the 1920s a small town known as Dalat had sprung up, which today is a major holiday destination for Vietnamese. At the turn of the 20th century, though the plateau was wild and sparsely populated with fierce tribes of minority people, distinct from the Vietnamese, and known crudely as *Moi* (meaning savage). The plateau, indeed most of Vietnam at this time, was inhabited by a variety of dangerous animals. Most prominent were tigers, which were so numerous that they even encroached upon the boundaries of Nha Trang itself.

Gabrielle spent her first year in Nha Trang escorting her husband on his excursions around the village. In 1905 she returned home for two years and lived both in Paris and London. Joseph remained for another year in Nha Trang and, alone, would set out and explore the surrounding countryside, where he would combine his scientific curiosity with a passion for hunting, collecting a variety of animals and birds (Bonhote, 1907). In London, Gabrielle chanced upon a meeting with the Scottish ornithologist William Robert Ogilvie-Grant (1863-1924), who would soon become the bird curator at the British Museum (Natural History), now the Natural History Museum (BM[NH]). She managed to persuade him that her husband, who was still in Vietnam, could collect birds that would be sent back to the Museum, for a fee of course. Her letters to Ogilvie-Grant are held in the BM[NH] and provide an interesting record of the development of this commercial enterprise. At the time, museums were keen to collect, identify and display new species as they emerged from the colonies. Gabrielle had something unique to offer: she was English and had access to a French colony. She obviously managed to win over Ogilvie-Grant and in 1905 Joseph wrote to Ogilvie-Grant suggesting that he could supply a variety of interesting specimens. Birds were then shot and the skins preserved and sent back to the BM[NH], with Gabrielle acting as the go-between in London. Ogilvie-Grant would choose which birds were of interest and pay a pre-arranged fee. Almost 300 skins were sent back over the next few years, and a number of new species were discovered, including *Cissa gabriellae* (the Indochinese Green Magpie) and *Garrulax vassali* (White-cheeked laughing-thrush) (Ogilvie-Grant, 1906).

This collecting was not confined to just birds, however. Gabrielle was soon introduced to Michael Oldfield Thomas (1858-1929), the curator of mammals at the BM[NH], and no doubt was able to charm him with stories of the abundance of new mammals that might be found in this remote region of the world. Importantly though, Oldfield Thomas had his own financial resources to fund new acquisitions. This was no minor point; the correspondence between Gabrielle and both Ogilvie-Grant and Oldfield Thomas held at the BM[NH] show that the purchase of the Vassal bird skins was now running into thousands of pounds in today's terms. Gabrielle was able to convince Oldfield Thomas that the newly discovered Lang Bian plateau, which Joseph had visited in her absence (Vassal, 1907), could provide potentially new mammal species. Gabrielle returned to Nha Trang in the spring of 1907 and immediately set about making a trip to Lang Bian. Her first task was to hire a guide, and she describes the problems she had in getting a suitable guide in a letter (dated 17 Sept. 1907, held at the BM[NH]) to Ogilvie-Grant as follows:

> "We have had all sorts of difficulties this time. The first native we got and taught fell ill as soon as we went inland. The next broke the gun we had given him and it was some time before we could procure another one from Hanoi".

In her travelogue "On and Off Duty in Annam" (Vassal, 1910) Gabrielle records one trip to the plateau, yet the letters she wrote to Ogilvie-Grant and Oldfield Thomas, held at the BM[NH], suggest two separate trips to the plateau, one in September 1907 and the other June-July 1908. In any event (see

below), the route to the plateau she would follow was the same on each occasion and one that was known to be particularly dangerous. The orchid collector Wilhelm Micholitz, using the same route to the plateau in 1903, not only got malaria but noted in one of his letters to the "Orchid King" Frederick Sander (Swinson, 1970):

> "One of the greatest drawbacks of collecting and exploring here is that the country is swarming with tigers. It is not safe to go anywhere alone and unarmed. At night nobody dares to venture out of doors (except) in company and bearing a number of flaming torches".

Remarkably, she made the trip without Joseph and was accompanied by only a guide and some native 'coolies'. Gabrielle left Nha Trang going south on the Mandarin Road. After resting overnight at *Phan Rang* (aka *Thap Cham*) she turned inland, commencing her 84 km expedition to the Lang Bian (Fig. 3). On horseback she followed the *Cai* River to the foot of the Annamite mountain chain, where they stayed overnight at the village of *Da Ban* (now renamed as *Song Pha*).

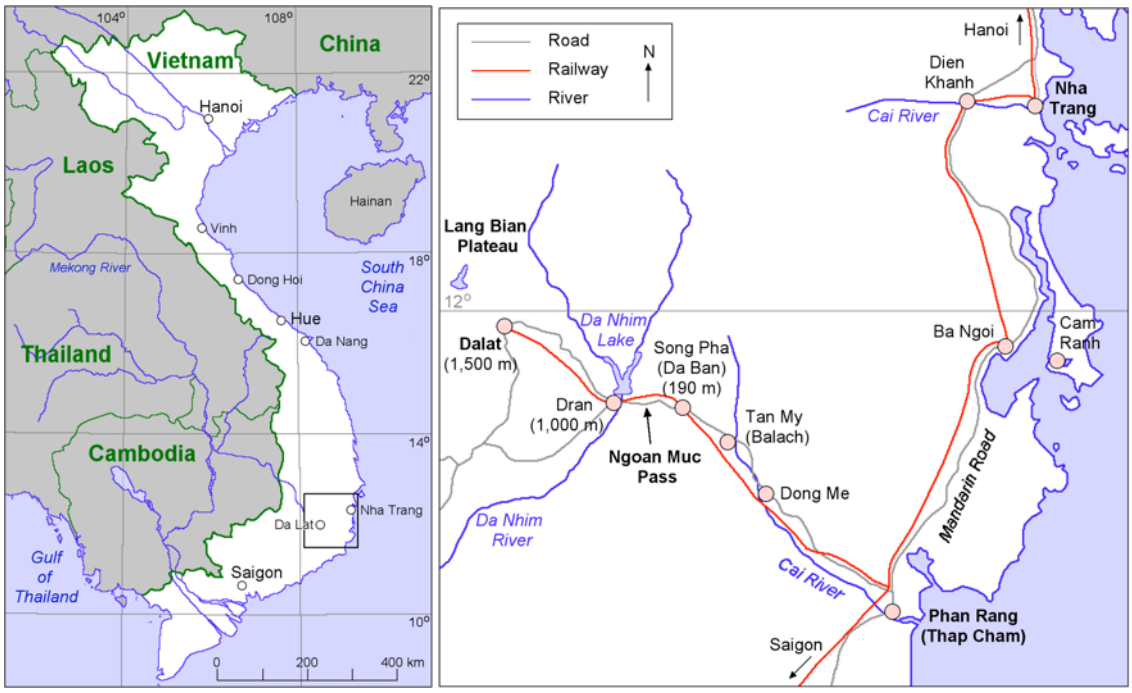

Fig. 3. Map of Vietnam showing the location of the area discussed in this study (left), and regional map (right). Current names for towns and villages are shown together with the old names used during colonial times where known. The Phan Rang-Dalat railroad is no longer active. – *Karte von Vietnam mit der Lage der in diesem Artikel besprochenen Region (links) und Detail-Karte der genannten Region (rechts). Sowohl die heute gebräuchlichen Namen von Städten und Dörfern als auch die während der Kolonialzeit gebräuchlichen Namen sind eingetragen. Die Eisenbahnlinie zwischen Phan Rang und Dalat ist heute nicht mehr in Betrieb.*

To ascend the steep incline she needed to follow a sinuous trail known as the Ngoan Muc Pass (or as the Bellevue Pass to the French). The next morning they set off again with new ponies and twenty *Moi* guides that had been sent ahead from *Phan Rang*. The Mois were naked except for loincloths and were decorated in assorted bracelets and bangles, smoked pipes and carried all their necessities on their backs in wicker baskets. Starting early they began to climb the steep slopes of the Ngoan Muc Pass, and once they had risen 500 metres they saw the first pine trees on the trail, indicating the higher elevation. Gabrielle noted the abundance of orchids in this area as well as gibbons, and she described her encounter with the latter as follows (Vassal, 1910):

> "Sometimes the silence was broken by the shrill cries or loud wails of monkeys, and the branches above our heads shook and rattled as a family party took flight. We could not always see them distinctly through the leaves, but my boy[1] shot two and brought them to me in triumph. They were both Gibbons, which are the only representatives of the man-like apes in Annam. One was entirely black except for a buffy gular patch, with long fur. It has since been named *Hylobates gabriellae*, after me. It was a new species. The other, *Hylobates leucogenys*, was also black, but had white whiskers."

These animals were skinned and sent back to Nha Trang and in November 1908 one of these specimens was deposited in the British Museum (Natural History) and became the type specimen of the species described by Oldfield Thomas as *Hylobates gabriellae* (BM[NH] 1908.11.1.1). In his paper (Thomas, 1909), Oldfield Thomas writes:

[1] Her manservant, *Da*.

> "I propose to name it in honour of Mrs. Vassal, to whose help much of her husband's success in obtaining interesting animals has been due."

Gabrielle continued with her trip to the Lang Bian and, reaching the summit of the Ngoan Muc Pass at an elevation of just over 1,000 m, looking east Gabrielle and her party had a breathtaking view of the coastal plains which on a clear day allows the coastline to be seen (Fig. 4). Crossing the *Da Nhim* river to reach the Dran (or D'ran) plateau, they then entered large natural forests of pine that are so typical of this region and finally reached the Lang Bian plateau the following day. Gabrielle was hosted by Captain Jules Canivey, who was the Government official charged with administering the new French settlement of Dalat. It was Capt. Canivey who enthralled Gabrielle with his accounts of tigers in the region, including his account of having shot and then being seriously mauled by a tiger.

Fig. 4. The Nguan Muc Pass. View from the top of the pass to the east. Photo: Simon M. Cutting (2006). – *Der Nguan Muc Pass: Aussicht von der Passhöhe nach Oste*n.

In either her first or second trip to the plateau, Gabrielle had her own encounter with a tiger while on her second trip to Dalat. While staying at the Agricultural Station (15 km outside of Dalat), a marauding tiger had come within metres of their huts. That morning Gabrielle and two Frenchmen went off in pursuit of the tiger. Gabrielle was not allowed to carry a gun but the two Frenchmen did allow her to bring a Brownie camera instead. They managed to locate the tiger but failed to kill it. Two weeks later the wounded, and potentially far more dangerous tiger, was again found to have entered their encampment. This time they tethered a goat and lay in wait for the animal to take the bait. Gabrielle was now allowed to take part in the hunt and at sunset, with barely any light remaining, the tiger appeared and Gabrielle surprised all by shooting and killing it.

The tiger was skinned and returned to England where its skull is stored at the BM[NH][2]. In 1968 this skull was used by the zoologist Vratislav Mazak as a type specimen to define the Indochinese subspecies, *Panthera tigris corbetti* (Mazak, 1968). Joseph would collect many other mammals some of which became type species (Bonhote, 1907).

Gabrielle wrote a definitive account of her three years in Vietnam in an English version "*On and off duty in Annam*" (Vassal, 1910) and two accounts in French as "*Mes Trois Ans d'Annam*" (Vassal, 1911, 1912). These travelogues provided a witty and interesting account of the French colonies and demonstrated Gabrielle's literary skills.

Her press reviews were generally kind and complimentary, but from the scientific community they were somewhat condescending and patronising.

[2] Mazak cites two tiger specimens held at the BM[NH] and both obtained from Nha Trang, 1910.3.10.8 and 1910.3.10.9, both of which were deposited by the Vassals.

William Churchill, who reviewed *On and Off Duty in Annam* for the American Geographical Society wrote (Churchill, 1912):

> "Ephemeral though works of this type must be in their very essence, sure to be displaced by later and more complete narratives, we cannot have too many of them." … "In the brief table of the scientific results of what, with the utmost naiveté, she calls 'making collections' we encounter *Cissa gabriellae*, *Lepus vassali*, and *Presybtis margarita*, which may perhaps be an explanation of a middle name hidden beneath an initial"

What Mr. Churchill had noticed was that specimens she had collected were being named after her or her husband. Today, the naming of species is the decision of the taxonomist but generally the names of the person who identified the species is no longer used in the species name. In Victorian and Edwardian times though these guidelines were not followed. In retrospect this was very much an unfair remark by her reviewer since she had not chosen the name and indeed, it was done without her knowing. He had also forgotten that many male collectors had their names attached to species names; Frederick Sander, the great orchid collector, had 200 orchids carrying his name (Swinson, 1970)!

Gabrielle would go on to write a number of travelogues of her trips to China and the French Congo, after which Gabrielle and Joseph returned to Paris. Sadly, most of her written works are now forgotten. During WW2 Gabrielle became part of the French Resistance movement, working with members of the resistance in helping allied pilots in hiding in Paris, later receiving a number of awards for her bravery.

Comments on the gibbons

There are a number of anomalies in Gabrielle's accounts or questions regarding the gibbon specimens mentioned in her report (Vassal, 1910) that are worth clarifying. They are briefly addressed below.

First, in Oldfield Thomas's report he states that Gabrielle's husband, Joseph, had collected the gibbon (Thomas, 1909). This is clearly at odds with Gabrielle's account.

Although it is generally believed that the type locality of the yellow-cheeked crested gibbon is Lang Bian (Jenkins, 1990: "Lang Bian, near Nha Trang, 100 km inland from Phan-rang, S. Annam, 1500 feet elevation [457 m]"), this is not correct. Gabrielle made a trip *to* the Lang Bian plateau and thus anything collected along the way was eventually labelled as such. Her description of the actual shooting of the gibbon describes a foliage inconsistent with pine trees. In contrast, the plateau itself had few trees and surrounding trees were pine in her book. According to her description of when and where she shot the gibbons, the type locality is on the ascent to the Dran Plateau.

Particularly strange is that a second specimen (apparently collected at the same locality on the same day as the first specimen) was reported to be black with white cheek patches ("whiskers") and was identified as "*H. leucogenys*", whereas the first specimen was black with yellow cheek patches. So far, there is no evidence that crested gibbons with white cheeks (be they *Nomascus leucogenys* or *N. siki*) occur or ever occurred south of the 16 degree northern latitude. How a crested gibbon with white cheeks could have been found at this locality remains unclear. The colouration of the cheek patches in wild-caught *N. gabriellae* usually range from pale yellow to pale orange colouration, and the second specimen may have exhibited a particularly pale cheeks. Maybe the BM[NH] curator of mammals, i.e. Oldfield Thomas, was initially mistaken as to what the second gibbon was. Gabrielle Vassal was not a scientist and would have been reliant on Thomas for taxonomic identifications.

It would be interesting to confirm the identity of the second (white-cheeked) specimen, but its whereabouts remain unknown at present. It is not mentioned in the accounts by Bonhote (1907) and Thomas (1909), and it is apparently not in in the collection of the British Museum (Natural History) (Jenkins, 1990).

It should be noted that a juvenile male of the Indochinese leaf monkey (*Trachypithecus germaini*) was also collected by Gabrielle from the same Lang Bian trip (Napier, 1985). According to Gabrielle's account, this monkey was shot by her assistant one day after the gibbons. "The next day he killed a long-tailed *Presbytis*. It had thick grey fur of a lovely shade of colour with white trousers and was almost as big as the Gibbons." (Vassal, 1910, p. 209). It became the holotype (BM[NH] 1908.11.1.5) of a new species *Presbytis margarita* described by Elliot (1909). Although Elliot mentions the "white hairs on the upper lip" of this monkey, it seems unlikely that this faint similarity with one of the gibbons could have caused a confusion between the two primates.

It is also unclear why the type specimen was recorded as being collected on 10 June 1908 according to the records of the BM[NH] (Thomas, 1909; Jenkins, 1990), whereas it was collected around September 1907 according to Gabrielle's letters.

As far as I can tell, Gabrielle made two trips to the plateau. I know from her written letters to Oldfield Thomas and to Ogilvie-Grant that the first was in September 1907 and the second in June-July 1908. Gabrielle's published accounts give no dates and I also know that she randomly mixes up the chronology of events. Her publications mention only one trip, during which the gibbons were collected. It is therefore not clear when the gibbon was killed. The written account suggests the gibbon was shot on the first trip, yet the BM[NH] records state 10 June 1908 (Thomas, 1909; Jenkins, 1990). Gabrielle did write one letter to Ogilvie-Grant (16 August 1908) stating that the gibbons had been sent, and presumably other

specimens the Vassals had collected and prepared were to be shipped in one single consignement (note that the BM[NH] records show that 20 specimens collected by the Vassals, including the *N. gabriellae*, were purchased in November 1908), which agrees with the gibbon being collected on Gabrielle's second trip to the plateau.

Acknowledgements

I would like to thank Dr. Robert Prys-Jones, Head of the Bird Group at the Natural History Museum at Tring, Hertfordshire, for encouraging me to pursue this work, and Dr. Robert Dallmann for the permission to use his gibbon photograph.

References

Bonhote, J. L. (1907). On a collection of mammals made by Dr. Vassal in Annam. *Proceedings of the Zoological Society, London* **1907**: 3-11.

Churchill, W. (1912). Review of 'On and off duty in Annam'. *Bulletin of the American Geographical Society* **44**(11): 858-859.

Elliot, D. G. (1909). Descriptions of apparently new species and sub-species of monkeys of the genera *Callicebus*, *Lagothrix*, *Papio*, *Pithecus*, *Cercopithecus* and *Presbytis*. *The Annals and Magazines of Natural History, London* **4**: 244-274.

Geissmann, T. (2007). Status reassessment of the gibbons: Results of the Asian Primate Red List Workshop 2006. *Gibbon Journal* **3**: 5-15.

Jenkins, P. D. (1990). *Catalogue of primates in the British Museum (Natural History) and elsewhere in the British Isles; part V: The apes, superfamily Hominoidea*, British Museum (Natural History), London, xiii+137 pp.

Mazak, V. (1968). Nouvelle sous-espece de tigre provenant de l'asie du sud-est. *Mammalia* **32**: 104-112.

Napier, P. H. (1985). *Catalogue of primates in the British Museum (Natural History) and elsewhere in the British Isles; part III: Family Cercopithecidae, subfamily Colobinae*, British Museum (Natural History), London, x+111 pp.

Ogilvie-Grant, W. R. (1906). New species and subspecies procured during Mr. H. C. Robinson's recent expedition to Gunong Tahan. *Bulletin of the British Ornithologists' Club* **19**: 9-15.

Swinson, A. (1970). *Frederick Sander: The orchid king*. Hodder and Stoughton Ltd., London, 252 pp. + 16 pp. of photographs and colour plates.

Thomas, O. (1909). A new gibbon from Annam. *Annals and Magazine of Natural History, London* **4**(8): 112-113.

Vassal, G. M. (1910). *On and off duty in Annam*. William Heinemann, London, xi+283 pp. + 66 plates. Downloadable from www.archive.org/details/onoffdutyinannam00vassiala

Vassal, G. M. (1911). Mes trois ans d'Annam. *Le tour du monde*, NS **17**: 61-108, 253-300. Text available on-line from http://collin.francois.free.fr/Le_tour_du_monde/textes/Annam/Annam1.htm

Vassal, G. M. (1912). *Mes trois ans d'Annam*. P. Hachette, Paris, vii+302 pp. + 32 plates.

Vassal, J. J. (1907). Le Lang-Bian. *La Revue Indo-Chinoise* (Issue 53): 1-20.

Zusammenfassung

Gabriellas Gibbon

Der Gelbwangen-Schopfgibbon (*Nomascus gabriellae*) wurde vor 100 Jahren als neue Art beschrieben, basierend auf einem Gibbon aus Vietnam. Die vorliegende Veröffentlichung beschreibt den geschichtlichen Hergang dieser Entdeckung, die der Sammeltätigkeit der Engländerin Gabrielle Maud Vassal zu verdanken ist. Nach ihr wurde der Gibbon auch benannt. Ihr Gatte nahm im Jahr 1904 eine wissenschaftliche Stelle am beim berühmten Schweizer Mikrobiologen Alexandre Yersin im Pasteur-Institut von Nha Trang, Süd-Vietnam (damals Annam) an. Die Vassals lebten eine Zeit lang in Nha Trang und sammelten wichtige Typus-Exemplare mehrere neuer Tierarten für das British Museum (Natural History) in London.

Hoolock gibbon and biodiversity survey and training in southern Rakhine Yoma, Myanmar

Thomas Geissmann[1], Mark Grindley[2], Frank Momberg[3], Ngwe Lwin[4], and Saw Moses[5]

[1] Anthropological Institute, University Zürich-Irchel, Winterthurerstr. 190, CH–8057 Zürich, Switzerland, E-mail: thomas.geissmann@aim.uzh.ch
[2] PRCF (People Resources and Conservation Foundation, Environmental Associate for Cambodia, Myanmar, and Thailand), Chiang Mai, Thailand, E-mail: mark.grindley@prcfunion.org
[3] FFI (Fauna and Flora International, Asia Director for Program Development), Jakarta, Indonesia, E-mail: frank.momberg@ffi.gmail.com
[4] BANCA (Biodiversity and Nature Conservation Association, Field Coordinator), Yangon, Myanmar
[5] BANCA (Biodiversity Specialist and Ornithologist), Yangon, Myanmar

This is a report on a training course introducing the methodology to be used in the Hoolock Gibbon Status Review project (of the Myanmar Conservation Program), which was field tested on a short hoolock gibbon and biodiversity survey in southern Rakhine Yoma, south-west Myanmar. The survey served to fine-tune skills learned by course participants, and as a test run for the project which aims to assess the status of the hoolock gibbons (genus *Hoolock*) in Myanmar. Although the country still holds large intact areas of prime gibbon habitat and is believed to support the largest remaining populations of hoolock gibbons, there is no significant data on the conservation status of the species in Myanmar. This first survey was carried out during the dry season (November 2008) in southern Rakhine Yoma. The study confirms the occurrence of hoolock gibbons in what appears to be the southernmost locality recorded so far, and supports their identification as western hoolock gibbon (*Hoolock hoolock*). Hoolock gibbons were confirmed present in very low densities, and several possible explanations for this finding are discussed. However, the main reason for the low density is believed to be low habitat quality. As a further result of the survey, several mammal and bird species were confirmed for the first time for this region of Myanmar, and a potentially new fish species was observed.

Introduction

Hoolock gibbons

Hoolock gibbons (genus *Hoolock*) are distributed in forested areas from eastern India and Bangladesh to Myanmar and southern China (Fig. 1). Geographically, these apes' natural range extends from east of the Brahmaputra river to west of the Salween river.

Currently, two species of hoolock gibbons are recognized: the Western Hoolock (*H. hoolock*), and the Eastern Hoolock (*H. leuconedys*) (Geissmann, 2007). Their respective ranges are separated by the Chindwin river, which flows into the Irrawaddy (= Ayeyarwady) river (Groves, 1967, 1972). The boundary between the two species is uncertain in the Chindwin headwaters in the north, and possibly includes a zone of intermediates. Moreover, a population of *H. leuconedys* was discovered in Arunachal Pradesh, north-east India (Chetry *et al.*, 2008; Das *et al.*, 2006), which has traditionally been

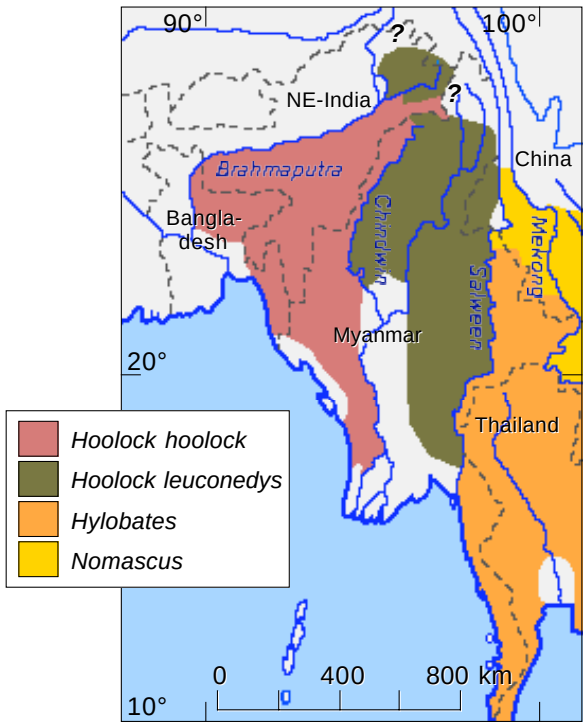

Fig. 1. Distribution of the hoolock gibbons (genus *Hoolock*) and gibbons of the genera *Hylobates* and *Nomascus* in adjacent areas. – *Verbreitung der Hulock-Gibbons (Gattung* Hoolock*) und der Gibbongattungen* Hylobates *und* Nomascus *der angrenzenden Gebiete*.

considered to be part of the distribution area of *H. hoolock*. As a result, gibbon populations in south-eastern Tibet are yet to be determined taxonomically.

Of all gibbons, the range of the hoolock gibbons extends the farthest north and west, and it is the only genus of apes represented in the Indian sub-continent. Hoolocks are found in several types of habitats: tropical evergreen forest, the wetter tropical semi-evergreen forests, sub-tropical monsoon evergreen broadleaf forests, and sub-tropical evergreen broadleaf hill or mountain forests. They appear to be less common in deciduous forest and scrub forest, and absent from mangrove (Choudhury, 1996; Gittins and Tilson, 1984; Lan, 1994).

Although hoolock gibbons occur from the floodplains to the mountains, they appear to be more common at altitudes of 80-1500 m (Choudhury, 1996; Mukherjee, 1986). They have been recorded at up to 2,550 m in Manipur, north-east India (Choudhury, 2001). In Myanmar, hoolocks also occur at higher altitudes. On the slopes of Mt. Victoria (Chin State, western Myanmar), they were observed at elevations of 2,100-2,300 m (King *et al.*, 1995). During the Vernay-Cutting expedition to north-eastern Myanmar, hoolocks were also observed in pine dominated forests at altitudes of up to 2,400-2,700 m (Anthony, 1941).

Previously found throughout the forests of its present range, deforestation and hunting have exterminated hooock gibbons from much of their historical range. From an original ranging habitat of about 168,000 square kilometres, the available habitat in 1987 was estimated at no more than 56,378 square kilometres, representing a 67 percent habitat loss (Feeroz and Islam, 1992).

Hoolock gibbons have experienced a drastic population decline. The 1971 and 1972 Zoological Survey of India census of primates estimated that the population of *H. hoolock* in Assam was between 78,000 to 80,000 individuals in north-east India (Chivers, 1977), whereas the present population there is estimated to be about 2,400 animals (Das *et al.*, 2006; Molur *et al.*, 2005). Other recent population estimates for *H. hoolock* include 200-280 individuals of *H. hoolock* in Bangladesh (Islam *et al.*, 2006; Molur *et al.*, 2005), whereas numbers for *H. leuconedys* include 50-300 individuals in China (Lan, 1994; Tian *et al.*, 1996; Zhang, 1998; Zhang *et al.*, 2002) and about 170 *H. leuconedys* in India (Das *et al.*, 2006).

Reasons for such decline have included rapid habitat loss and habitat fragmentation (shifting cultivation, logging), hunting (food, traditional "medicine"), lack of environmental awareness and education, and the absence of conservation measures (Feeroz and Islam, 1992; Geissmann, 2007). Habitat fragmentation forces gibbons to descend from trees to go across forest clearings, making them even more vulnerable to hunting and predation. Indeed, at some Indian localities, hoolocks are rare due to large scale hunting for food. Intense hunting of gibbons by local tribes is reported in Assam (Choudhury, 1991), and gibbon meat and bones are quite valuable as a tonic in some traditional Asian medicines. There is some evidence to suggest that hunting for wildlife trade also occurs at extremely high levels in Myanmar (Rao *et al.*, 2002).

Myanmar is among the most biologically diverse countries in mainland Southeast Asia. In contrast to its neighbours, large areas (about 30%) of Myanmar are still forested, providing a unique opportunity to conserve biodiversity within protected areas (Rao *et al.*, 2002). At present, Myanmar potentially supports the largest remaining populations of both hoolock species. However, gibbons in Myanmar remain largely unstudied, and there are several thousand square kilometres of unsurveyed habitat. There are no population estimates of *H. hoolock* available. For *H. leuconedys*, a population census was conducted in Mahamyaing Wildlife Sanctuary (WS), Sagaing division (Brockelman, 2005; Gibbon Survey Team, 2005). Surveys were also conducted by Wildlife Conservation Society (WCS) in Hukaung Valley WS, Kachin state (Saw Htun, personal communication to TG, 2006). Based on vocal surveys, there are approximately two groups per square kilometre in Mahamyaing WS, with a total population of about 5,900 individual gibbons (Brockelman, 2005). Based on that result, the total population of *H. leuconedys* in Myanmar may be over 10,000 individuals, and perhaps up to 50,000 individuals (Brockelman, personal communication, cited in Geissmann, 2007).

However, other than the two surveys mentioned above and some presence/absence data from a few general biodiversity surveys in protected areas, no additional data on the status of hoolock gibbons in Myanmar exists. The species has been identified as a priority for conservation in Myanmar (Tordoff *et al.*, 2005), with the immediate priority being the conduct of a status review. Such a status review is deemed critical for identifying, prioritizing, and planning conservation interventions to increase the probability for the long-term survival of the Myanmar population of hoolock gibbons.

Background to the project

The first Rakhine Yoma gibbon survey presented in this report is part of the Hoolock Gibbon Status Review project (of the Myanmar Conservation Program) implemented jointly by the People Resources and Conservation Foundation (PRCF), Fauna & Flora International (FFI), the Myanmar Biodiversity and Nature Conservation Association (BANCA) and the Zoology Department of the University of Yangon.

The project aims to assess the conservation status of the hoolock gibbon in Myanmar, while strengthening the capacity of the conservation movement in primate surveying, monitoring, and conservation. Globally, hoolock gibbon populations are dwindling due to forest clearance, disturbance, and hunting. Myanmar still holds large and intact areas of prime habitat for hoolock gibbons, but there is no

significant data on the conservation status of these apes.

A comprehensive review on the conservation status of the species will help identify, prioritize, and plan conservation interventions to enhance the possibilities for the long-term conservation of hoolock gibbons. The proposed project will help initiate hoolock gibbon conservation efforts, by increasing the knowledge on the distribution and relative abundance of this species in Myanmar.

Through surveys and analyses of gibbon population status, the project will identify major threats to gibbon populations in Myanmar and raise awareness among stakeholders as well as the general public regarding conservation needs for the species. To ensure sustainability of project outcomes, specialists in the project will train counterpart staff from the local non-government 'Biodiversity and Nature Conservation Association' (BANCA) and the Zoology Department of Yangon University.

Materials and methods

A program and itinerary of this survey are listed in Table 1.

Table 1. Program of the training workshop and survey. – *Programm des Trainings-Workshops und der Gibbonerhebung im Freiland.*

Date	Topic	Days
21-23 Nov.	Training workshop in Yangon	3
24 Nov.	Move from Yangon to Chaung Tha, Rakhine province	1
25 Nov.	Walk to forest, select camp site, and establish listening posts	1
26-30 Nov.	Field survey work, and interview work (29-30 Nov)	5
30 Nov. – 1 Dec.	Return from Chaung Tha, Rakhine province, to Yangon	1
2-5 Dec.	Analyse results and write report	2
Total		13

Training

As an introduction to the Hoolock Gibbon Status Review project (of the Myanmar Conservation Program), a training workshop was held in Yangon between 21 and 23 Nov. 2008 (Fig. 2). The participants included lecturers and students from Yangon University (13), Western Yangon University (2), Pyay University (1), Dawei University (1), local NGO staff from BANCA [Biodiversity and Nature Conservation Association] (3), and the Rakhine Coastal Association (1).

The training topics included:

- Introduction to this project, to FFI, and to PRCF (Frank Momberg, Mark Grindley)
- Introduction to conservation issues in Myanmar: priority areas, species and threats (Dr. Htin Hla)
- Summary of Mahamyaing Wildlife Sanctuary Gibbon Survey WCS (Pwint Thu Aye)
- Distribution of long-tailed macaques in some areas of Myanmar (Dr. Aye Mi San)
- What are gibbons? Introduction to gibbon biology (Dr. Thomas Geissmann)
- Gibbon conservation issues (Dr. Thomas Geissmann)
- Status review method (Frank Momberg)
- Introduction to hoolock singing behaviour, with sound and video examples (Dr. Thomas Geissmann)
- Survey techniques for gibbons (Dr. Thomas Geissmann)
- Getting familiar with hoolock gibbons and selected key species at the Yangon Zoo (Dr. Thomas Geissmann)
- Introduction to compass and GPS handling (Mark Grindley)
- Interview techniques (Mark Grindley, Frank Momberg)
- Health and safety / first aid training (Dr. Htin Hla, Mark Grindley)

Additional training sessions in interview techniques and compass and GPS handling was provided during the field survey (Fig. 3). A training session in plotting and triangulating gibbon song data and in estimating gibbon group densities was held after the survey on 2 Dec. 2008 in Yangon.

Field survey area

Survey location

The first gibbon survey and training field work of this project was carried out during the dry season (last week of Nov. 2008) in the southern Rakhine Mountain Range (Rakhine Yoma). Rakhine Yoma lies in the distribution range of the western hoolock gibbon (*H. hoolock*), inland of the Bay of Bengal, between the Myanmar-Bangladesh border and the Ayeyarwady River. The mountains of Rakhine Yoma are covered by patches of primary forest within a landscape dominated by secondary vegetation (largely bamboo) resulting from shifting cultivation. The survey area was located in a small mountain ridge facing the Bay of Bengal adjacent to Taing Kyo village and, further inland, Chaung Tha village in Thandwe district, Gwa township in Rakhine division (Fig. 4).

Chaung Tha village profile

Chaung Tha village is located in Boak Pyin creek, about 3 km from the coast, about 1 km from the main road (coordinates: 17°50'40.3"N, 94°29'50.6"E). The village comprises 44 households (50 families), with a population of approximately 260 people. It is ethnically Chin, with the predominant religion being Christianity. The nearest forest is about 3 km away (0.5-1 hour walking) on the top of the Ngadanni Kyaw hills (50-500 meters elevation), which form the first ridge line parallel to the coast. A village interview was conducted with a small focus

Fig. 2. Training workshop held at the beginning of the Hoolock Gibbon Status Review project in Yangon, 21 Nov. 2008. Photo: Thomas Geissmann. – *Zu Beginn des Hoolock-Schutzprojektes wird in Yangon ein dreitägiger Trainings-Workshop abgehalten*.

Fig. 3. Training session on interview techniques held at the field camp site on 28 Nov. 2008. Photo: Mark Grindley. – *Erlernen der Interview-Methoden im Lager des Untersuchungsgebietes am 28. Nov. 2008*.

group to obtain basic socio-economic data related to farming, forest resource use and wildlife.

Forest ecosystems

The survey area ranges from 100-500 meters with secondary bamboo vegetation and patches of degraded forests on the western, seaward slopes and mostly contiguous lowland evergreen degraded forest on the mountain ridge and eastern slopes (Fig. 5). This forest block is separated from a larger forest block of evergreen and semi-evergreen forest on the central ridges of Rakhine Yoma to the east.

Interview survey methods

Participatory rural appraisal (PRA) methods were used to obtain a village profile on livelihoods and natural resource management with an emphasis on forest use. The PRA was conducted with a small focus group from Chaung Tha village, including the village leader, the local church leader and an experienced hunter. The focus group discussion focused on farming, land tenure, forest utilization (timber and non-timber forest products), forest change, threats to forest and wildlife, human-wildlife conflicts, and local development initiatives. A forest and land use sketch map was produced, highlighting forest and farming areas, primate distribution, and hunting areas.

Additionally, interviews were conducted with eight hunters to identify locations, time and number of primate sightings and primates heard, and to identify the species based on the described characteristics (size, tail presence/absence, tail length, fur colouration, marks, locomotion, feeding behaviour, and habitat). Additional topics included threats to the species and their habitat, population status (rare/common) and trends, hunting methods (snaring/trapping, shooting, hunting with dogs), market prices, and trade chains for each present primate species. Any hunted primates were recorded in detail (species, numbers, location, hunting method, market price).

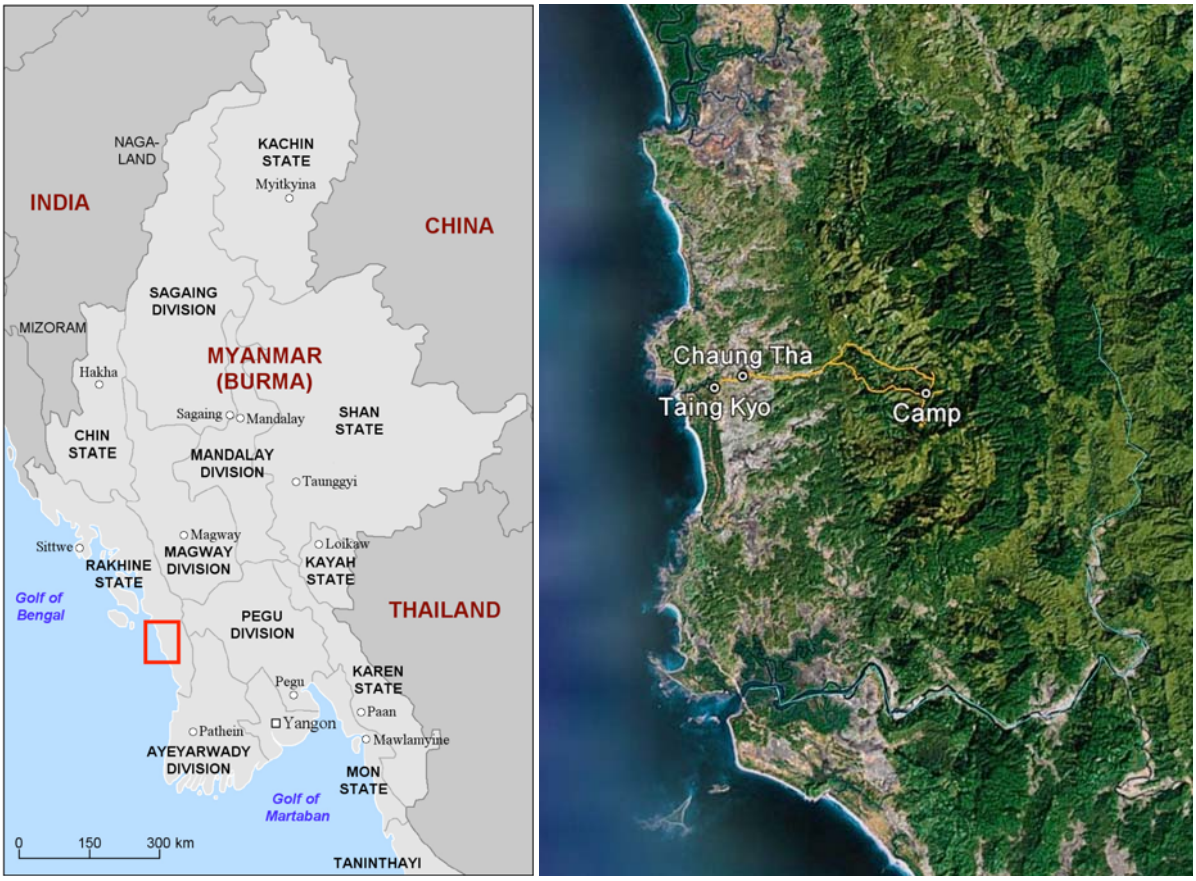

Fig. 4. Map of Myanmar showing location of field site (left), and overview of field site (right), showing the villages Taing Kyo and Chaung Tha, the camp site, and access routes (yellow). Width of right map is about 25 km. – *Karte von Myanmar mit der Lage des Untersuchungsgebietes (links), und Übersicht des Untersuchungsgebietes mit der Lage der Dörfer Taing Kyo und Chaung Tha und des Lagers im Untersuchungsgebiet*.

Fig. 5. Views of the habitat in the survey area. The photo on the right shows a deforested patch (upper left corner of the picture). Photos: Frank Momberg and Saw Moses. – *Ansichten des Habitats im Untersuchungsgebiet. Im Foto rechts ist in der oberen linken Ecke eine entwaldete Stelle zu erkennen*.

Field survey

Participants in the field survey included:

Mi Mi Hlaing, Yu Yu Cho, Daw Ohmar Cho, Mg Kyaw Kyaw, Pwint Thu Aye, Saw Soe Awng, Mg Zay Lodt Aung, and Thet Naing Aung (Yangon University, Department of Zoology), May Myat Soe and Kyaw Thet Khang (local academic institutions in Rakhine State), Saw Moses and Ngwe Lwin (BANCA, Biodiversity and Nature Conservation Association).

Field survey techniques most suitable to estimate densities of gibbon populations are variants of the fixed point method, whereby the loud morning songs of the gibbons are monitored from fixed listening posts (Brockelman and Ali, 1987; Brockelman and Srikosamatara, 1993).

In order to facilitate comparison of results with those of the earlier gibbon surveys in Mahamyaing Wildlife Sanctuary, Sagaing division, Myanmar (Brockelman, 2005; Gibbon Survey Team, 2005), we adopted the same auditory survey method as far as possible.

At the study site, a camp was established at a location with the following coordinates: 17°50'28.3"N, 94°32'05.4"E, elevation: 417 m (Fig. 6). Three listening posts were selected from which gibbon calls were monitored during five consecutive mornings. The coordinates of the listening posts and the survey hours spent at each of them are listed in Table 2. Only one listening post (LP3) proved to be unsuitable because of its location in a valley and was replaced by a new post (LP4) after one survey day.

Listening posts were about 400-500 m apart and located on hilltops (Fig. 7) in order to enable the survey participants to hear gibbons from as many directions as possible. Surveyors had to leave the camp before dawn in order to arrive at the listening posts before 06:00 h (Fig. 8). Listening for gibbon songs was carried out daily from at least 06:00 to 11:30 h. Only on the last survey day (30 Nov. 2008) was survey time shorter because the team had to travel back to Yangon on the same day.

Table 2. Listening post coordinates and survey time. – *Koordinaten der verwendeten Hörposten und Anzahl Stunden, die auf den Hörposten verbracht wurden*.

Listening post	Listening post coordinates and altitude [m]	Survey dates, Nov. 2008	Total hours spent at listening post
LP1	17°50'34.6"N, 94°32'10.3"E, 415 m	26-30 Nov	27.5 h (5.5+6+6+6+4 h)
LP2b	17°50'20.0"N, 94°32'03.1"E, 455m	26-30 Nov	27 h (5+6+6+6+4 h)
LP3	17°50'29.4"N, 94°32'14.9"E, 364 m	26 Nov	6 h
LP4	17°50'09.7"N, 94°32'05.2"E, 508 m	27-30 Nov	21 h (6+6+6+3 h)
Total			81.5 h

Fig. 6. Establishing the camp site in the survey area, 25 Nov. 2008. Photo: Thomas Geissmann. – *Im Untersuchungsgebiet wird ein Camp eingerichtet, 25. Nov. 2008*.

Fig. 7. Map of field site showing position of camp and listening posts (Source: GoogleEarth/Myanmar Primate Conservation Program). – *Karte des Untersuchungsgebietes mit der Position des Camps und der einzelnen Hörposten, von denen aus die Gibbongesänge erfasst wurden*.

Fig. 8. Camp site at 04:45 in the morning: the teams are preparing to walk to their respective listening posts, 27 Nov. 2008. Photo: Thomas Geissmann. – *Das Lager um 04:45 Uhr am Morgen: Die einzelnen Teams bereiten sich auf die tägliche Wanderung zu ihren Hörposten vor*.

Each listening post was manned by at least two surveyors. At the listening posts, watches of the surveyors were synchronized with the GMT of the GPS. Time, compass direction, estimated distance, and type of all gibbon songs were recorded on a field form. Compass bearing and distance estimates were checked by two surveyors. Song types included (1) solo song bouts, (2) duets with two singers, (3) duets with more than two singers, (4) duets with unknown number of singers. Hoolock song bouts have an average duration of 15-20 min (Feeroz and Islam, 1992; Gittins and Tilson, 1984; Lan *et al*., 1999; Tilson, 1979). If a song interval (silence) was longer than 5 minutes, the calls after the interval were recognised as a new song bout.

In addition to gibbon song data, surveyors also recorded direct observations of birds and mammals, other wildlife signs and evidence for hunting (hunters, gunshots, traps, snares), both at the listening posts and on the way to and from the posts each morning.

Furthermore, various team members also carried out daily surveys for birds and other animals by

walking slowly through the forest, and night surveys surveys for nocturnal species using spotlights from about 19:30 to 22:00 hours.

Mapping and density determination

Time, directions and estimated distances of gibbon songs on each day were plotted and triangulated on graph papers. Density of gibbon groups was estimated based on the triangulated results. Temporal overlap in songs or song bouts produced within short intervals from different locations helped to identify different groups, and songs that mapped more than 500 m apart were also assumed to be from different groups. Comparing song times and estimated locations of singing gibbons recorded from different listening posts was used to identify song data referring to the same groups.

Although gibbon songs can often be heard in the forest over distances well exceeding 1 km, gibbons singing behind hills are often estimated to be further away than they actually are. Furthermore, different gibbon groups beyond 600 m from the listener are more difficult to be distinguished than groups singing at closer distances. As a result, gibbon densities were estimated using a 0.6 km and a 1 km listening radius. The earlier gibbon survey in Mahamyaing Wildlife Sanctuary, Sagaing division, Myanmar revealed that the 0.6 km radius consistently produced higher density estimates than the 1 km listening radius (Brockelman, 2005; Gibbon Survey Team, 2005).

Average hoolock gibbon group sizes have been reported to be 3.2 individuals in Assam (n = 24 groups) and 3.5 in Bangladesh (n = 7 groups) (Gittins and Tilson, 1984). In our analyses we will assume an average group size of 3.3 individuals, which is the approximate mean of the above two estimates.

Results 1: Interview survey

The following information on farming, forest resource use and wildlife was collected during interviews conducted with inhabitants of the Chaung Tha village in the afternoon and evening of 29 Nov. 2008 (Fig. 9). Chaung Tha is the closest village to the field survey area.

Farming system

Rice cultivation is the pre-dominant farming system with 12 families owning paddy fields and 15 families working on upland 'swidden' fields (*taungya*). Four families practice both wet rice and upland rice cultivation (i.e. paddy and *taungya*). Wet rice is entirely rain-fed, with one crop cultivated annually. Swidden fields are farmed on a five to six year rotation basis.

Other agricultural cash crops and subsistence crops include chilli, peanuts, betel leaves, banana, sesame, beans, pumpkin, tomato, water melon, bitter leaves, eggplant, rosella leaves, and corn. Two farmers planted cashew trees this season for the first time. Paddy fields are privately owned, while no private or communal tenure exists for shifting cultivation land in Chaung Tha.

Forest land in the village is *de jure* owned by the state, but *de facto* an open access area due to a lack of boundary demarcation, management or enforcement. This access extends to the concept that even famers from other villages may make use of unclaimed land or resources. Fifteen families have no farm land, while ten suffer from food shortages between August and September.

Livestock

Most villagers keep 1-2 cattle, 1-2 pigs and chicken. Only two families own 7-8 cows which are rented to other farmers for ploughing.

Fig. 9. Survey team members conducting interviews in Chaung Tha, 29 Nov. 2008. Photo: Frank Momberg. – Die Teilnehmer des Untersuchungsteams führen gruppenweise Interviews mit Bewohnern des Dorfes Chaung Tha.

Forest resource use

Timber extraction: Most families participate in timber extraction during the rainy season, from July to September. Ten families rely on timber extraction throughout the year for income (mostly landless villagers). About 10 families from neighbouring Taing Kyo participate in timber extraction. Ironwood is cut at a distance of 30-60 minutes from the village, to obtain *white wood* (less expensive, lighter coloured hardwood as referred to by villagers) up to three hours from the village. Ironwood is becoming rare. Trees are usually cut with a DBH (diameter at breast height) of more than 30 cm. Fuelwood is collected by residents of this and nearby coastal viallages for home consumption only. Two families from Taing Kyo make charcoal year round near Chaung Tha village, from local wood supplies.

Wildlife extraction: Fifteen families snare wildlife during the rainy season. The main target species are wild pig and red muntjac. However, other mammals such as sun bears, gaurs, macaques, and slow lorises get trapped as well. Hunters also report regular snaring of binturong (*Arctictis binturong*). The animal's Burmese name, *Kyaung Myee Kauk* means, literally, "cat with curly/curled tail". According to informants, the animal is snared about three times per year. In the past sambar deer were also snared regularly, while hunters rarely trap them now. Hunters today snare only 50% of the wild pigs and red muntjac in comparison to five years ago. Two families hunt pangolins with dogs and one hunter from Taing Kyo village uses an air gun to hunt birds (Fig. 10). Few people (5-10) have crossbows. They hunt red muntjacs, Phayre's leaf monkeys and macaques. No shotguns are used in Chaung Tha and Taing Kyo villages.

Fig. 10. An Asian Fairy Bluebird (*Irena puella*) hunted by airgun in the forest above Chaung Tha village, 29 Nov. 2008. Photo: Frank Momberg. – *Dieser Elfenblauvogel (*Irena puella*) wurde am 29. November 2008 von einem Jäger mit einem Luftgewehr im Wald oberhalb des Dorfes Chaung Tha erlegt.*

Non-timber forest product collection: The most important NTFPs are bamboo poles, with 5-6 families harvesting poles full time for sale to Taing Kyo for house construction and for fish drying racks. Most villagers collect bamboo shoots during the rainy season and sell to the neighbouring coastal village of Taing Kyo. Other forest products for sale are medicinal plants (Pyin U, Paung Ma Ya Za), and mushrooms and firewood for local consumption. We asked village leaders to rank the economic importance of forest products. Results were as follows: 1. Timber, 2. Bamboo poles, 3. Wildlife, 4. Bamboo shoots, 5. Medicinal plants, 6. Rattan.

Other income from labour

Thirty families work as labourers on fields, ten families work on fishing boats in the neighbouring village of Taing Kyo.

Wildlife conflicts

No wildlife-human conflicts are currently reported in Chaung Tha village. The last human-elephant conflict was recorded in 2000 when a single elephant raided crops. The last human-tiger conflict occurred in 1998 when a cow was killed by a tiger. Since then no signs of tigers have been reported from the village forests.

Development initiatives

There are limited initiatives to reduce poverty and no initiatives targeting sustainable resource use. Caritas has just started a micro-credit program, and the local catholic church is providing five hectares of land for poor families to farm on a two year rotational basis. UNICEF has financed public sanitation and water facilities.

Threats to forests/ habitat

The main threat to the forest was the cyclone in 2005, followed by timber extraction over the last 20 years leading to increased forest degradation making the forest more vulnerable to windfall and fire. Shifting cultivation was a significant threat over ten years ago when Chin farmers from Chaung Tha still practiced wide spread shifting cultivation. This has led to the the current mosaic of forests and secondary bamboo re-growth. Nowadays fewer people practice shifting cultivation, which is largely limited to the seaward, western mountain slopes (Fig. 11).

Threats to wildlife

Interviews indicate the most significant threats to wildlife are snaring and hunting, which have already led to the extinction of some species (e.g. Tigers) while populations from other species such as ungulates and primates have experienced a significant decline. Primates are hunted with cross-bows and macaques are occasionally snared. Hunters are reportedly not targeting gibbons any more. However, we were not able to verify this information. No signs of hunting or snaring were observed at the study site, with two exceptions. (1) A snare laid by porters on the survey (and promptly dismantled), which was baited with chicken offal and presumably targeting small carnivores. (2) An Asian Fairy Bluebird was killed with an air rifle by a hunter whom we encountered on the return from the field survey (see above, Fig. 10). The next most serious threats to wildlife are said to be habitat fragmentation and degradation, which have been caused by previous commercial logging, as well as on-going community-based timber extraction and shifting cultivation.

Fig 11. Patches of former shifting cultivation on top (above) and on the western slopes (below) of the Ngadanni Kyaw hills. Photos: Thomas Geissmann. – *Stellen früherer Brandrodungen auf dem Grat (oben) und am Westhang des Ngadanni Kyaw-Hügelzuges*.

Results 2: Field survey

Gibbons

Interview data

According to the interview data, a gibbon group consisting of an adult pair with an infant were observed in September and November 2008 near LP4. Gibbon calls were heard in November 2008 near the waterfall creek near LP3, and in November 2008 near the A-Lal area. This would suggest that as many as three gibbon groups occur in the survey area. Furthermore, a gibbon group consisting of 1-3 individuals was heard and observed in 2008 near the Ba-Wan river (Fig. 12). This locality may, however, be outside of the range of the listening posts.

Fig 12. Oblique view of field site topography and gibbon records. The elevation is exaggerated by a factor of 1.5 in this view. Direction: Looking south-east (Source: GoogleEarth/Myanmar Primate Conservation Program). – *Aufsicht auf das Untersuchungsgebiet (mit Blickrichtung nach Südosten) und Lage der Gibbonvorkommen*.

Aural evidence

Only two gibbon songs were reliably heard during the five consecutive mornings spent on the listening posts: one solo song bout and one duet song bout. Both occurred at the same time (10:17-10:42) to the northeast of LP1, and both were heard from that LP only. The distance of the solo song was estimated to be about 900 m, the duet song was estimated to be more than than 1 km away. One possible song was recorded on 27 Nov. at LP2 (06:48-07:00) at a distance of over 1 km towards the east, but the wind made it impossible to identify reliably whether a gibbon song was actually heard or not. In any case, calling rate was very low during this survey. The possible reasons for this are discussed further below.

Direct sightings

Two primates that may have been gibbons were encountered during this survey (30 Nov) near LP4, but they fled through the canopy so quickly that no reliable identification was possible. On the following day, this area was carefully surveyed and a group of gibbons was encountered and observed during 15 minutes by one of us (SM). The group consisted of an adult pair with an infant carried by its mother. The infant was less than a year old, as it still exhibited the buff infant colouration. The white eye-brows of the male appeared to touch each other above the ridge of the nose, a characteristic typical of the western hoolock (*H. hoolock*).

As both the location and the composition of the group matched the information provided by two of the interviewees, this can be taken as an indicator of the reliability of the informants. Furthermore, this observation revealed that at least one gibbon group was located in the immediate vicinity of one of the listening posts. The calling activity was relatively low, as evidenced by the lack of song production by the group during the five consecutive suvey days of the study.

Density estimates

In the following estimates, the aural evidence and the direct sightings are combined.

No gibbon group song and only one solo song bout were heard from within a listening radius of 1 km, and no gibbon song at all from within a listening radius of 0.6 km. All songs were heard from

LP1 only. As no gibbon song bout was heard from more than one listening post, no triangulation was possible. Because mated hoolock gibbons are not known to produce solo songs, the song we heard was produced, in all probability, by a solitary individual and not by a group.

The sighted gibbon group was located within the 0.6 km radius of LP4.

The resulting density estimates/km^2 for gibbon groups as well as gibbon individuals in the survey area are listed in Table 4. When calculating the area surveyed from each listening post, the areas of non-habitat have to be deducted. These included bamboo, grassland and cultivated areas, all resulting from shifting cultivation. We estimated that these areas amounted to 10% in LP1, 30% in LP2b and 20% in LP4. The amount of non-gibbon habitat in the listening area could have been determined more accurately if GIS technology had been available for this survey, which was, however, not the case.

Considering the limited time available for this survey, these estimates are tentative.

Table 4. Gibbon group and individual density estimates for the survey area. – *Schätzwerte für die Bestandesdichte der Gibbongruppen und -individuan im Studiengebiet.*

Listening post[1]	**Listening radius**			
	0.6 km		**1.0 km**	
	Groups	Individuals	Groups	Individuals
LP1	0	0	0	1
LP2b	0	0	0	0
LP4	1	3	1	3
Total gibbons	1	3	1	4
Density / km^2	0.37	1.11	0.13	0.53

[1] Listening post LP3 is not included as it was in use during only one survey morning.

In an earlier study on the hoolock gibbons in Mahamyaing Wildlife Sanctuary, Sagaing division (Brockelman, 2005; Gibbon Survey Team, 2005), gibbon density estimates were, on average, 2.3 groups/km^2 for the 0.6-km listening radius, and 1.8 groups/km^2 for the larger 1-km radius. These density estimates are roughly one order of magnitude larger than those determined in the present study (0.37 and 0.13 groups/km^2, respectively).

Gibbon calling rate is the main factor used in the calculation of gibbon density. Gibbon groups living in areas with high population densities sing more often than groups in low density areas. The population density of gibbons in the study appears to be very low, judging from the low numbers of gibbons encountered during surveys (see above). The low calling rate observed during this survey (as described above) could, however, have several additional causes:

(1) Low habitat quality may not support higher gibbon densities in the survey area, which in turn would keep calling rates low. In several parts of the survey area, the canopy was open, and the forest was fragmented or interspersed with large patches of bamboo. In these areas, the habitat was certainly not optimal for gibbons. Causes for suboptimal habitat quality in the survey area are believed to include selective logging and local shifting cultivation, but also damages to the forest resulting from the cyclone of 2005 (and likely other tropical storms before and after 2005). Many wind-thrown trees were encountered in and around the survey site. Human induced damages to habitat quality probably have the larger impact on gibbon density, as it is unlikely that gibbon densities would have decreased so drastically only three years after a cyclone.

(2) Gibbon calling rate fluctuates seasonally, with more calls being produced during high fruit availability in the wet season and fewer calls being producing during the dry season. The survey was conducted during the dry season.

(3) High hunting pressure may have selected against calling gibbons, as hunters use the calls to locate and approach the gibbons. There is no evidence for gibbons being hunted in recent years, but gibbons may have been hunted in earlier years, which would explain the low density of gibbons encountered during the survey (see below).

(4) Gibbons rarely sing during certain weather conditions (rain, wind, cold temperatures). There was no rain and the weather was warm (≥20°C) during the survey. During two early mornings, it was relatively windy, but in both cases, the wind disappeared around 08:30, so that the gibbons would have had sufficiently favourable weather conditions for singing.

Other mammals

Table 3 provides a list of the mammals encountered during the survey or reported to occur in the survey area by the interviewees. Eight of the 24 taxa listed have not previously been recorded in south-west Myanmar, according to the distribution maps provided in Francis (2008). These include all of the squirrel species observed during this survey (Fig. 13). It appears that the distribution of mammals in Myanmar by Francis (2008) did not take into consideration unpublished field reports from Myanmar, which makes it possible that our findings on range extension have been documented previously.

Table 3. Mammals recorded during the survey. * denotes a species that has not been recorded previously in south-western Myanmar (Rakhine province), according to Francis (2008). – *Säugetierarten, die während dieser Untersuchung festgestellt wurden. Arten, die laut Francis (2008) bisher nicht im südwestlichen Myanmar (Provinz Rakhine) festgestellt wurden, sind mit einem Stern (*) markiert*.

Order	Family	Species	*	Evidence					IUCN status[1]
				Visual	Aural	Feces	Tracks	Inter-view	
Pholidota	Manidae	Sunda pangolin (*Manis javanica*)						+	EN
Scandentia	Tupaiidae	Northern treeshrew (*Tupaia belangeri*)		+					
Chiroptera	unid. genera	unid. species		+					
Primates	Loridae	Northern slow loris (*Nycticebus bengalensis*)						+[2]	VU
	Cercopithecidae	Northern pig-tailed macaque (*Macaca leonina*)						+	VU
		Rhesus macaque (*M. mulatta*)	*					+[3]	
		Long-tailed macaque (*M. fascicularis*)						+[4]	
		Phayre's leaf monkey (*Trachypithecus phayrei*)						+[5]	EN
	Hylobatidae	Western hoolock (*Hoolock hoolock*)		+	+			+[6]	EN
Carnivora	Canidae	Dhole (*Cuon alpinus*)						+	NT
	Ursidae	Sunbear (*Helarctos malayanus*)						+[7]	EN
	Viverridae	Binturon (*Arctictis binturong*)	*					+[8]	VU
	Felidae	Tiger (*Panthera tigris*)	*					+[9]	EN
Proboscidea	Elephantidae	Asian elephant (*Elephas maximus*)						+[10]	EN
Artiodactyla	Suidae	Eurasian wild pig (*Sus scrofa*)					+	+	
		Red muntjac (*Muntiacus muntjak*)			+			+	
	Cervidae	Sambar (*Rusa unicolor*)						+[11]	NT
	Bovidae	Gaur (*Bos frontalis*)				+	+	+	VU
		Water buffalo (*Bubalus bubalis*)	*				+	+	EN
Rodentia	Sciuridae	Black giant squirrel (*Ratufa bicolor*)	*	+					NT
		Variable squirrel (*Callosciurus finlaysonii*)[11]	*	+	+				
		Irrawaddy squirrel (*C. pygerythrus*)	*	+					
		Blackish tree squirrel with white tail-tip, maybe a variant of the variable squirrel	*	+					
	Muridae	Indet sp.		+					

[1] Abbreviations: CR Critically Endangered, DD Data Deficient, EN Endangered, NT Near Threatened, VU Vulnerable. For criteria and subcriteria on which the category assessment is based, see IUCN (2001) and Standards and Petitions Working Group (2006).

[2] Snared in the rainy season 2008

[3] Could also be *M. assamensis*, as the two species are very similar and the interview data does not allow distinguishing the species. They are identified here as *M. mulatta* since the known distribution range of that species is closer to the survey area. Snared in 2004 and 2005.

[4] Outside the survey area, in mangrove forest close to village, observed catching fish, crab, and clam

[5] Infant in yellow coat caught on 22 Nov. 2008, sold to trader in Tiang Kyo. Group of about 5-6 regularly seen near LP4 of this survey, one individual cross-bowed in 2005. Also reported from northeast of the village in A-Lal mountain, contiguous with survey forest

[6] Group of 1 pair with infant seen in Sept. 2008 and in Nov. 2008 near LP4. Gibbon calls were heard in Nov. 2008 near the waterfall creek near LP3, and in Nov. 2008 near A-Lal mountain range. One group (1-3 individuals) was heard and seen in 2008 near Ba-Wan river, possibly outside the survey area.

[7] Snared in the rainy season 2008

[8] Regularly snared about 3 times per year

[9] Last seen in 1998

[10] One individual seen crop-raiding in 2002, species occasionally seen before the cyclone of 2005

[11] Previously abundant, now rare

[12] Red fur, two forms seen: most of them with white tip of tail, some without white tip

Fig. 13. Left: The variable squirrel (*Callosciurus finlaysonii*) was common in the study area. Most individuals observed during the survey had reddish fur with a white tail-tip, as shown in this photograph. Only some individuals were lacking a the white tip. Right: Irrawaddy squirrel (*C. pygerythrus*). Photos: Thomas Geissmann. – *Links: Das Finlayson-Hörnchen (*Callosciurus finlaysonii*) war häufig im Studiengebiet anzutreffen. Die meisten Individuen waren von roter Fellfarbe mit weisser Schanzspitze, nur wenige Tiere wiesen kein Weiss auf. Rechts: Irawadi-Hörnchen (*C. pygerythrus*)*.

Fig. 14. The Little Spiderhunter (*Arachnothera longirostra*) was one of the most typical bird species in the survey area. Here it is seen feeding on nectar from banana flowers. Photo: Thomas Geissmann. – *Der Kleine Spinnenjäger (*Arachnothera longirostra*) war eine der typischen Vogelarten im Untersuchungsgebiet. Hier ernährt sich einer dieser kleinen Vögel vom Nektar von Bananenblüten*.

Birds

A total of 145 bird species were recorded during this survey (Fig. 14). They are listed in the Appendix of this report. The following four of these were not previously recorded in south-west Myanmar, according to Robson (2005):

- White-throated Needletail (*Hirundapus caudacutus*)
- Chinese Sparrow Hawk (*Accipiter soloensis*)
- Pale Blue Flycatcher (*Cyornis unicolor*)
- Slaty-blue Flycatcher (*Ficedula tricolor*)

One species recorded, the Great Hornbill (*Buceros bicornis*), is listed as "Near Threatened" by the IUCN's Red List assessment (IUCN, 2008).

As only five observation days were spent in the field it can be assumed that significantly more species occur in this forestthan seen. Several of the observed bird species such as the Great Hornbill (*Buceros bicornis*), Wreathed Hornbill (*Aceros undulatus*), Abbot's Babbler (*Malaconcincla abbotti*), or Chestnut-headed Tesia (*Tesia castaneocoronata*) typically inhabit primary forest. Therefore, many more species of birds and mammals occur in the less disturbed forest blocks in this region.

Other animals

Due to time constraints, we did not attempt systematic surveys of other orders besides mammals and birds. However, snakeheads (genus *Channa*) were repeatedly encountered in the small creek near LP3, and one young individual (Fig. 15) was observed to travel several meters across a dry pebble bed to another puddle of water. Several larger specimens were collected for later scientific examination (Fig. 16). They might represent a previously undescribed catfish species (Pwint Thu Aye, personal communication).

Fig. 15. After travelling several meters across dry land, this young snakehead inspects a new part of the creek near LP3. Photo: Thomas Geissmann. – *Nachdem er mehrere Meter über Land gewandert ist, untersucht ein junger Schlangenkopffisch die neu von ihm aufgesuchte Stelle im Bach bei Hörposten LP3*.

Fig. 16. A captured larger specimen of the same snaekhead species is examined in the camp by Pwint Thu Aye. Photos: Saw Moses. – *Ein gefangenes Tier derselben Schlangenkopffischart wird im Lager untersucht.*.

Conclusions

The study confirms the presence of gibbons in the southern Rakhine Yoma. There are some historical records of hoolock gibbons from Rakhine state (Anderson, 1881, Blyth, 1875, Tickell, 1859a,b). Blyth (1875) gives both Sandoway (18°27'N, 94°23'E) and Akyab (20°08'N, 92°54'E) as localities. Based on this evidence, Groves (1972, p. 66) concluded that "there seems thus no reason to

doubt that this species extends further south than the Chin Hills; but how far south, and what subspecies it belongs to, are doubtful." Since then, the occurrence of hoolock gibbons in Rakhine state has been confirmed during tiger surveys of 1999-2002 (Lynam 2003, p. 57). Lynam (2003) specifies the following sites: Northern Rakhine (21°05'-21°22'N, 92°21'-92°29'E), and Rakhine Elephant Range (18°01'-18°59'N, 94°36'-94°45'E). The study site (around 17°50'N, 94°32'E) appears to be the southernmost record for hoolock gibbons, so far, and its position west of the Chindwin river supports their identification as western hoolock gibbon (*Hoolock hoolock*).

The present survey confirms that forest habitat in our study area in the southern part of the Ngadanni Kyaw Hills of southern Rakhine Yoma is severely degraded and fragmented. The main threats to the survival of the hoolock gibbon are habitat loss and fragmentation and habitat degradation. Hunting poses a serious threat to wildlife in general. The main hunting method used is snaring, which does not target strictly arboreal primates such as gibbons. Crossbows, however, are used to hunt primates, but hunters from Chaung Tha village claim not to target gibbons. Nevertheless we cannot exclude that hunting with crossbows and occasional shotguns poses a serious threat to gibbons in southern Rakhine Yoma. Additional hunter interview surveys in other villages need to be conducted to confirm and quantify hunting pressure on gibbons in southern Rakhine Yoma.

Gibbon densities in the survey area are very low (0.13-0.37 groups/km^2), and for this reason the site was not an ideal training location. Observations and interview results suggest the main reason for low densities is poor habitat suitability due to degradation, which corresponds to findings on the hoolock regions of Bangladesh and north-east India.

Overall, the goal of a training course to introduce and practice gibbon survey methods was achieved, and a competent field team has now been established. Further surveys under this project will expand the picture of the threats and status of the hoolock gibbon in Myanmar, and help identify priorities for conservation interventions.

Acknowledgements

We thank Prof. Dr. Win Maung (Zoological Department of Yangon University) for co-organising the training workshop, Dr. Aye Mi San and Pwint Thu Aye (Zoological Department of Yangon University) and Dr. Htin Hla (BANCA) for contributing to the workshop, and Dr. Thein Pe (Rakhine Coastal Association) for assistance at the field survey site. Dr. Bosco Pui Lok Chan (Kadoorie Farm & Botanic Garden, Hong Kong) kindly provided information on the identification of snakeheads. This training and field survey is conducted under the Hoolock Gibbon Status Review project (of the Myanmar Conservation Program) which is jointly implemented by the Biodiversity and Nature Association (BANCA), Yangon University (Department of Zoology), People Resources and Conservation Foundation (PRCF), and Fauna & Flora International (FFI), with financial support from the Arcus Foundation Great Apes Program, and the United States Fish and Wildlife Service, Great Apes Conservation Fund. The use of US grant funds in Myanmar for this project is authorised by the US Treasury Department's Office of Foreign Assets Control.

References

Anderson, J. (1881). Catalogue of Mammalia in the Indian Museum, Calcutta. Part I. Primates, Prosimiae, Chiroptera, and Insectivora, Indian Museum Trustees, Calcutta.

Anthony, H. E. (1941). Mammals collected by the Vernay-Cutting Burma expedition. *Field Museum of Natural History - Zoological Series* **27**: 37-123.

Blyth, E. (1875). Catalogue of the mammals and birds of Burma. Journal of the Asiatic Society of Bengal, Calcutta **44**(part 2, extra number): xxiv + 167 pp.

Brockelman, W. Y. (2005). *Conservation of the hoolock gibbon (*Hylobates hoolock leuconedys*) in Mahamyaing Wildlife Sanctuary, Sagaing division, Myanmar*. Forest Department and Wildlife Conservation Society, Myanmar Program, 20 pp.

Brockelman, W. Y., and Ali, R. (1987). Methods of surveying and sampling forest primate populations. In Marsh, C. W., and Mittermeier, R. A. (eds.), *Primate conservation in the tropical rain forest*, Alan R. Liss, Inc., New York, pp. 23-62.

Brockelman, W. Y., and Srikosamatara, S. (1993). Estimation of density of gibbon groups by use of loud songs. *American Journal of Primatology* **29**: 93-108.

Chetry, D., Chetry, R., Das, A., Loma, C., and Panor, J. (2008). New distribution records for *Hoolock leuconedys* in India. *Primate Conservation* **23**: 125-128.

Chivers, D. J. (1977). The lesser apes. In Prince Rainier III of Monaco, and Bourne, G. H. (eds.), *Primate conservation*, Academic Press, New York, pp. 539-598.

Choudhury, A. (1991). Ecology of the hoolock gibbon (*Hylobates hoolock*), a lesser ape in the tropical forests of north-eastern India. *Journal of Tropical Ecology* **7**: 147-153.

Choudhury, A. (1996). A survey of hoolock gibbon (*Hylobates hoolock*) in southern Assam, India. *Primate Report* **44**: 77-85.

Choudhury, A. (2001). Primates in northeast India: An overview of their distribution and conservation status. *ENVIS Bulletin: Wildlife and Protected Areas (Non-human primates of India, A. K. Gupta, ed.)* **1**(1): 92-101.

Das, J., Biswas, J., Bhattacharjee, P. C., and Mohnot, S. M. (2006). First distribution records of the eastern hoolock gibbon (*Hoolock hoolock leuconedys*) from India. *Zoos' Print Journal* **21**(7): 2316-2320.

Feeroz, M. M., and Islam, M. A. (1992). *Ecology and behaviour of hoolock gibbons of Bangladesh*, MARC (Multidisciplinary Action Research Centre), Dhaka, Bangladesh, 76 pp.

Francis, C. M. (2008). *A field guide to the mammals of Thailand and South-East Asia*. Asia Books, Bangkok, 392 pp.

Geissmann, T. (2007). Status reassessment of the gibbons: Results of the Asian Primate Red List Workshop 2006. *Gibbon Journal* **3**: 5-15.

Gibbon Survey Team (2005). *Final report on Mahamyaing Wildlife Sanctuary Gibbon Survey*. Forest Department and Wildlife Conservation Society, Myanmar Program, 38 pp.

Gittins, S. P., and Tilson, R. L. (1984). Notes on the ecology and behaviour of the hoolock gibbon. In Preuschoft, H., Chivers, D. J., Brockelman, W. Y. & Creel, N. (eds.), *The lesser apes. Evolutionary and behavioural biology*, Edinburgh University Press, Edinburgh, pp. 258-266.

Groves, C. P. (1967). Geographic variation in the hoolock or white-browed gibbon (*Hylobates hoolock* Harlan 1834). *Folia Primatologica* **7**: 276-283.

Groves, C. P. (1972). Systematics and phylogeny of gibbons. In Rumbaugh, D. M. (ed.), *Gibbon and siamang, vol. 1*, Karger, Basel and New York, pp. 1-89.

Islam, M. A., Feeroz, M. M., Muzaffar, S. B., Kabir, M. M., and Begum, S. (2006). *Conservation of the hoolock gibbons (*Hoolock hoolock*) of Bangladesh: Population estimates, habitat suitability and management options*, United States Fish and Wildlife Service, 48 pp.

IUCN (2001). *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, U.K., ii+30 pp. Downloadable from www.iucn.org/themes/ssc/redlists/techdocs.htm

IUCN (2008). *2008 IUCN Red List of Threatened Species*. <www.iucnredlist.org>. Downloaded on 10 February 2009.

King, B., Farrow, D., Robson, C., Buck, H., and Fisher, T. (1995). Recent hoolock gibbon, *Hylobates hoolock*, observations in West Myanmar (Burma). *Natural History Bulletin of the Siam Society* **43**: 367-368.

Lan, D. (1994). Progress of surveys of hoolock gibbon in Yunnan: Distribution, population size, habitat and conservation. *Chinese Primate Research and Conservation News* **3**(1): 8-10.

Lan, D.-Y., Ma, S.-L., Li, S.-C., and Guo, G. (1999). [Timing of hoolock gibbon (*Hylobates hoolock*) songs in West Yunnan]. *Zoological Research* **20**(4): 273-277 (Chinese text, English summary).

Molur, S., Walker, S., Islam, A., Miller, P., Srinivasulu, C., Nameer, P. O., Daniel, B. A., and Ravikumar, L. (Ed.). (2005). *Conservation of western hoolock gibbon (*Hoolock hoolock*) in India and Bangladesh*, Zoo Outreach Organisation / CBSG-South Asia, Coimbatore, India, 132 pp.

Mukherjee, R. P. (1986). The ecology of the hoolock gibbon, *H. hoolock*, in Tripura, India. In Else, J. G., and Lee, P. C. (eds.), *Primate ecology and conservation*, Cambridge University Press, Cambridge and London, pp. 115-123.

Rao, M., Myint, T., Zaw, T., and Htun, S. (2005). Hunting patterns in tropical forests adjoining the Hkakaborazi National Park, north Myanmar. *Oryx* **39**(3): 292-300.

Robson, C. (2005). *New Holland field guide to the birds of Sout-east Asia*. New Holland Publishers, London, 304 pp.

Standards and Petitions Working Group (2006). *Guidelines for using the IUCN Red List categories and criteria. Version 6.2*. Prepared by the Standards and Petitions Working Group of the IUCN SSC Biodiversity Assessments Sub-Committee in December 2006. 60 pp. Downloadable from http://app.iucn.org/webfiles/-doc/SSC/RedList/RedListGuidelines.pdf

Tian, B. P., Ji, W. Z., and Peng, Y. Z. (1996). The present status of living primates and experimental primates research in China. *Primate Report* **44**: 71-76.

Tickell, S. R. (1864a). Note on the gibbon of Tenasserim, *Hylobates lar*. *Annals and Magazines of Natural History, London* **14**: 360-363.

Tickell, S. R. (1864b). Note on the gibbon of Tenasserim, *Hylobates lar*. *Journal of the Asiatic Society, Bengal, Calcutta*, N.S. **33**: 196-199.

Tilson, R. L. (1979). On the behaviour of the hoolock gibbons (*Hylobates hoolock*) during different seasons in Assam, India. *Journal of the Bombay Natural History Society* **76**: 1-16.

Tordoff, A. W., Eames, J. C., Eberhardt, K., Baltzer, M. C., Davidson, P., Leimgruber, P., Uga, U, and Than, U Aung (2005). *Myanmar: Investment opportunities in biodiversity conservation*. Bird-life International, Yangon, xxii + 124 pp.

Zhang, S.-Y. (1998). Current status and conservation strategies of primates in China. *Primate Conservation* **18**: 81-84.

Zhang, Y., Chen, L., Qu, W., and Coggins, C. (2002). The primates of China: Biogeography and con-servation status. *Asian Primates* **8**(1-2): 20-22.

Appendix: Birds recorded during the survey

An asterisk (*) denotes those three species that have not been recorded previously in south-western Myanmar (Rakhine province), according to Robson (2005).

Family	Species		Evidence[1]		*	IUCN status[2]
			Visual	Aural		
Phasianidae	Red Junglefowl	*Gallus gallus*		+		
Picidae	Greater Flameback	*Chrysocolaptes lucidus*	+	+		
	Bay Woodpecker	*Blythipicus pyrrhotis*	+			
	Heart-spotted Woodpecker	*Hemicircus canente*	+			
Megalaimidae	Blue-throated Barbet	*Megalaima asiatica*	+	+		
	Blue-eared Barbet	*Megalaima australis*	+	+		
	Coppersmith Barbet	*Megalaima haemacephala*	+			
	Lineated Barbet	*Megalaima lineata*		+		
Bucerotidae	Oriental Pied Hornbill	*Anthracoceros albirostris*	+			
	Great Hornbill	*Buceros bicornis*	+			NT
	Wreathed Hornbill	*Aceros undulatus*	+			
Upupidae	Common Hoopoe	*Upupa epops*	(+)			
Trogonidae	Red-headed Trogon	*Harpactes erythrocephalus*	+	+		
Coraciidae	Indian Roller	*Coracias benghalensis*	(+)			
Alcedinidae	Common Kingfisher	*Alcedo atthis*	+			
Halcyonidae	Black-capped Kingfisher	*Halcyon pileata*	+			
	White-throated Kingfisher	*Halcyon smyrnensis*	(+)			
Meropidae	Green Bee-eater	*Merops orientalis*	++			
	Blue-tailed Bee-eater	*Merops philippinus*	+			
Cuculidae	Plaintive Cuckoo	*Cacomantis merulinus*	+			
	Asian Koel	*Eudynamys scolopacea*		+		
	Green-billed Malkoha	*Phaenicophaeus tristis*	+			
Centropadidae	Greater Coucal	*Centropus sinensis*	+			
Psittacidae	Vernal Hanging Parrot	*Loriculus vernalis*	+			
	Red-breasted Parakeet	*Psittacula alexandri*	++			
Apodidae	Himalayan Swiftlet	*Collocalia brevirostris*	+			
	White-throated Needletail	*Hirundapus caudacutus*	+		*	
	Brown-backed Needletail	*Hirundapus giganteus*	+			
	House Swift	*Apus affinis*	+			
	Fork-tailed Swift	*Apus pacificus*	+			
	Asian Palm Swift	*Cypsiurus balasiensis*	(+)			
Tytonidae	Barn Owl	*Tyto alba*		+		
Strigidae	Collared Scops Owl	*Otus bakkamoena*		+		
	Mountain Scops Owl	*Otus spilocephalus*		+		
	Collared Owlet	*Glaucidium brodiei*		+		
	Asian Barred Owlet	*Glaucidium cuculoides*		+		
Columbidae	Rock Pigeon	*Columba livia*	(+)			
	Spotted Dove	*Streptopelia chinensis*	++			
	Eurasian Collared Dove	*Streptopelia decaocto*	(+)			
	Oriental Turtle Dove	*Streptopelia orientalis*	+			
	Red Collared Dove	*Streptopelia tranquebarica*	(+)			
	Emerald Dove	*Chalcophaps indica*	+			
	Yellow-footed Green Pigeon	*Treron phoenicoptera*	+			
Scolopacidae	Common Sandpiper	*Actitis hypoleucos*	(+)			
Charadriidae	Red-wattled Lapwing	*Vanellus indicus*	(+)			
Accipitridae	Oriental Honey-Buzzard	*Pernis ptilorhyncus*	+			
	Black Kite	*Milvus migrans*	+			
	Brahminy Kite	*Haliastur indus*	+			
	Crested Serpent Eagle	*Spilornis cheela*	+			
	Shikra	*Accipiter badius*	+			
	Chinese Sparrow Hawk	*Accipiter soloensis*	+		*	
	Common Buzzard	*Buteo buteo*	+			
	Mountain Hawk Eagle	*Spizaetus nipalensis*	+			
Falconidae	Common Kestrel	*Falco tinnunculus*	+			

[2] NT = Near Threatened

Appendix (*ctd*.)

Family	Species		Evidence[1]		*	IUCN status
			Visual	Aural		
Ardeidae	Little Egret	*Egretta garzetta*	(+)			
	Great Egret	*Casmerodius albus*	(+)			
	Cattle Egret	*Bubulcus ibis*	(++)			
	Indian Pond Heron	*Ardeola grayii*	(+)			
	Black-crowned Night Heron	*Nycticorax nycticorax*		(+)		
Irenidae	Asian Fairy Bluebird	*Irena puella*	++			
	Golden-fronted Leafbird	*Chloropsis aurifrons*	+			
	Blue-winged Leafbird	*Chloropsis cochinchinensis*	+			
Laniidae	Brown Shrike	*Lanius cristatus*	+			
	Grey-backed Shrike	*Lanius tephronotus*	+			
Corvidae	Red-billed Blue Magpie	*Urocissa erythrorhyncha*	+			
	Large-billed Crow	*Corvus macrorhynchos*	+			
	Ashy Woodswallow	*Artamus fuscus*	(+)			
	Black-naped Oriole	*Oriolus chinensis*	+			
	Black-hooded Oriole	*Oriolus xanthornus*	+			
	Black-winged Cuckooshrike	*Coracina melaschistos*	+			
	Scarlet Minivet	*Pericrocotus flammeus*	+			
	Bar-winged Flycatcher-Shrike	*Hemipus picatus*	+			
	Bronzed Drongo	*Dicrurus aeneus*	+			
	Crow-billed Drongo	*Dicrurus annectans*	+			
	Spangled Drongo	*Dicrurus hottentottus*	+			
	Ashy Drongo	*Dicrurus leucophaeus*	+			
	Black Drongo	*Dicrurus macrocercus*	(+)			
	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	+			
	Lesser Racket-tailed Drongo	*Dicrurus remifer*	+			
	Black-naped Monarch	*Hypothymis azurea*	++			
	Asian Paradise-flycatcher	*Terpsiphone paradisi*	+			
	Common Woodshrike	*Tephrodornis pondicerianus*	+			
Muscicapidae	Blue Rock Thrush	*Monticola solitarius*	(+)			
	Blue Whistling Thrush	*Myophonus caeruleus*	+			
	Asian Brown Flycatcher	*Muscicapa dauurica*	+			
	Red-throated Flycatcher	*Ficedula parva*	+			
	Slaty-blue Flycatcher	*Ficedula tricolor*	+		*	
	Verditer Flycatcher	*Eumyias thalassina*	+			
	Blue-throated Flycatcher	*Cyornis rubeculoides*	++			
	Pale Blue Flycatcher	*Cyornis unicolor*	+		*	
	Grey-headed Canary Flycatcher	*Culicicipape ceylonensis*	++			
	White-rumped Shama	*Copsychus malabaricus*	+			
	Oriental Magpie Robin	*Copsychus saularis*	+			
	Black-backed Forktail	*Enicurus immaculatus*	+			
	Pied Bushchat	*Saxicola caprata*	(+)			
	Siberian Stonechat	*Saxicola maura*	+			
Sturnidae	Vinous-breasted Starling	*Sturnus burmannicus*	+			
	Asian Pied Starling	*Sturnus contra*	(+)			
	Chestnut-tailed Starling	*Sturnus malabaricus*	+			
	Jungle Myna	*Acridotheres fuscus*	+			
	Common Myna	*Acridotheres tristis*	(+)			
	Hill Myna	*Gracula religiosa*	+	+		
Paridae	Great Tit	*Parus major*	+			
	Sultan Tit	*Melanochlora sultanea*	+			
Hirundinidae	Red-rumped Swallow	*Hirundo daurica*				
	Barn Swallow	*Hirundo rustica*	(+)			
	Pacific Swallow	*Hirundo tahitica*	+			
	Nepal House Martin	*Delichon nipalensis*	+			
Pycnonotidae	Streak-eared Bulbul	*Pycnonotus blanfordi*	+			
	Red-vented Bulbul	*Pycnonotus cafer*	+			
	Red-whiskered Bulbul	*Pycnonotus jocosus*	+			
	Black-crested Bulbul	*Pycnonotus melanicterus*	+			
	Olive Bulbul	*Iole virescens*	+			

Appendix (*ctd*.)

Family	Species		Evidence[1]		*	IUCN
			Visual	Aural		status
Cisticolidae	Zitting Cisticola	*Cisticola juncidis*	(+)			
Zosteropidae	Oriental White-eye	*Zosterops palpebrosus*	+			
Sylviidae	Chestnut-headed Tesia	*Tesia castaneocoronata*	+			
	Dark-necked Tailorbird	*Orthotomus atrogularis*	+			
	Common Tailorbird	*Orthotomus sutorius*	+			
	White-tailed Leaf Warbler	*Phylloscopus davisoni*	+			
	Dusky Warbler	*Phylloscopus fuscatus*	+			
	Yellow-browed Warbler	*Phylloscopus inornatus*	+			
	White-crested Laughingthrush	*Garrulax leucolophus*	+	+		
	Greater Necklaced Laughingthrush	*Garrulax pectoralis*	+	+		
	Abbott's Babbler	*Malacocincla abbotti*	+			
	Puff-throated Babbler	*Pellorneum ruficeps*	+	+		
	Large Scimitar Babbler	*Pomatorhinus hypoleucos*	+			
	Golden Babbler	*Stachyris chrysaea*	+			
	Grey-throated Babbler	*Stachyris nigriceps*	+			
	Rufous-capped Babbler	*Stachyris ruficeps*	+			
	Rufous-fronted Babbler	*Stachyris rufifrons*	+			
	Striped Tit Babbler	*Macronous gularis*	++			
	Nepal Fulvetta	*Alcippe nipalensis*	+			
	Brown-cheeked Fulvetta	*Alcippe poioicephala*	+	+		
	White-bellied Erpornic	*Erpornic zantholeuca*	+			
Nectariniidae	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	+			
	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	+			
	Copper-throated Sunbird	*Nectarinia calcostetha*	(+)			
	Crimson Sunbird	*Aethopyga siparaja*	+			
	Little Spiderhunter	*Arachnothera longirostra*	++			
Passeridae	House Sparrow	*Passer domesticus*	(+)			
	Russet Sparrow	*Passer rutilans*	+			
	Yellow Wagtail	*Motacilla flava*	+			
	Baya Weaver	*Ploceus philippinus*	Nests +			
	Scaly-breasted Munia	*Lonchura punctulata*	+			
	White-rumped Munia	*Lonchura striata*	+			

[1] Evidence:
+ present (seen, heard, nests)
++ common (> 30 individuals recorded)
(+/++) only present in open habitat, only seen or heard during first and/or last survey day on the way between Taing Kyo village and camp site in open cultivation area (paddy fields, gardens, scrub) on the coastal plain and/or the shifting cultivation in the foothill zone.

[2] NT = Near Threatened

Zusammenfassung

Bestandeserhebung und Trainingskurs zur Bestandeserhebung des Hulock-Gibbons und der Biodiversität im südlichen Rakhine Yoma-Gebiet von Myanmar

Dies ist ein Bericht über einen Trainingskurs zur Methodik, die im Projekt „Hoolock Gibbon Status Review“ des „Myanmar Conservation Program“ zum Einsatz kommen soll, und über eine kurze Bestandeserhebung der Hulocks und der Biodiversität während der Trockenzeit im südlichen Teil des Rakhine Yoma-Gebietes in Südwest-Myanmar.

Das Vorkommen der Gibbons konnte bestätigt werden und scheint das südlichste Vorkommen der Hulocks zu sein, das bisher beschrieben wurde. Die beobachteten Gibbons konnten als Westliche Hulocks (*Hoolock hoolock*) identifiziert werden. Die Freilanduntersuchung zeigte aber auch auf, dass das Waldhabitat im südlichen Rakhine Yoma-Gebiet stark gestört und zerstückelt ist.

Die Hauptbedrohungen für das Überleben der Hulocks sind Habitatverlust und –zerstückelung, während Jagd ein ernste Bedrohung für Wildtiere im Allgemeinen darstellt. Die häufigste Jagdmethode ist das Auslegen von Schlingen. Sie ist kaum eine Bedrohung für Tiere wie Gibbons, die praktisch ausschliesslich in den Bäumen leben. Armbrüste hingegen werden zur Jagd auf Affen eingesetzt, aber die Jäger vom Dorf Chaung Tha geben an, keine Jagd auf Gibbons zu machen. Nichtsdestoweniger ist nicht auszuschliessen, dass die Jagd mit Armbrüsten und gelegentlich Flinten eine ernste Bedrohung für die Gibbons im südlichen Rakhine Yoma-Gebiet darstellt. Weitere Interviews mit Jägern in anderen

Dörfern sollten durchgeführt werden um den Jagddruck auf Gibbons im südlichen Rakhine Yoma zu bestätigen und mengenmässig zu erfassen.

Die Bestandesdichte der Gibbons im Untersuchungsgebiet war sehr niedrig (etwa 0.13-0.37 Gruppen/km^2). Der Hauptgrund dafür dürfte in der niedrigen Qualität des Lebensraumes liegen. Dies deckt sich auch mit Befunden aus den Hulock-Gebieten von Bangla Desh und Nordost-Indien. Obwohl das Ziel eines Trainingskurses – Vorstellung und Einüben der Methoden zur Bestandeserhebung von Gibbons – erfüllt wurde, erwies sich das Untersuchungsgebiet aufgrund der geringen Gibbondichte nicht als idealer Ort für ein solches Training.

Als ein weiteres Ergebnis dieser Erhebung konnten mehrere Säugetier- und Vogelarten zum ersten Mal für diese Region von Myanmar bestätigt und eine möglicherweise neue Fischart beobachtet werden.

Status of the western black crested gibbon (*Nomascus concolor*) in the Nam Ha National Protected Area, Lao PDR

Jeff Brown

Center for Tropical Ecology and Conservation,
Antioch University, Keene, NH 03431, U.S.A.
Email: jeffrey_brown@antiochne.edu

The western black crested gibbon (*Nomascus concolor*) is in need of urgent management attention. UNESCO and the Lao National Tourism Authority (NTA), in Phase II of its Nam Ha Ecotourism Project, and the Wildlife Conservation Society (WCS), through the continuation of the Western Black Crested Gibbon Conservation and Ecotourism Project, proposed conserving the species through the development of ecotourism in the Vieng Phoukka area of the Nam Ha National Protected Area (NPA), Luang Namtha Province, Lao PDR. Research carried out from July 2005 through March 2006 re-assessed the distribution and density status of western black crested gibbons within five kilometers of three villages where the species was known to exist during a preliminary gibbon survey carried out in 2003. The new gibbon surveys revealed a decline in detectable gibbon groups since 2003 as well as new evidence of forest clearance and hunting in known gibbon habitat. As a result, the number of gibbons was too low to sustain gibbon based ecotourism, one of a number of conservation schemes meant to conserve them. These findings indicate that developing ecotourism treks based on gibbon presence in the Nam Ha NPA is not advisable.

Introduction

The western black crested gibbon (*Nomascus concolor*) is a critically endangered ape distributed with few relict populations in China, Laos, and Vietnam (Geissmann, 2007b). In Lao PDR, the species is known to occur only in two areas in the northernmost part of the country (Fig. 1, left map). One locality, which is the focus of this paper, is the Nam Ha National Protected Area (NPA) in Luang Namtha province. The other locality is the Nam Kan Provincial Protected Area (PPA) in Bokeo province (Geissmann, 2007a).

Although the Nam Ha NPA was reported to support gibbons by Tizard *et al.* (1997), the population was later considered extirpated by hunting (Duckworth *et al.*, 1999) until surveys carried out in Jan.-Mar. 2003 recorded gibbon songs at three locations within the protected area (Johnson *et al.*, 2004a, b, 2005). The population size and distribution of the western black crested gibbon in the Nam Ha NPA, however, were still unknown.

Lao PDR currently has 20 protected areas covering 14% of total land area. Due to the fact that tourism forms the largest sector of the economy, community based ecotourism has become the most promising tool to achieve the government objectives of poverty alleviation, economic growth, and conservation of the nation's natural resources. This includes increasing the effectiveness of protected areas in Lao PDR to successfully manage threats to endangered species (Lao National Tourism Authority, 2005). UNESCO and the Lao National Tourism Authority (NTA), in Phase II of its Nam Ha Ecotourism Project, and the Wildlife Conservation Society (WCS), through the continuation of the Western Black Crested Gibbon Conservation and Ecotourism Project, proposed conserving the western black crested gibbon through the development of ecotourism in the Vieng Phoukka area of the Nam Ha NPA, Luang Namtha Province (Fig. 1, right map) (UNESCO, 2004).

This paper reports on field surveys carried out between July 2005 and March 2006 to re-assess the distribution and density status of the western black crested gibbon within five kilometres of the three villages where gibbon calls were heard during the gibbon survey carried out in 2003 (Johnson *et al.*, 2004a, b, 2005).

Anticipated results included: (a) accurate determination of gibbon distribution; (b) estimates of population densities; (c) detailed information on the feasibility of development of gibbon-based ecotourism treks, and locations of such treks; and (d) detailed information on a little known endangered gibbon species, which is necessary to aid in the planning of conservation initiatives to preserve the species and provide for their future welfare and population increase.

Study site

The study area is located within the province of Luang Namtha in the far northwest of Lao PDR and is bordered by China to the north and Myanmar to the west (Fig. 1). The province covers about 9,325 km^2 of which approximately 85% is considered mountain-

ous. The Nam Ha NPA covers 2,230 km^2 of predominantly mixed deciduous forest within the province. Although the area is considered densely forested, there are 25 villages located within the protected area and 86 located just beyond its boundaries (Anonymous, 2003; Hedemark and Johnson, 2004). Two views of the Nam Ha NPA are shown in Figs. 2-3.

Methodology

Hunter surveys were administered in the three villages of Namlo and Phouye Mai, in Vieng Phoukka District, and Nongpaset in Nale district (Fig. 1). These villages correspond to the three locations where gibbons were reported to occur in 2003 based on interview surveys (Tizard *et al*., 1997) and gibbon songs heard during field surveys (Johnson *et al*., 2004a, b, 2005). Hunter surveys consisted of semi-structured interviews of individual hunters identified by village headmen to determine the current status of western black crested gibbons. Interviews were conducted by Nam Ha protected area staff.

Fixed listening point surveys (Brockelman and Ali, 1987) were carried out around the same three villages in order to monitor song bouts of wild gibbons. Listening post techniques used in this study were modified from those used by Johnson *et al.* (2005). Listening post locations were selected based on the hunter interviews and information gathered from the 2003 surveys (Johnson *et al*., 2004a, b, 2005). The listening posts were placed in prominent locations along mountain ridge tops so that it was possible to hear gibbon calls within valleys, uninterrupted by various topographical features.

Gibbon groups typically consist of two to six individuals (Brockelman and Srikosamatara, 1993). The most reliable period to listen for crested gibbon calls is during the morning hours from 05:30 to 09:30 a.m. when gibbons are most likely to engage in "morning duets," (Geissmann, 2007a; Geissmann *et al*., 2007), which are songs given by mated pairs and typically carry for up to 2 km (Brockelman and Ali, 1987). Therefore, from one listening post it is theoretically possible to sample a circular area of up to roughly 12.6 square kilometres for gibbon presence. As the probability of detecting calls decreases with distance, using a radius of 0.6 km produces more reliable density estimates.

Gibbons typically call during periods of "good weather," which are characterized by cloud cover of less than 50%, no rain, and little or no wind (Brockelman and Ali, 1987). Monitoring was conducted during the Luang Namtha dry season, November 2005 – March 2006, when good weather conditions were prevalent. At least three "good weather" days per listening post session were required to survey a location for gibbon presence (Brockelman and Ali, 1987).

Six listening posts were used in Namlo, four in Nongpaset, and four in Phouye Mai. Two teams, one each at two different listening stations approximately 500 meters apart, recorded the listening post positions using GPS, recorded compass bearings of any vocalizations of gibbons, weather conditions for each period of 15 minutes, and tape recorded the complete song bout of any gibbons heard (following the methodology of Johnson *et al*., 2005). Locations of calling gibbons detected by both teams were determined by triangulation if possible (Fig. 4).

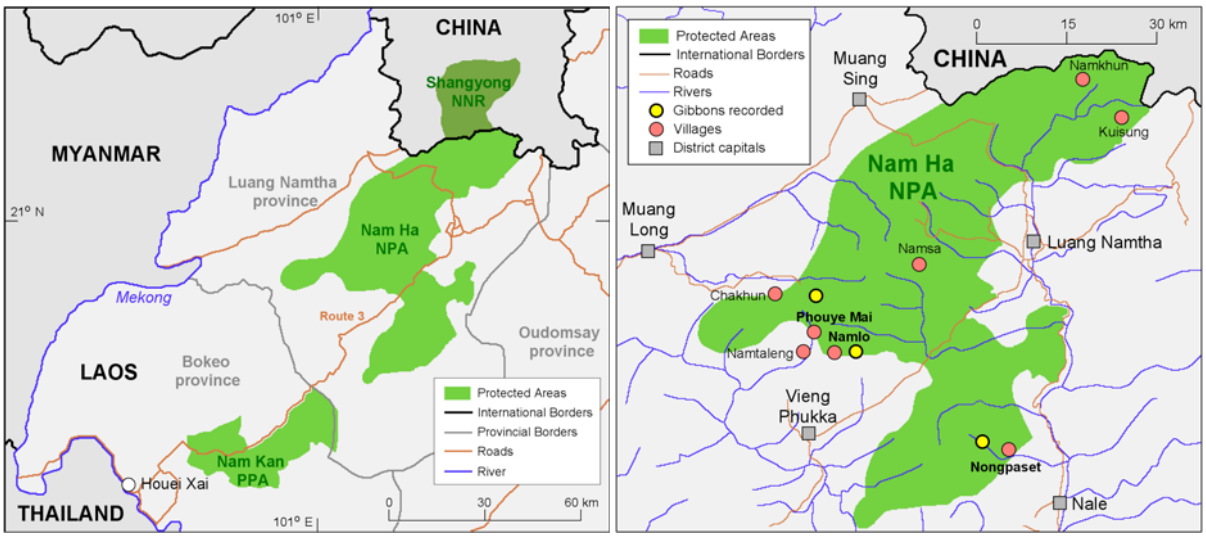

Fig. 1: Location of the Nam Ha NPA study site within Luang Namtha province and in relation to surrounding countries (left), and location of Namlo, Phouye Mai, and Nongpaset villages (right), where gibbons were detected in 2003 and where surveys were carried out in 2005-2006 (Maps after Johnson *et al*., 2005). – *Lage des Nationalen Schutzgebietes (NPA) von Nam Ha innerhalb der Provinz Luang Namtha (links), und Lage der Dörfer Namlo, Phouye Mai und Nongpaset, in deren Nähe während der Bestandesaufnahme im Jahre 2003 Gibbons festgestellt wurden und 2005-2006 die Bestandesaufnahmen dieser Studie durchgeführt wurden (rechts)*.

Fig. 2. Looking towards the Nam Ha National Protected Area from the south. The Nam Ha boundary begins after the deforested hills in the foreground and does include the mountainous territory in the background. This photo illustrates the widespread fragmentation and deforestation that has taken place here. Photo: Jeff Brown. – *Blick von Süden gegen das Nationale Schutzgebiet (NPA) von Nam Ha. Das Schutzgebiet beginnt hinter den entwaldeten Hügeln im Vordergrund und umfasst das gebirgige Gebit im Hintergrund. Das Bild illustriert die starke Zerstückelung des Waldes und die Entwaldung, die hier stattgefunden haben*.

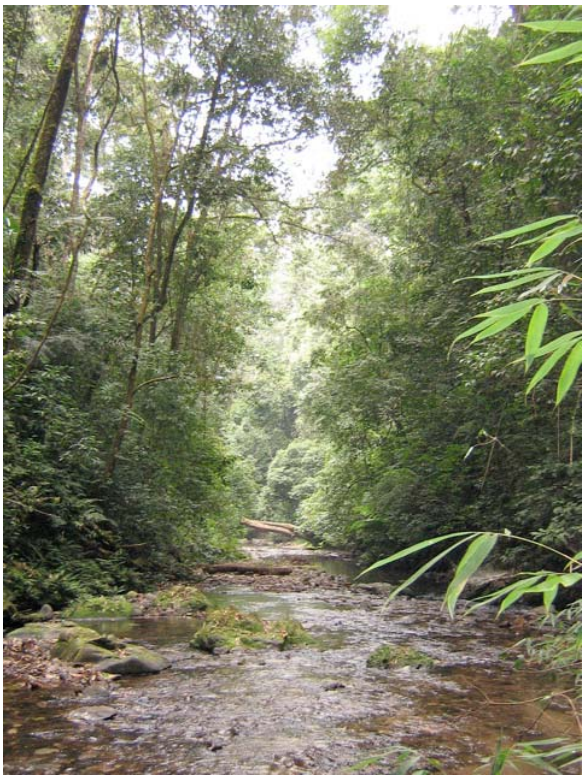

Fig. 3. Forest in Nam Ha NPA, within the survey area north of Phouye Mai village. Photo: Jeff Brown. – *Wald im Nationalen Schutzgebiet (NPA) von Nam Ha innerhalb des Studiengebietes nördlich des Dorfes Phouye Mai*.

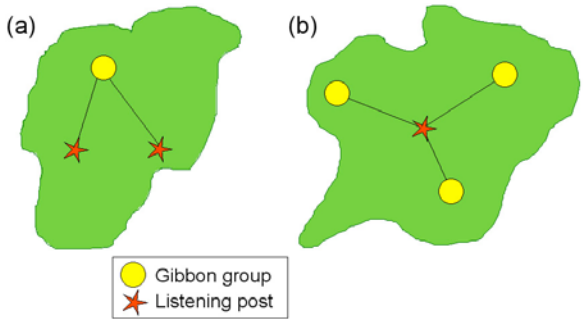

Fig. 4. Two methods of gibbon sampling using their song bouts: (a) Two listening posts using triangulation to determine approximate location of one gibbon group. (b) One listening post detecting several gibbon groups but without the ability to determine approximate location using triangulation. – *Zwei Methoden zur Bestandeserfassung der Gibbons mit Hilfe ihrer Gesänge: (a) Mit zwei oder mehr Hörposten können die Positionen der singenden Gibbongruppen durch Triangulation relativ genau bestimmt werden. (b) Bei Verwendung eines einzelnen Hörpostens (*listening post*) können zwar Gesänge mehrerer Gruppen erfasst, aber ihre Positionen nicht sehr genau bestimmt werden*.

The survey team routinely consisted of at least one WCS representative, two district area forestry staff, one protected area staff, two police officers, and two military officers as mandated by the Government of Lao PDR. Village volunteers who were later recruited for a gibbon monitoring program were also hired as guides and porters for the survey effort.

Additionally, any information such as anecdotal village reports of gibbon hunting and killings, habitat alteration, and other relative data to the current status of western black crested gibbons was noted.

Village volunteers living near the gibbon groups were encouraged to participate in a village gibbon monitoring program. They participated in the gibbon surveys and one gibbon log book was installed in each of the three villages so that one literate volunteer (e.g. school teacher) could note gibbon calls heard and reported by village residents throughout the year. The objective of this mechanism was to more fully engage local communities in gibbon conservation, as well as to provide a log of gibbon observations. It is recognized that without the full support of local communities it will be very difficult to protect and increase gibbon populations (Johnson *et al*., 2005).

Results

Namlo area

Three forest surveys were carried out in the vicinity of Namlo village, and each time the survey team reached the village, the team was informed that gibbons were heard in the recent past. All of the ten hunters interviewed in Namlo village reported hearing or seeing gibbons within the past two years (Table 1).

Table 1. Summary of results of individual hunter interviews – *Übersicht über die Resultate der Interviews mit Jägern*.

Village	Number of hunters inter-viewed	Average age of hunters (SD)	Number (%) of hunters that re-ported seeing or hearing gibbons since 2003 gibbon survey
Namlo	10	27 (5.25)	10 (100%)
Nongpaset	14	41 (10.74)	7 (50%)
Phouye Mai	7	31 (11.73)	3 (43%)

Based on these hunter reports, the survey team dedicated the greatest amount of total survey time to surveying the areas near Namlo where gibbons were reported to have been observed. The team did not detect any gibbons during this period (Table 2). While surveying from 05:30 to 09:30 throughout the survey period of twelve days, ten gunshots were heard (Table 3). During the initial survey from November 16 to November 21, 2005, the survey team discovered two hectares of freshly cleared forest where 25 villagers (six families) were observed actively tending opium and vegetable crops (Table 4, Fig. 4). It was also reported by members of the survey team who had participated in the 2003 survey that the area cleared was intact in 2003, and that the base camp used in that survey had been located within forest on the same site.

Nongpaset village

In the village of Nongpaset, Nale District, 50% of hunters reported seeing or hearing gibbons within the past two years (Table 1). Two different surveys were conducted in the area where gibbons were reported to have been observed. No gibbon groups were detected (Table 2). There was also evidence of hunting activity (Table 3).

Table 2. Summary of 2005-2006 gibbon survey. – *Zusammenfassung der Gibbon-Bestandes-erfassung von 2005-2006*.

Village	Survey effort per village effort		
	Number of days (Survey dates)	Average hours per listening post team	Number of gibbon groups heard
Namlo	12 *(16-21 Nov, 20-22 Dec, 8-10 Feb)*	26.00	0
Nongpaset	6 *(4-7 Jan, 16-17 Mar)*	20.25	0
Phouye Mai	7 *(18-24 Jan)*	24.00	1

Table 3. Summary of hunting signs encountered during sampling period 2005-2006. – *Zusammen-fassung der Hinweise auf Jagdaktivität im Zeitraum dieser Studie, 2005-2006*.

Village	Number of days sampled	Number of gun-shots[1]	Other hunting evidence
Namlo	12	10	6 armed hunters observed
Nongpaset	6	1	1 detonated bomb snare, 1 armed hunter observed
Phouye Mai	7	0	3 hunter camps

[1] Exclusively during 05:30-09:30 a.m. sampling period

Table 4. Land observed under opium cultivation in vicinity of gibbon habitat – *Für den Opium-anbau verwendete Landfläche in der Nähe des Gibbonhabitats*.

Village	Number of hectares under opium cultivation	Additional comments
Namlo	2	25 villagers encountered in cleared area
Nongpaset	None observed	
Phouye Mai	7	

Phouye Mai village

One gibbon group was heard from 09:00 to 09:11 on January 21, 2006 (Table 2), approximately 7 km north of Phouye Mai village, which is located approximately 6 km northwest of Namlo (Fig. 1). Seven hunters were interviewed in this village and

three of them confirmed observing gibbons within the past two years (Table 1). Within the survey area, hunter camps were discovered (Table 3, Fig. 6). Upon returning from the survey site north of Phouye Mai, a different route was taken whereby a large portion of cleared forest was discovered and opium was confirmed to be planted in all fields (Table 4, Fig. 7).

In both the Namlo and Phouye Mai cases where opium plantations were discovered, this happened accidentally, and the survey did not comprehensively evaluate total land under cultivation in gibbon habitat. During a cultural event in honour of the survey team upon returning to Phouye Mai from the gibbon survey area, the survey team was asked not to reveal any opium plantation areas to protected area authorities. It was never revealed to them that a protected area authority was present and part of the survey team. This facilitated a more open and candid atmosphere between the survey team and village population.

Fig. 5. Recently cleared gibbon habitat near the village of Namlo. Photo: Jeff Brown. – *Frisch abgeholztes Gibbonhabitat in der Nähe des Dorfes Namlo.*

Fig. 6. Survey team on site of hunter camp north of Phouye Mai village. Photo: Jeff Brown. – *Das Feld-Team in einem Jäger-Lager nördlich des Dorfes Phouye Mai.*

Fig. 7. Two different opium plantations, both located north of Phouye Mai village. Photos: Jeff Brown. – *Zwei verschiedene Opium-Pflanzungen nördlich des Dorfes Phouye Mai.*

Discussion

Comparison of survey results

A comparison of the western black crested gibbon survey results from 2003 (Johnson *et al*., 2003) and 2005-2006 shows a decline in gibbon observations (Table 5). Five groups were detected in a period of 12 days (42.13 hours) in 2003 as compared to one group detected in a period of 25 days (70.25 hours) in 2005-2006. What caused the different results of the 2003 and the 2005/6 surveys? Five possible explanations will briefly be considered below.

Table 5. Comparison of results from the 2003 gibbon survey to the 2005-2006 survey. – *Vergleich der Resultate der beiden Gibbon-Bestanderfassungen von 2003 und 2005/2006*.

Village	Survey effort in number of days (average hours) per listening post team		Number of gibbon groups heard	
	2003	2005/6	2003	2005/6
Namlo	1 day (3.68 hrs)	12 days (26.00 hrs)	2	0
Nongpaset	4 days (13.16 hrs)	6 days (20.25 hrs)	1	0
Phouye Mai	7 days (25.29 hrs)	7 days (24.00 hrs)	2	1
Total	12 days (42.13 hrs)	25 days (70.25 hrs)	5	1

(1) Recent land clearance by villagers in previously known areas of gibbon habitat, and hunting activity observed by the survey team, suggests that the gibbon population in the survey areas was reduced (and possibly extirpated locally) as a result of habitat destruction and hunting.

(2) In addition, it is also possible that gibbons sing less often in response to increased hunting pressure or as a result of reduced population density (Brockelman and Srikosamatara, 1993). This could also explain why fewer gibbon groups were heard during the 2005/6 survey as compared to the 2003 surveys.

(3) In Namlo, lack of gibbon detection by the team was explained by the hunters as "bad luck." All ten hunters confirmed gibbon observations, and gibbons were reportedly heard each time in the recent past upon our subsequent return visits to the village for surveying. However, considering that the most time was spent surveying in this area with no observations recorded by the survey, recent land clearance by villagers in previously known areas of gibbon habitat, and hunting activity observed by the survey team, it is possible that the hunters of Namlo were not telling the truth regarding gibbon presence.

(4) As another explanation for the different results of the 2003 and 2005/6 surveys, the gibbons may have emigrated from their 2003 location east of Namlo further east or northeast into less disturbed upper mixed deciduous forest (Fig. 1). As gibbons are territorial and very reluctant to leave an established territory, this scenario is not very likely.

(5) Yet another explanation for the difference in results could be that the 2003 survey took place from January to March of that year, and the 2005-2006 survey took place from November to March of those years. While this represents a slight difference in the timing of the surveys, gibbon calling frequency is highest during the dry season and both surveys took place during the regional dry season from November to March. Therefore, this difference is unlikely to be significant.

In summary, habitat destruction and hunting may have reduced the gibbon population in the survey area since 2003, and the reduced population density and increased hunting pressure may have reduced the singing activity of the remaining gibbons.

Implications for ecotourism

The goal of conserving and enhancing gibbon populations through the development of ecotourism

in villages adjacent to gibbon habitat cannot be realized based on these results – the number of gibbons heard during the surveys was too low to sustain gibbon based ecotourism. While the Lao NTA has already developed ecotourism in the villages of Namlo and Phouye Mai and those villages have been hosting and been exposed to tourists since 2003, it will not be feasible to develop or market a tourism product based around the seeing or hearing of western black crested gibbons. In contrast to gorilla tourism in the great lakes region of Africa, where tourists are guaranteed to view endangered mountain gorillas and the necessary linkage between ecotourism and wildlife conservation has been well established, the low number of gibbon observations in this study suggests that tourists will not have a high probability of encountering gibbons so that ecotourism based on seeing and/or hearing them is not viable (Ringer, 2002).

The hunting activity observed in the form of audible gunshots, visible hunters and hunting camps, and clearing of forest predominantly for the cultivation of opium and vegetable crops is neither compatible with the goals of habitat protection and enhancement within the protected area, nor the stated goals of ecotourism.

This research suggests that the western black crested gibbon remains in need of the most urgent attention among all gibbon species in Lao PDR (Duckworth *et al*., 1999; Geissmann *et al*., 2000; Johnson *et al*., 2005). The small populations detected in 2003 failed to be detected in 2005/6, and the state of ecotourism in known gibbon areas remains precarious. The demand for nature based tourism, however, continues to be a leading draw for international tourists visiting Luang Namtha province (Brown, 2007). In order to preserve what is left of the species, urgent attention in the form of monitoring and patrolling gibbon habitat, and enforcement of the law will necessarily have to be carried out. While the Nam Ha Ecotourism Project has been in place for nine years now, and although there are clearly financial benefits to some villages in the vicinity of the protected area, the goal of preserving and enhancing biodiversity has not been realized, and it is doubtful that it will unless significant changes are made by relevant stakeholders.

More promising for the Laos population of the western black crested gibbon are the findings by Geissmann (2007a) of the species in the Nam Kan Provincial Protected Area (PPA), in neighbouring Bokeo Province, Lao PDR (Geissmann, 2007). Geissmann surveyed one valley of the reserve and recorded 64 gibbon song bouts in fourteen complete sampling days. The estimated population density was 2.2 individuals per square km, the highest estimated density of the species currently known (Geissmann, 2007a). One reason given for the high density estimate is the local hunting taboo on gibbons (Geissmann, 2007a).

Recommendations

The remaining populations of the western black crested gibbon in China have been estimated at 1,000–1,300 individuals (Jiang *et al.*, 2006), and the populations in Vietnam may count less than 100 individuals (Geissmann *et al*., 2000). No comprehensive population survey or assessment has been conducted of the only two known populations of this species in Laos (i.e. in the Nam Ha NPA and the Nam Kan PPA). Considering the small size of populations in China and Vietnam and considering that this ape species is critically endangered (Geissmann, 2007b), assessing the size of the Laotian populations should be a priority in ape conservation.

Based on the data available at present, however, efforts at conserving this species in Laos should urgently be directed at protecting the remaining population in Nam Kan PPA.

Acknowledgements

I would like to thank the following people who made this research possible: Dr. Beth Kaplin of Antioch University, Dr. Renae Stenhouse, Technical Advisor for the WCS Lao PDR Program and Dr. Arlyne Johnson, Co-director of the WCS Lao PDR Program provided valuable knowledge, insight, and guidance; Mr. Mike Hedemark, Co-director of the WCS Lao PDR Program and Mr. Troy Hansel, Deputy Director of the WCS Lao PDR Program, for allowing this research to proceed. Specifically in country, the research was conducted in close collaboration with Mr. Steven Schipani and Mr. Robert Tizard of the UNESCO Nam Ha Ecotourism Project Phase II. Additionally, I wish to thank Mr. Phimkeo Thamlasin and Mr. Singphone Luongleuxay of the Luang Namtha Provincial Agriculture and Forestry Office.

Special thanks to the UNESCO Asia and Pacific Regional Bureau for Education in Bangkok, Thailand. The majority of the funding for this project was provided to WCS by the United States Fish and Wildlife Service Great Ape Conservation Fund No. 2005-96200-4IIG-8884-2000. The Center for Tropical Ecology and Conservation at Antioch University New England also provided additional funds for this research.

References

Anonymous (2003). *Biodiversity profile for Luang Namtha province*. A report produced for Science, Technology and Environment Agency and UNDP for the Lao PDR Biodiversity Country Report. Laos, WCS Lao Program, 59 pp. Downloadable from www.rhinoresourcecenter.com/ref_files/1178934681.pdf

Brockelman, W. Y., and Ali, R. (1987). Methods of surveying and sampling forest primate populations. In Marsh, C. W., and Mittermeier, R. A. (eds.), *Primate conservation in the tropical rain forest*, Alan R. Liss, Inc., New York, pp. 23-62.

Brockelman, W. Y., and Srikosamatara, S. (1993). Estimation of density of gibbon groups by use of loud songs. *American Journal of Primatology* **29**: 93-108.

Brown, J. 2007. *Conservation of the western black crested gibbon, Nomascus concolor, through ecotourism development in the Nam Ha National Protected Area, Lao PDR*. MSc thesis, Department of Environmental Studies, Antioch University New England, Keene, NH, USA, 61 pp.

Duckworth, J. W., Salter, R. E., and Khounboline, K. (compilers) (1999). *Wildlife in Lao PDR: 1999 status report*, IUCN – The World Conservation Union / Wildlife Conservation Society / Centre for Protected Areas and Watershed Management, Vientiane, xiv+275 pp.

Geissmann, T. (2007a). First field data on the Laotian black crested gibbon (*Nomascus concolor lu*) of the Nam Kan area of Laos. *Gibbon Journal* **3**: 56-65.

Geissmann, T. (2007b). Status reassessment of the gibbons: Results of the Asian Primate Red List Workshop 2006. *Gibbon Journal* **3**: 5-15.

Geissmann, T., Nguyen Xuan Dang, Lormée, N., and Momberg, F. (2000). *Vietnam primate conservation status review 2000 – Part 1: Gibbons (English edition)*. Fauna & Flora International, Indochina Programme, Hanoi, 130 pp. (Downloadable from www.gibbons.de)

Geissmann, T., Trinh Dinh Hoang, La Quang Trung, and Tallents, L. (2007). A brief survey for crested gibbons in Bach Ma National Park, central Vietnam. *Gibbon Journal* **3**: 43-49.

Hedemark, M., and Johnson, A. (2004). *Nam Ha management plan 2003-2010*. Wildlife Conservation Society (WCS), Vientiane, 94 pp. Downloadable from www.luang-namtha.org/nature/nature.htm

Jiang, X., Luo, Z., Zhao, S., Li, R., and Liu, C. (2006). Status and distribution pattern of black crested gibbon (*Nomascus concolor jingdongensis*) in Wuliang Mountains, Yunnan, China: Implication for conservation. *Primates* **47**: 264-271.

Johnson, A., Singh, S., Duangdala, M., Chanthasone, B., Namsombath, T., and Hedemark, M. (2004a). *A preliminary survey for gibbon and other primates in the Nam Ha National Protected Area, Lao PDR*, Wildlife Conservation Society, Vientiane, 37 pp.

Johnson, A., Singh, S., and Duangdala, M. (2004b). A preliminary survey for the black-cheeked crested gibbon (*Nomascus concolor*) in the Nam Ha national protection area, northern Lao PDR. In Nadler, T., Streicher, U., and Ha Thang Long (eds.), *Conservation of primates in Vietnam*, Frankfurt Zoological Society, Vietnam Primate Conservation Programme, Endangered Primate Rescue Center, Cuc Phuong National Park, Hanoi, pp. 117-118.

Johnson, A., Singh, S., Duangdala, M., and Hedemark, M. (2005). The western black crested gibbon *Nomascus concolor* in Laos: New records and conservation status. *Oryx* **39**(3, July): 311-317.

Lao National Tourism Administration (2005). *National ecotourism strategy and action plan 2005-2010. Summary*. Lao National Tourism Administration, Vientiane, 26 pp. Downloadable from www.ecotourismlaos.com/pub_reports.htm

Ringer, G. D. (2002). Gorilla tourism: Uganda uses tourism to recover from decades of conflict. *Alternatives Journal, Canadian Environmental Ideas and Action* **28**: 16-19.

Tizard, R., Davidson, P., Khounboline, K., and Salivon, K. (1997). *A wildlife and habitat survey of Nam Ha and Nam Khong Protected Areas, Luang Namtha province, Lao PDR*. CPAWM/Wildlife Conservation Society (WCS), Vientiane, Lao PDR, 58 pp.

UNESCO (2004). *The National Tourism Authority of Lao PDR – UNESCO Nam Ha Ecotourism Project, Phase II*. UNESCO Bangkok Office, Bangkok, and NTA – Lao Contact Information, Vientiane, 17 pp. Downloadable from www.unescobkk.org/index.php?id=486

Zusammenfassung

Bestandesentwicklung des Westlichen Scharzen Schopfgibbons (*Nomascus concolor*) im Nam Ha National-Schutzgebiet, Laos

Der Westliche Schwarze Schopfgibbon (*Nomascus concolor*) ist in China, Laos und Vietnam nur noch mit kleinen Restpopulationen vertreten und gilt als stark gefährdete Art (Geissmann, 2007b). UNESCO und die *National Tourism Authority* (NTA) von Laos vorgeschlagen, diese Art mit Hilfe eines Ökotourismus-Projektes im Nam Ha National-Schutzgebiet (Provinz Luang Namtha, Nordlaos) zu schützen. In der vorliegenden Studie wurden in den Jahren 2005/2006 Bestandesaufnahmen der Gibbons im Nam Ha National-Schutzgebiet durchgeführt, und zwar an den drei Orten, an denen sie Jahr 2003 noch nachgewiesen wurden. Die Resultate belegen, dass der Gibbonbestand seit 2003 weiter zurückggangen ist und dass im Lebensraum der Gibbons gejagt und Wald abgeholzt wurde. Als Folge davon sind die Gibbonbestände nun zu klein, um ein Ökotourismus-Projekt zu unterhalten, da den Besuchern weder ein optischer noch ein akustischer Nachweis von Gibbons garantiert werden kann. Zudem widersprechen die allgegenwärtigen Spuren von Jagd und Abholzung den Zielen und Vorstellungen des Ökotourismus.

Crested gibbons in southeastern Yunnan, China: Status and conservation

Ni Qingyong[1] and Jiang Xuelong[2]

[1] College of Animal Science and Technology, Sichuan Agriculture University, Yaan, Sichuan 625014, China. E-mail: niqingyong@hotmail.com

[2] Kunming Institute of Zoology, the Chinese Academy of Sciences, Kunming, Yunnan 650223, China

Four to seven groups of western black crested gibbon (*Nomascus concolor*) were estimated in isolated habitats at Bajiaohe, Xilongshan and Huanglianshan in southeastern Yunnan, according to a gibbon survey conducted in 2003. For completion of the estimates, populations in the south of Luchun county, Daweishan and east of Wenshan prefecture, where the northern white-cheeked gibbon (*N. leucogenys*) and the Cao-vit crested gibbon (*N. nasutus*) were historically distributed, will need to be verified in the future. All populations are threatened by extinction, especially the two gibbon groups at Bajiaohe in Jinping county. Hunting and habitat loss has led to a population decline in most locations. The survival of the remaining gibbons becomes increasingly difficult because of hunting, human disturbance, small population size, habitat fragmentation and habitat deterioration.

Introduction

Crested gibbons (genus *Nomascus*) had been widely distributed in southeastern Yunnan province, China, before the 1970s. In the 1980s, their distribution area became restricted to several counties and the gibbon population decreased rapidly to less than 100 individuals. Since the 1990s, just small areas in two or three counties may still support gibbons (Table 1). However, most information about gibbon distribution and status in southeastern Yunnan is based on data collected in the 1980s. Afterwards, no further surveys were conducted there prior to our study. Three different gibbon species are believed to occur in southeastern Yunnan. The western black crested gibbon (*Nomascus concolor*) occurs west of the Red River, and the Cao-vit crested gibbon (*N. nasutus*) east of the Red River. The northern white-cheeked gibbon (*N. leucogenys*) was reported to be sympatric with *N. concolor* in Luchun county (Ma and Wang, 1986), although this information was based on interview data only.

Population and Distribution Status

Methods

With the support of FFI China Office, we conducted a series of surveys on the status and distribu-

Table 1. Historical distribution and estimated numbers of crested gibbons in southeastern Yunnan. – *Ursprüngliche Verbreitung und geschätzte Bestandesgrössen der Schopfgibbons in Südost-Yunnan.*

Time period	Distribution in southeastern Yunnan	Estimated numbers	Reference
Before 1950s	Most areas in southeastern Yunnan		Ma and Wang, 1988
1950s-1970s	Jiangcheng, Luchun, Jinping, Hekou, Pingbian, Honghe, Yuanyang, Jianshui, Mengzi, Wenshan, Maguan, and Malipo counties		Wang *et al.*, 2000
1980s	Huanglianshan in Luchun county and Xilongshan in Jinping county	15-25 groups, 60-100 individuals	Wang *et al.*, 2000
	Jiangcheng and Luchun county[1]		Maand Wang, 1986
	Huanglianshan in Luchun county, Fenshuiling and Xilongshan in Jinping county, Daweishan in Pingbian county, small areas in Honghe county	40-60 individuals[2]	Ma and Wang, 1986, 1988
	Daweishan in Pingbian-Hekou county, Fenshuiling in Jinping county, Huanglianshan in Luchun county, other areas among Jinping, Luchun and Yuanyang counties	Less than 100 individuals	Ma *et al.*, 1987
1990s	Wutaishan and Xilongshan in Jinping county	Small population	Wang *et al.*, 2002
	Huanglianshan Nature Reserve in Luchun county	6-10 groups, more than 30 individuals	Wang *et al.*, 2003

[1] *N. leucogenys*

[2] *N. c. concolor*, including populations in Ailaoshan

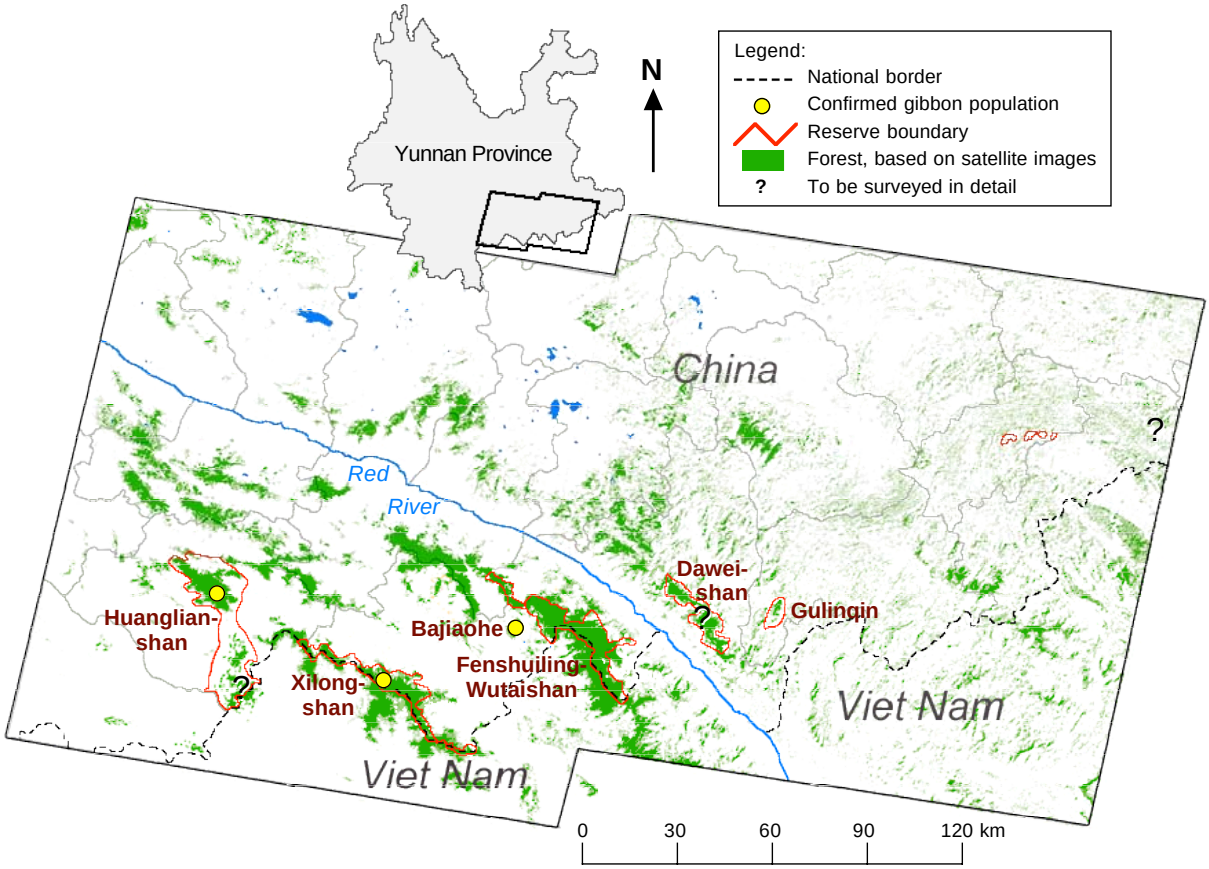

Fig. 1. Distribution of gibbon populations in southeastern Yunnan. – *Verbreitung der Schopfgibbon-Populationen in Südost-Yunnan.*

tion of crested gibbons in southeastern Yunnan, in the period from August 2003 to December 2004. The area is identified by the coordinates 22°25′–23°50′N, 101°40′–105°50′ E, and covered about 40,000 km^2, distributed over three prefectures which are all located at the Vietnamese border.

Interviews were carried out first in order to confirm where gibbons have been present in recent decades. Gibbons were considered to be locally extinct if more than 30 years had passed since the last sighting. In the remaining gibbon localities, more detailed data was collected in surrounding villages. As a result, seven sites were identified as gibbon localities based on interviews with 137 persons. They are listed in Table 2. Three of the sites are located in Huanglianshan. Subsequently, team members set up camps and installed listening posts at each site in order to confirm the presence of gibbons and estimate their group density by use of their loud songs, as described by Brockelman and Srikosamatara (1993). The number of listening posts used at each site and the number of days spent surveying each site are also listed in Table 2.

Table 2. Field surveys on the distribution and population of crested gibbons in southeastern Yunnan. – *Feldexkursionen zum Nachweis von Verbreitung und Bestandesgrösse der Schofgibbons in Südost-Yunnan.*

Location	Number of survey days	Number of listening posts	Gibbon population estimate	Elevation (m)
Gulinqing	8	2	extinct	1,500-1,900
Daweishan	5	2	?	720-1,300
Xilongshan	6	2	1-2 groups	2,200-2,600
Bajiaohe	8	2	2 groups	1,900-2,200
Huanglianshan:			1-3 groups	1,800-2,500
Huo-bu-liang-zi	14	3		
A-bo-wu-du	10	2		
Jia-ni-guo-ma	11	3		
Total	62	16	4-7 groups	

Cao-vit crested gibbon (*N. nasutus*)

Even though no live gibbons had been heard or sighted since the 1970s in Yunnan province east of Red River, we conducted a field survey there with several teams. Unfortunately, the survey was restricted by scarcity of skilled members, because a training course for gibbon population survey was carried out only four months later. As a result, two of the potential gibbon localities identified by interview data, Daweishan and east of Wenshan Prefecture (Fig. 1), were not surveyed in detail. As the forest is well-preserved and hunting is illegal since 20 years in these areas, it is possible that gibbons might have survived there. However, no direct evidence is available to confirm that gibbons still occur at these sites.

Western black crested gibbon (*N. concolor*)

West of the Red River, the western black crested gibbon still occurs in Jinping county and Luchun county based on our interview results. The remaining primary forests in Jinping county are preserved in Fenshuiling National Nature Reserve, which consists of two independent parts, Xilongshan and Fenshuiling-Wutaishan (Fig. 1). The management bureau had sent two black-coloured juvenile gibbons – both collected in Xilongshan – to Gejiu Zoo in the 1990s, but they survived only for about one year. In 2000, an infant gibbon from the same site had been housed in the bureau office but died of dyspepsia after several months. However, no direct information was obtained from the field surveys in both parts of the Fenshuiling National Nature Reserve. These forests are very close to the Vietnamese border, and the villagers reported that gibbons often moved between China and Vietnam. As the gibbon population is probably very small and far away from human settlements, it is particularly difficult to hear or observe them.

Outside the nature reserve, two gibbon groups were confirmed in the north of Jinping county, living in an isolated forest near Bajiaohe village (Fig. 1). This was the only gibbon population directly observed in this survey (Fig. 2).

Interviews conducted in Luchun county (adjacent to Jinping county) provided comparatively more reports on gibbons than those conducted in Jinping county. Apparently, gibbons were frequently heard and sighted in recent years close to the core area of Huanglianshan. Based on the interview data, we estimate that two to five gibbon groups may occur in this forest, but this was not confirmed by the field surveys.

Thus, the total population estimate for the survey area amounts to four to seven gibbon groups (Table 2).

Northern white-cheeked gibbon (*N. leucogenys*)

In the past, northern white-cheeked gibbons were distributed in Jiangcheng and Luchun (Ma and Wang, 1986), but their present status is unknown. Most forest in the reported distribution area was destroyed by the building of hydro-electric stations along the Lixianjiang and Xiaoheijiang rivers.

Fig. 2. The two female western black crested gibbons of Group A at Bajiaohe (Jinping county). Photo: Ni Qingyong. – *Zwei der Gruppe A zugehörigen Weibchen des Westlichen Schopfgibbons in Bajiaohe (Präfektur Jinping)*.

According to the results of our interview survey, a small population of white-cheeked crested gibbons might still survive near the border between China and Vietnam.

Preliminary Ecology Study at Bajiaohe

After the population and distribution survey, we carried out a study on gibbon behaviour and ecology at Bajiaohe from December 2004 to October 2006. Two gibbon groups lived in an unprotected forest located 10 km away from the Fenshuiling Nature Reserve. Group A consisted of two adult females and a juvenile male; Group B of an adult male, an adult female and a male infant. The forest had an altitude range of 1,700-2,200 m and was surrounded by villages, tea plantations, crops and barren land (Fig. 3). Barren land refers to areas planted with corn before the 1950s, and overgrown by croften weed with scattered trees and shrubs after a forest restoration project. Croften weed (*Eupatorium adenophorum*) is an invasive plant species from South America common in Yunnan since 1935. The isolated status of the forest lasted since more than 50 years according to the elders of the Bajiaohe village. The total forested area was about 250 ha, but it was

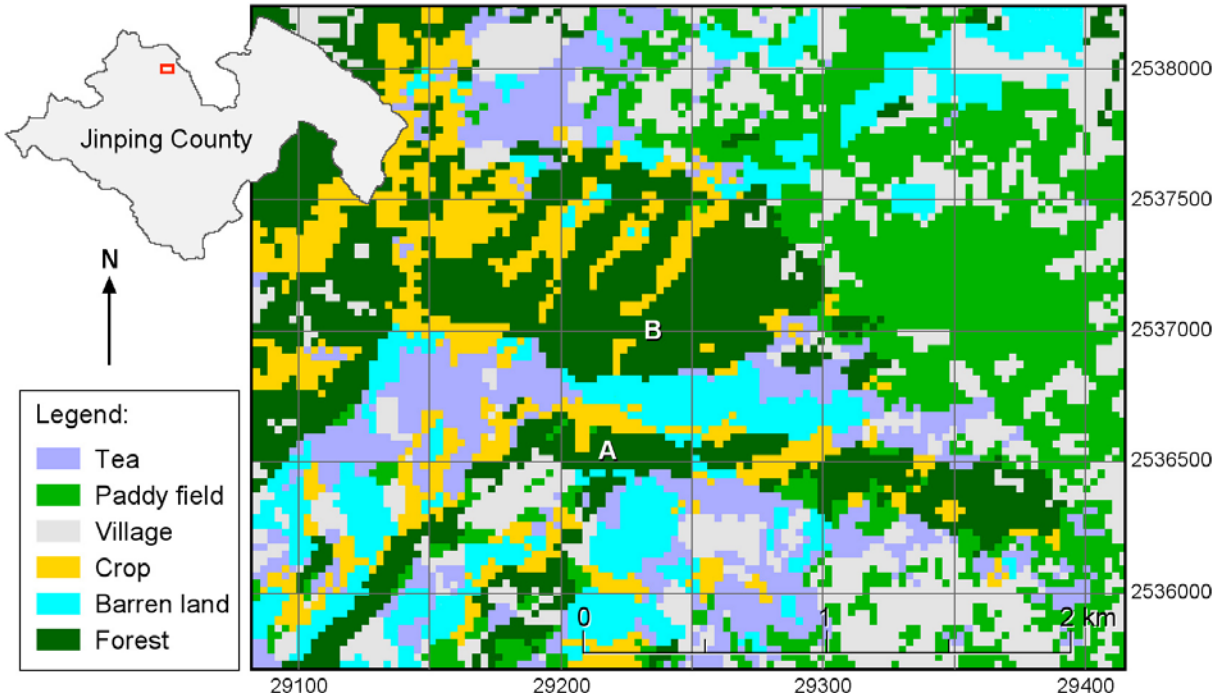

Fig. 3. Land use and land cover map of the Bajiaohe study site in Jinping county, and location of the gibbon groups A and B. – *Landnutzung und Vegetation in der Studienregion von Bajiaohe in Jinping County, sowie Lage der Territorien der beiden Gibbongruppen A und B*.

Fig. 4. Tsaoko (*Amomum tsao-ko*) plantations in the forest of the Bajiaohe area (Jinping county). Photo: Ni Qingyong. – *Tsaoko-Pflanzungen (Chinesischer Cardamom,* Amomum tsao-ko*) im Wald bei Bajiaohe (Jinping County)*.

fragmented by barren slopes, which made contact between the two gibbon groups difficult. Under the canopy of the forest, Tsaoko or Black Cardamom (*Amomum tsao-ko*) was planted widely (Fig. 4). In the tsaoko plantations, trees were selectively logged and shrubs were eliminated.

We collected behavioural data on Group A using the instantaneous scan sampling method (Altmann, 1974), with scans being separated by intervals of three minutes. The frequency of gibbon disturbance by humans was also monitored during the study. Disturbances included gun shots, loud calling, and

people walking under the canopy close to the gibbons. Data were collected between 06:00 and 18:00 hr in the time period from October 2005 to May 2006. The gibbon group was observed during 67 days, and a total of 328 hours of direct observations were achieved.

The home range of Group A was found to be limited to an isolated forest area of 12 ha. Gibbons could reach the forest edge by moving through trees, sometimes through bamboo or tsaoko, but never down to the ground. The activity pattern of the study group, recorded as an average monthly percentage allocated to each activity, showed that nearly half of the activity period was spent resting, followed by travelling and feeding behaviour, whereas singing and other activities occupied less of the group's time (Fig. 5). Resting time made up a particularly high percentage during the winter months due to the lower temperature. Conversely, more time was spent travelling during the warm seasons.

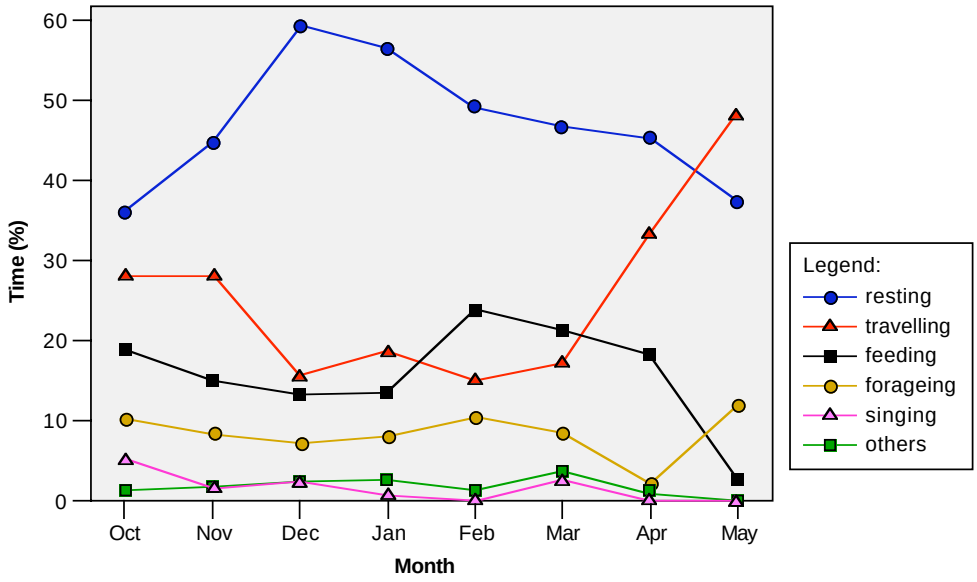

Fig. 5. Monthly activity pattern of Group A at Bajiaohe (Oct. 2005 – May 2006). – *Monatliches Aktivitätsbudget der Gibbongruppe A bei Bajiaohe (Zeitraum Oktober 2005 bis Mai 2006)*.

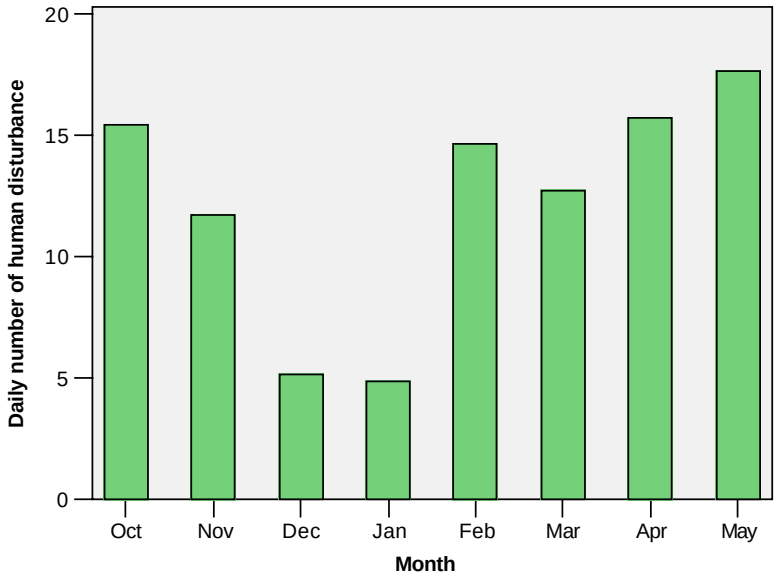

Fig. 6. Mean daily occurrence of human disturbance of gibbon Group A at Bajiaohe (Oct. 2005 – May 2006). – *Durchschnittliche Zahl von täglichen Störungen der Gibbongruppe A bei Bajiaohe durch Menschen (Zeitraum Oktober 2005 bis Mai 2006)*.

The gibbons' activities were often affected by human beings. Mean daily amount of human disturbance exhibited obvious fluctuations caused by the seasonality of agricultural activities (Fig. 6). In October and November, for instance, cattle grazing sites were moved to the forest, because open areas at lower altitude were needed for rice planting. This time was also the tsaoko harvesting season in the forest. From February to May, on the other hand, fodder collecting for livestock was common in the

gibbon habitat. Upon encountering humans, the gibbon group usually produced a short alarm call and moved away at once, so that it spent more time travelling during the months of heavy disturbance.

Discussion

Although some areas need more detailed surveys, the results of our study indicate that the gibbon populations in southeastern Yunnan are very small and vulnerable. Groups at Xilongshan and Huanglianshan may have been able to survive for a longer time because the habitat is large and relatively undisturbed.

As elsewhere in China (Jiang *et al.*, 2006; Zhou *et al.*, 2005), hunting was identified as the most immediate threat to gibbons in southeastern Yunnan. Ethnic groups in this region are accustomed to hunting wildlife, mostly for food. A former hunter of the Miao ethnic group showed us bones from five gibbons he had hunted at the same time. Some gibbon hunting is also directed at harvesting ingredients of traditional "medicine", for example a product called "*Lu-nan-ni*" in the language of the Dai ethnic group. It was particularly worrying to find that poaching still occurs at present although hunting has been forbidden since the 1980s. In Bajiaohe, for instance, all primates were extirpated by hunting, except a few gibbons. The gibbons probably owe their survival to a local belief that a hunter who had killed a gibbon would soon die with his family.

Habitat destruction has been a current threat to gibbon survival, but was usually ignored in local economic policy. In Honghe prefecture, for instance, forest cover decreased by 28.2% in the time period from 1945 to 1993. On the other hand, areas of rubber tree and tsaoko (*Amomum tsao-ko*) plantations and the human population increased rapidly, as shown in the example of Jinping county (Fig. 7). Besides, many inhabitants live on the edge of poverty and depend on harvesting firewood in the forest for cooking and heating, which leads to a further deterioration of the forest and further exposes gibbons to hunting.

Conservation issues

In southeastern Yunnan, all forests supporting gibbons – except Bajiaohe – are located in nature reserves. In theory, at least, this facilitates monitoring and protecting the gibbons. As the gibbon populations in this region are very small, gibbon conservation receives very little support from local governments and conservation organizations, which in turn is a limitation for forest management. As a result, poaching and illegal planting not only occurs in fragemented and unprotected forests like Bajiaohe, but even in the nature reserves.

Fortunately, gibbons are rarely hunted because killing a gibbon is considered a bad omen by many local people. Moreover, selective logging was also declared illegal at Bajiaohe following our study. During a spontaneous workshop, local communities agreed on a new village law that forbids the villagers from further destroying the remaining forest, subject to a fine if breached (Fig. 8).

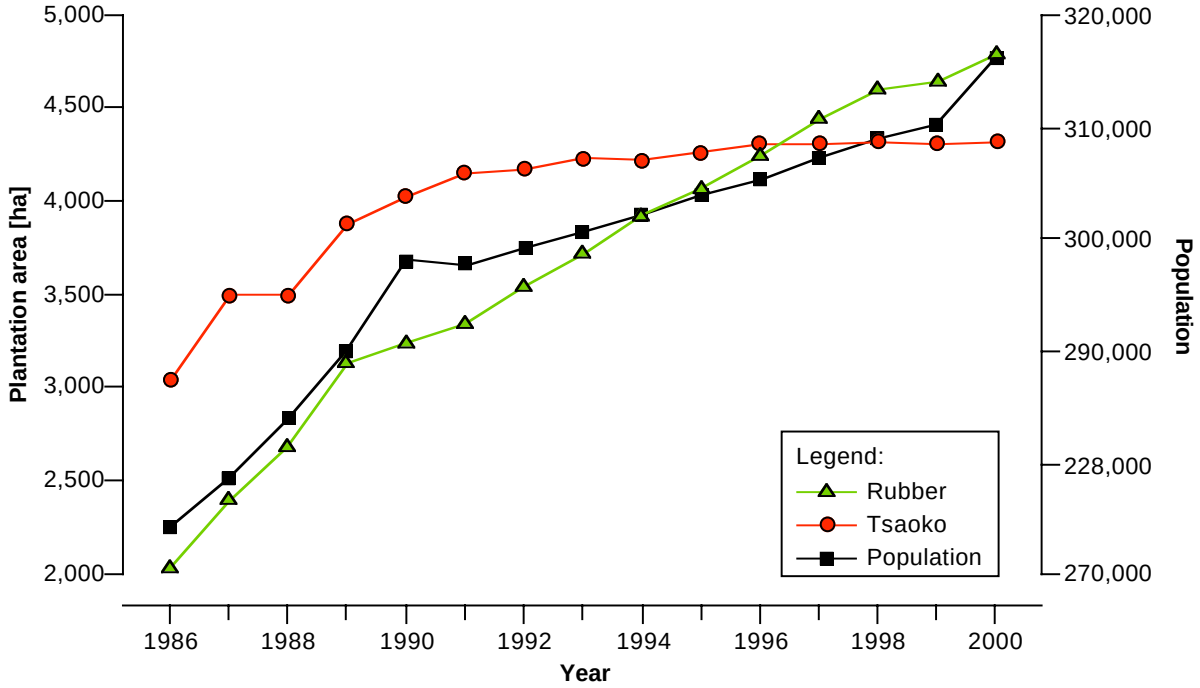

Fig. 7. Changes in rubber and tsaoko plantation areas and human population size in Jinping county from 1986 to 2000. – *Zunahme der Landflächen, die in Jinping County für Gummi-Plantagen und Tsaoko-Pflanzungen (Chinesischer Cardamom) verwendet werden, sowie der Bevölkerung im Zeitraum von 1986 bis 2000.*

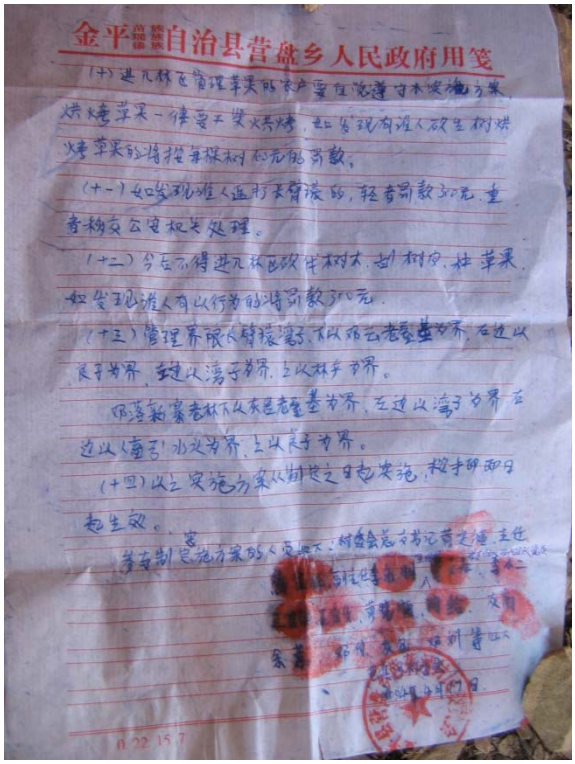

Fig. 8. Village law for forest conservation at Bajiaohe. Photo: Ni Qingyong. – *Dorfgesetz zum Schutz des Waldes bei Bajiaohe*.

The gibbon population at Xilongshan and the un-verified populations south of Luchun county and east of Wenshan prefecture are all close to the boundary between China and Vietnam. The gibbons in the border areas might range in both countries or be in contact with gibbon groups on the Vietnamese side of the border. Therefore, gibbon conservation in this area would benefit from a cross-border effort by China and Vietnam. A joint survey in the forest areas along the border should be considered as a first step, though it will be difficult to carry out. Working in these areas is complicated due to ongoing border disputes, leading to a delicate political situation which makes survey work there nearly impossible. Furthermore, it is problematic to take food supplies and equipment to such areas, which are far from human settlements, for a detailed survey.

Acknowledgements

The population survey was supported by Fauna and Flora International. We are grateful to the nature reserve management and forestry bureaus in Jinping, Luchun, Pingbian and Hekou, and the governments at Bajiaohe and Yingpan town for the permission to carry out the field research.

References

Altmann, J. (1974). Observational study of behavior: sampling methods. *Behaviour* **49**: 227-265.

Brockelman, W. Y., and Srikosamatara, S. (1993). Estimation of density of gibbon groups by use of loud songs. *American Journal of Primatology* **29**: 93-108.

Jiang, X. L., Luo, Z. H., Zhao, S. Y., Li, R. Z., and Liu, Z. M. (2006). Status and distribution pattern of black crested gibbon (*Nomascus concolor jingdongensis*) in Wuliang Mountains, Yunnan, China: implication for conservation. *Primates* **47**: 264-271.

Ma, S., and Wang, Y. (1986). [The taxonomy and distribution of the gibbons in southern China and its adjacent region - with description of three new subspecies]. *Zoological Research* **7**: 393-410 (Chinese text, English summary).

Ma, S., and Wang, Y. (1988). [The recent distribution, status and conservation of primates in China]. *Acta Theriologica Sinica* **8**: 250-260 (Chinese text, English summary).

Ma, S. L., Li, C. Y., Wang, Y. X., and Liu, G. C. (1987). Status and distribution of rare and endangered mammals in Honghe prefecture, Yunnan. In Wang, Y. X. (ed.), *Scientific survey on bio-resources in Honghe Prefecture, Southern Yunnan*. Yunnan Minority Press, Kunming, pp. 41-55 (Chinese text).

Wang, Y. X., Feng, Q., Jiang, X. L., and Lin, S. 2002. Mammals in Fenshuiling. In Xu, J. C. (ed.), *The report of integrated scientific expedition in Jinping Fenshuiling Nature Reserve, Yunnan*, Yunnan Science and Technology Publishing House, Yunnan, pp. 63-90 (Chinese text).

Wang, Y. X., Feng, Q., Zhou, L. M., He, J. H., and Bai, Y. F. (2003). Special report on primates. In Xu, J. C. (ed.), *The Huangliangshan Nature Reserve in Luchun, Yunnan*. Yunnan Science and Technology Publishing House, Yunnan, pp. 124-131 (Chinese text).

Wang, Y. X., Jiang, X. L., and Feng, Q. (2000). Distribution, status and conservation of black-crested gibbon (*Hylobates concolor*) in China. *Acta Anthropologica Sinica* **19**: 138-147 (Chinese text, English summary).

Zhou, J., Wei, F. W., Li, M., Zhang, J. F., Wang, D. L., and Pan, R. L. (2005). Hainan black-crested gibbon is headed for extinction. *International Journal of Primatology* **26**: 453-465.

Zusammenfassung

Schopfgibbons im Südosten der chinesischen Provinz Yunnan: Bestand und Schutz

Bestandeserhebungen der Gibbons im Südosten der Provinz Yunnan im Jahr 2003 haben ergeben, das schätzungsweise noch vier bis sieben Gruppen des Westlichen Schwarzen Schopfgibbons (*Nomascus concolor*) in isolierten Waldgebieten bei Bajiaohe, Xilongshan and Huanglianshan vorkommen. Mög-

liche Gibbonvorkommen im Süden von Luchun County, in Daweishan und im Osten der Präfektur Wenshan, also im historischen Verbreitungsgebiet des Nördlichen Weisswangen-Schopfgibbons (*N. leucogenys*) und des Cao-Vit Schopfgibbons (*N. nasutus*), müssen noch überprüft werden. Alle Populationen sind vom Aussterben bedroht, besonders die zwei Gruppen bei Bajiaohe in Jinping County. Jagd und Habitatszerstörung haben an den meisten Orten zum Rückgang der Gibbonbestände geführt. Das Überleben der verbleibenden Gibbons ist stark gefährdet durch Jagd, Störung durch Menschen, kleine Bestandesgrössen und Verschlechterung des Lebensraumes. Trotz Schutzstatus kommt es im Gebiet immer wieder zu Abholzung und zu Abschüssen von Gibbons. Das Überleben verdanken die Gibbons in diesem Gebiet nicht zuletzt dem Aberglauben, dass nach dem Erlegen eines Gibbons den Schützen und dessen Familie selber der baldige Tod ereilen werde. Die lokale Bevölkerung erhält wenig staatliche Unterstützung und ist deshalb auf natürliche Ressourcen für die Ernährung angewiesen. Zudem werden Gibbons auch für die Herstellung von Präparaten der traditionellen Medizin verwendet.

The northern white-cheeked gibbon (*Nomascus leucogenys*) is on the edge of extinction in China

Fan Peng-Fei[1,2] and Huo Sheng[1]

[1] Institute of Eastern-Himalaya Biodiversity Research, Dali University, Yunnan, P. R. China.
[2] To whom correspondence should be addressed; e-mail: fanpf1981@gmail.com

We carried out a short interview survey of the northern white-cheeked gibbon (*Nomascus leucogenys*) in the Mengla and Shangyong Nature Reserves (Xishuangbanna prefecture, Yunnan province), which are blieved to support the last white-cheeked gibbons in China. Before 1970, this gibbon species was common in Xishuangbanna and could be found in 29 out of 34 villages visited. By 1990, the populations had declined or even become locally extinct in most of the localities. Based on this interview survey, only three separate localities might still hold a very small gibbon population, and this species is on the edge of extinction. Most of the gibbon habitat inside the nature reserves is still intact, but illegal hunting by Chinese and Laotian hunters poses a serious threat to gibbons and other wildlife in the reserves. It seems that both nature reserves still hold a population of Phayre's leaf monkey (*Trachypithecus phayrei*), and macaques (*Macaca mulatta* or *M. assamensis*, and *M. arctoides*). The population of slow loris (*Nycticebus* sp.) may have declined during the past two decades because of conversion of forests at lower altitudes to rubber plantations. The pig-tailed macaque (*M. leonina*) is very rare in the nature reserves. There are eight captive northern white-cheeked gibbon individuals in the popular tourist location "Wild Elephant Valley" (Mengyang Nature Reserve) which could be used as a base to improve public conservation awareness.

Introduction

The northern white-cheeked gibbon (*Nomascus leucogenys*) occurs from southern Yunnan province to northern Laos and northern Vietnam (Fig. 1) and is listed as Critically Endangered by the IUCN's Red List assessment (Geissmann, 2007b; IUCN, 2008). In Vietnam, this species has been extirpated from several areas where it was previously recorded, and is now present only in a few localities in the northwest and north-central parts of the country (Geissmann *et al*., 2000). While no population estimates from Laos are available, the species appears to be relatively common in the north of the country. In fact, the Laos might still hold most of the world's remaining population of the northern white-cheeked gibbon (Duckworth, unpublished data).

In China, the northern white-cheeked gibbon used to be found at Mengla, Jiangcheng and Luchun counties (Ma and Wang, 1986). The morning calls of gibbons could be heard in the Mengla county town in 1958 but has disappeared since the 1970s (Gao *et al*., 1981). The estimated population of this species in China was 1,000 individuals in the 1960s (Tan, 1985) but decreased to 100 individuals in the 1980s (Tan, 1985; Fooden *et al*., 1987; Ma and Wang, 1988). Yang *et al*. (1985) carried out a large scale gibbon survey in Yunnan province, covering 56 counties in 10 prefectures where gibbons had been previously recorded. Their survey reported 27 northern white-cheeked gibbon groups with 99-122 individuals in Mengla Nature Reserve and Shangyong Nature Reserve, Mengla county, at elevations between 800 and 1,600 m. No gibbons were found in Jiangcheng, and only black crested gibbons (*N. concolor*) were found in Luchun (Yang *et al*., 1985). Combined information reported by Yang and Zhang (1987) and Hu *et al*. (1989) confirmed at least nine groups with 36 individuals distributed in seven forest patches in Mengla Nature Reserve and Shangyong Nature Reserve. Each patch supported only one or two groups and the distance between any two patches was about 20 km (Hu *et al*., 1989).

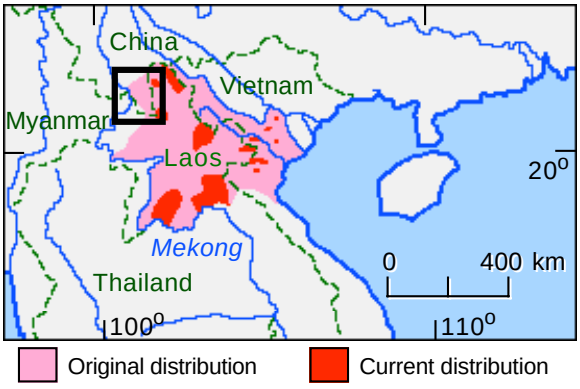

Fig. 1. Distribution area of the northern white-cheeked gibbon (*N. leucogenys*) and location of the survey area. After Geissmann (2007a). – *Heutige (rot) und ursprüngliche (rosa) Verbreitung des Nördlichen Weisswangen-Schopfgibbons (*N. leucogenys*) und Lage des Untersuchungsgebietes.*

Since the surveys conducted in the 1980s, no valid information on current existence, status and

population size of the northern white-cheeked gibbons in China is available. Some gibbon experts (e.g. Bill Bleisch, personal communication) think this species might have already become extinct in China.

We carried out a short interview survey in December 2008 to evaluate current population status, historic distribution and threats to the northern white-cheeked gibbons in China. In addition to information on gibbons, we also collected some preliminary distribution information on other primate species.

Methods

Our survey was carried out between 1 and 13 December 2008. The survey itinerary is shown in Table 1.

The last populations of *Nomascus leucogenys* are thought to survive only in Mengla Nature Reserve and Shangyong Nature Reserve, both located in Mengla county, Xishuangbanna prefecture (Yang *et al*., 1985). Therefore, this interview survey focused on the villages either surrounding or inside these two nature reserves. In addition, we also visited captive white-cheeked gibbons in two localities of the Xishuangbanna area: (1) the Xishuangbanna Tropical Botanical Garden, located in Menglun township, Mengla county, and (2) the "Wild Elephant Valley" in the Mengyang Nature Reserve (N 100°53′29.66″ E 22°2′41.69″). The survey area is shown in Fig. 2.

An interview questionnaire sheet was used to record the information (Table 2). We tried to interview two to three people in each village, but only interviewed one person in several villages because of one or several of the following reasons: 1) very few old hunters lived in small villages; 2) they worked in the field far away from the village; 3) they did not like to talk with us.

When analyzing the information from all interviewees of the same village, we tried to assess the following questions: 1) Have gibbons ever lived near this village? 2) When did they disappear? 3) Why did they disappear? 4) Do other primate species still occur near the village?

Results

Current population status

We visited 34 villages surrounding or inside the two nature reserves and interviewed 78 people (Table 3). Only three interviewees – of three different localities – reported having seen or heard gibbons in 2007 or 2008. These three localities (Nanman, Nangongshan, and Mankang) are separated by roads and many villages (Fig. 2) and belong to three different regions (Longmen region, Yaoqu region and Mengyuan region, respectively).

Table 1. Itinerary of interview survey of northern white-cheeked gibbon in Xishuangbanna prefecture. – *Reiseroute des Interview-Surveys zum Status des Nördlichen Weisswangengibbons in der Präfektur Xishuangbanna.*

Date, Dec. 2008	Activity	Days
1,2	Drive from Dali to Xishuanbanna	2
3	Wait for the permission to carry out the survey	1
4,5	Visit Hetu and Nanpin(g) in Mengman region	2
6	Visit Jinzhulin, Niupeng, Longmen, Pinghe, and Nanman in Longmen region	1
7	Visit Huilong, Nanshahe, Guangnali, Yeniudong, and Jingpiao in Bubang region	1
8	Visit Hongwei, Manyan, Jinchanghe, Longtanqing, Hongmaoshu, and Qiaotou in Mengban region	1
9	Visit Maocaoshan, Naxiu, Taoziqing, Kami, Panshan, and Longga in Mengban region	1
10	Visit Nangongshan, Guangming(yidui), Bujiao, Yiwanshui, Wangsi(xinzai), and Longba in Yaoqu region	1
11	Visit Naka, Nanpin(g), Mengyuan, and Mankang in Mengyuan region, Xiangming Forestry station, and Xishuangbanna Tropical Botanical Garden (Menglun township)	1
12	Visit the captive gibbons in "Wild Elephant Valley" of Mengyang Nature Reserve	1
13	Drive back to Dali	1
	Total days	13

How reliable is this information? The occurrence of gibbons is reported by just one person per site, whereas it would be desirable to have information from several or all interviewees from these sites. Why are the results not more consistent? In other words: why were not more people at the same sites able to report gibbons? Two possible explanations should be considered: (1) the people who did not report gibbons were unfamiliar with the forest, or (2) the people who did report gibbons erred.

The first explanation appears to be more likely, because few villagers have visited the forest in recent years due to two reasons: (1) the local people are forbidden to go into the core area of the reserves, and (2) villagers are increasingly wealthy and, since they have planted rubber trees, busy outside the forest. As a result, it is not surprising that only one person has confirmed gibbons at each site.

Additional information on the three interviewees who did report evidence on the continued occurrence of gibbons in Xishuangbanna may be helpful to assess the reliability of their reports. All three informants were well familiar with gibbons, but the informants from Nanman and Mankang appeared to be somewhat more reliable than the informant from Nangongshan.

Table 2. Interview table for northern white-cheeked gibbon survey in Xishuangbanna. – *Interview-Formular für den Survey zum Status des Nördlichen Weisswangengibbons in der Präfektur Xishuangbanna*.

Date:	**Investigator name:**
Village name:	**Interviewee name:**
Latitude:	**Gender:**
Longitude:	**Age:**
Altitude:	**Nationality:**
1. Have you seen any primates near your village? 2. How many different kinds of primates have you seen? Please describe their characteristics one by one (colouration, locomotion, calls, tail length, etc.).	
If interviewee mentions gibbons when answering Question 2, then ask the following questions: 3. How many times have you seen gibbons? 4. When and where have you seen gibbons? 5. When was the last time you saw or heard gibbons?	If interviewee does not mention gibbons when answering Question 2, then ask the following questions: 6. Have you ever heard gibbon calls? Can you imitate it? 7. When and where did you hear the calls? 8. When and where did you hear the last call? 9. Why did gibbons disappear from the forest? 10. What is the current condition of the forest where gibbons used to occur before? 11. Which other primate species still occur in the forest around your village? 12. Do you know whether anybody has ever shot gibbons in the past? When and how many gibbons did they shoot? (Not asked everyone)

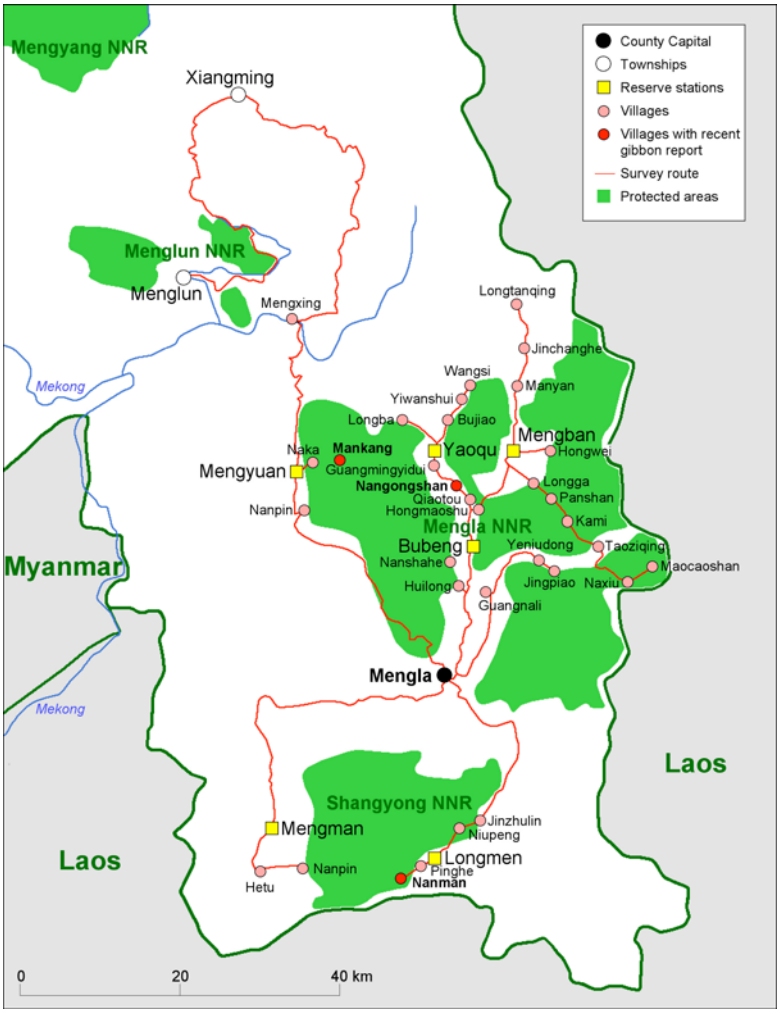

Fig. 2. The interview survey area in Mengla county, Xishuangbanna prefecture. – *Untersuchungsgebiet für den Interview-Survey zum Status des Nördlichen Weisswangengibbons in der Präfektur Xishuangbanna*.

Table 3. Distribution of different primate species in the survey area, Mengla county, Xishuangbanna prefecture, based on our interview data. Grey shading indicates localities with recent gibbon reports (2007-2008). – *Verbreitung verschiedener Primatenarten im Untersuchungsgebiet in der Präfektur Xishuangbanna. Zu den grau markierten Tabellenbereichen liegen Berichte über rezente Gibbonvorkommen (2007-2008) vor*.

Village	Coordinates		Ele	Number	Primates species[1]					
	N	E	vation [m]	of inter-viewed people	*Nle**	*Tph*	*Mmu / Mas*	*Mne*	*Mar*	*Nyc*
Hetu	21°16′25.9″	101°20′06.8″		1	1983	+	+			+
Nanping	21°16′36.2″	101°23′06.5″	740	3	2003	+	+		+	+
Jinzhulin	21°19′40.4″	101°35′48.2″	843	1	?		+			
Niupeng	21°19′15.8″	101°34′42.0″	925	2	2006	+	+		+	+
Longmen	21°16′58.7″	101°32′15.1″	924	1	1998 (Nanman)	+	+		+	+
Pinghe	21°16′49.9″	101°31′40.2″	947	2		+	+		+	+
Nanman	21°15′55.9″	101°30′06.9″	873	3	2008 (Zhaokan-liang)	+	+		+	+
Huilong	21°35′9.7″	101°34′34.8″	735	2	Before 1980	+	+			
Nanshahe	21°36′50.2″	101°33′57.4″	723	4	1989	+	+		+	+
Guangnali	21°34′41.4″	101°36′37.3″	670	3	1990	+			+	
Yeniudong	21°36′59.8″	101°40′16.4″	813	2	1979	+	+		+	+
Jingpiao	21°36′17.0″	101°41′17.5″	828	3	1984	+	+			+
Hongwei	21°44′12.4″	101°40′59.0″	812	2	1981	+	+	+	+	+
Manyan	21°48′29.7″	101°38′46.0″	789	3	1980	+			+	
Jinchanghe	21°50′50.2″	101°39′12.4″	854	1	1976	+	+			
Longtanqing	21°53′45.8″	101°38′37.8″	955	4	1980	+	+			
Hongmaoshu[2]	21°40′18.6″	101°35′48.1″	692	4		+	+		+	+
Qiaotou[3]				5						
Maocaoshan	21°36′42.3″	101°48′30.5″	1189	3	1986	+	+			
Naxiu	21°35′29.1″	101°46′40.6″	1050	2	Before 1978					
Taoziqing	21°37′51.8″	101°44′32.4″	1033	2	1982	+	+		+	
Kami	21°39′31.2″	101°42′10.7″	775	1	Before 1988					
Panshan	21°40′58.6″	101°41′11.3″	761	2	1982					
Longga	21°42′01.7″	101°39′50.6″	727	1	1980	+	+			
Nangongshan[4]	21°41′56.9″	101°34′20.0″	836	4	2008	+				
Guangming	21°43′14.3″	101°32′33.9″	807	2	1993 (Lei-gongyan)	+			+	+
Bujiao	21°46′09.4″	101°33′41.7″	855	1	Before 1988	+	+			
Yiwanshui	21°47′35.2″	101°34′47.6″	947	2	1978	+	+			
Wanshixinzhai	21°48′23.5″	101°35′19.8″	966	3	1978	+	+			
Longba	21°46′17.7″	101°30′24.6″	967	2						
Naka	21°43′13.7″	101°23′56.6″	764	2	1972	+	+			
Nanping	21°40′26.2″	101°23′31.4″	769	2	1980	+				
Mengyuan	21°42′43.4″	101°22′50.7″	688	2		+	+			
Mankang[5]				1	2007 (Lei-gongyan)	+	+		+	
Xiangming	22°16’	101°27’		3			+			
Xiaoheijiang	22°00′38.9″	101°15′53.0″	590	8					+	

[1] Abbreviations: *Nle* Northern white-cheeked gibbon (*Nomascus leucogenys*), *Tph* Phayre's leaf monkey (*Trachypithecus phayrei*), *Mmu / Mas* Rhesus macaque (*Macaca mulatta*) or Assamese macaque (*M. assamensis*). These two macaque species are too similar to be distinguished through this interview survey. *Mle* Northern Pig-tailed macaque (*M. leonina*), *Mar* Stump-tailed macaque (*M. arctoides*), *Nyc* Slow lori (*Nycticebus* sp.)

[2] This village was relocated from the core area of Mengla Nature Reserve to its current location in 2006.

[3] The people living in this village moved from Meizi, Ninger county, to this current location to plant rubber. Five people confirmed their home town still has gibbons. One of us (FP) called a hunter who shot a gibbon in Meizi and who confirmed the gibbons in Meizi have black cheeks. This is a new distribution locality for *Nomascus concolor*.

[4] This village was transplanted from the core area of Mengla Nature Reserve to its current location in 1988.

[5] We did not visit this village because we found no road to access it, but one of us (FP) called and interviewed one ranger who lives in this village.

* Last record of gibbons in a village. The local name of the exact place where the informants observed the gibbons is indicated in parentheses.

\+ Species still occurs around the village.

(1) The interviewee in Nanman assists soldiers in patrolling the international border between China and Laos about 8-10 times every year. He observed one adult male gibbon several times in 2007 and 2008.

(2) The interviewee in Mankang was a good hunter in past, and is now working as a ranger for the reserve. Several other interviwees recommended this man to us saying that he had the best knowledge of the forest and its animals. He confirmed the continued occurrence of a very small gibbon population in Leigongyan.

(3) At least four gibbon groups reportedly lived around Nangongshan before the 1980s and nearly everyone above age 30 knew gibbons from this area. One interviewee told us he saw three black individuals around August 2008 but did not hear the calls. Based on his description, these animals were gibbons, but several other interviwees living in the same village or nearby have not seen any gibbons in this area in recent years.

During the interview, one person said a small gibbon population may occur in Xiangming (far away from the nature reserves), so we visited Xiangming Forestry Station on 11 Dec. 2008. The staff members said they had never seen or heard gibbons and had also never heard other people reporting gibbons in this area. We inspected the plantation type in the forestry station. The forest is severely fragmented and the largest patch is about 5 km long and 2 km, wide and surrounded by two villages. Thus, it is unlikely to support a gibbon population. If there is a gibbon group, local people would easily hear its calls. We also interviewed a group of local people on the way from Xiangming back to Menglun town. They have only seen stump-tailed macaques (*Macaca arctoides*) in the Xiangming area.

One person from Qiaotou who had previously lived in Jianshe village, Meizi town, Ninger county (new name of Puer county since 2007), reported gibbons still occur in Meizi and these gibbons have black cheeks. If correct, this would be a new distribution locality for the black crested gibbon (*Nomascus concolor*).

Historical distribution

Before 1970, the northern white-cheeked gibbon was a common species in Mengla Nature Reserve and Shangyong Nature Reserve. Gibbons were reported to occur near 29 villages out of the 34 villages we visited, but since 1990 they have survived only in five localities (Nanping, Niupeng, Nanman, Nangongshan, Leigongyan). Of these, the gibbons in Nanping and Niupeng may have disappeared, as the local people have not heard any gibbon calls in recent years (Table 3).

Why have the gibbons disappeared?

Most of the people did not like to talk about this question or they did not know the reason. Twenty-eight people believed that hunting was the main reason. Seven people confirmed that 15-17 gibbons were shot by them or other hunters between 1960 and 1985. The men of the Aini ethnic group like to shoot adult female gibbons (yellow individuals). A successful hunt of female gibbons was regarded as the standard of a good husband, and their wives used gibbon fur to weave cotton. Moreover, some hunters used the gibbon's ellbow bones as chopsticks (Fig. 3).

Fig. 3. Gibbon ellbow bones (ulnae) used as chopsticks in Guangnali, Mengla county. Photo: Fan Pengfei. – *Unterarmknochen (Ellen) von Gibbons, die in Guangnali (Mengla County) als Essstäbchen benutzt werden*.

In 1979, the Chinese government distributed muskets to local people to defend their home town when China was involved in the war with Vietnam. Most of these muskets were not used in the war but to hunt wild animals. Although the government took the muskets back between 1980 and 1983, the populations of some animals (gibbons, hornbills, and wild buffaloes) declined during those years to levels from which they could hardly recover. Staff members and rangers of the nature reserve told us that illegal hunting by Chinese and Laotian hunters still occurs within the nature reserves today. We have met three

people carrying guns near the nature reserve during this short survey.

Three people said gibbons disappeared because their population was small and their reproduction rate was slow. Two people thought deforestation was the main reason. One person in Yeniudong thought a serious disease was the main reason why gibbons disappeared. In 1979, when China and Vietnam were at war with each other, this previously unknown disease spread in the forests around Yeniudong. Many animals including monkeys, wild boars and mice died due to it. One person brought a dead wild boar back to the village and all the domestic pigs in the village died. After this disease incidence, no gibbon calls were heard from this village.

Captive gibbons in Xishuangbanna Tropical Botanical Garden and Mengyang Nature Reserve

Until recently, the Xishuangbanna Tropical Botanical Garden kept two gibbons on an isolated artificial island surrounded by a pool. One of the gibbons drowned in the pool about 3 years ago, and another male died the same way in 2008.

The "Wild Elephant Valley" in Mengyang Nature Reserve had eight northern white-cheeked gibbons, including three males and five females, at the time of our visit. One female changed to adult colouration in summer 2008. This female and one male were paired and released in the forest. They could sleep in the forest but still depended on food supply from the tourists (Fig. 4). The other six individuals were juveniles and were kept in two small cages housing three individuals each. A scientific management plan is needed for this captive population. We were unable to obtain information on the provenance of the captive gibbons from the management and staff members. No records of the gibbons were kept in the past. All of these eight individuals were infants when they arrived at the site, one male in 2003, two females and two males in 2004, and three females in August 2006.

Other primate species

Although gibbons have disappeared from many localities, *Trachypithecus phayrei*, *Macaca mulatta* or *M. assamensis*, and *M. arctoides* are reported to still occurr around most of the villages visited (Table 3). Rhesus macaques (*M. mulatta*) and Assamese macaques (*M. assamensis*) look very similar, and therefore they cannot be told apart based on our interview survey.

Only one person confirmed the occurrence of *M. nemestrina* inside the Mengla Nature Reserve. This species may be very rare in the survey area, but a photograph of one family group of this species has been taken by Feng Liming using a camera trap, thus confirming the occurrence of *M. nemestrina*.

Nycticebus sp. was a common species in earlier times but may have disappeared from several villages in more recent years because most forest outside the nature reserve has been transformed to rubber plantations.

Fig. 4. "Wild Elephant Valley" in Mengyang Nature Reserve: a released adult pair of northern white-cheeked gibbons still depends on the food supply provided by tourists. Photo: Fan Pengfei. – *Dieses Paar Nördlicher Weisswangen-Schopfgibbons wurde im Touristenort "Wild Elephant Valley" im Mengyang-Naturreservat weitgehend ausgewildert, es bedarf aber immer noch der Zufütterung durch die Besucher*.

Discussion

Threats to the gibbons in Xishuangbanna

In Xishuangbanna, most of the forest outside the nature reserve has been cleared for rubber plantation (Fig. 5). But deforestation has not been the main threat to gibbons since a large area of forest inside the nature reserve has been well protected and could still provide refuge for gibbons and other wild animals (Fig. 6). Despite this habitat protection, gibbons have disappeared.

Illegal hunting has been the main threat to gibbons in Xishuangbanna. The Yao and Aini ethnic groups in Xishuangbanna are traditional hunters and hunting is part of their life. They mostly hunt species of mammals including gibbons. Although the animals living in the nature reserve have been protected by law in China, these people still hunt endangered animals in the nature reserve. In one village, nine of the total 16 adult men were sent to jail for illegal hunting. Hunters from Laos have also posed a serious threat for endangered animals living close to the

Fig. 5. The forest outside of the nature reserve has been cleared for rubber plantation, as in this area near Jingpiao. Photo: Fan Pengfei. – *Der Wald ausserhalb der Naturreservate wurde weitgehend durch Gummibaum-Plantagen ersetzt. Bild aus der Nähe des Dorfes Jingpiao*.

Fig. 6. The forest inside the nature reserve has been well protected, as in this area near Niupeng. Photo: Fan Pengfei. – *Der Wald innerhalb der Naturreservate ist gut erhalten. Bild aus der Nähe des Dorfes Niupeng*.

border. The Chinese government has tried to catch the illegal hunters acting within the nature reserve, but this has been a difficult task given the hunters' familiariy with the topography of the area.

The future for the northern white-cheeked gibbons in Xishuangbanna

If the northern white-cheeked gibbon still occurs in Xishuangbanna – as suggested by some of our interview results – the population must be extremely small (few groups at best) and fragmented. The forest is relatively well-protected and provides a last survival chance for this gibbon and gives us some hope to conserve the species in China. If the government cannot stop illegal hunting, however, the protection of gibbons in Xishuangbanna will not be successful. Even if illegal hunting is stopped, however, it is questionable whether the gibbon population will be able to recover, due to the small size and fragmented distribution of the population.

Public awareness of the gibbons' plight is not high in China. The captive gibbon population in "Wild Elephant Valley" of the Mengyang Nature Reserve may provide an opportunity to improve the public's gibbon conservation awareness. "Wild Elephant Valley" is a very popular tourist spot in China. About 2,000-3,000 people visit it everyday to look for wild elephants. Gibbons could attract the attention of many tourists when elephants are absent (Fig. 7). Unfortunately, there are no billboards to introduce gibbons to the tourists. In addition, local tour guides do not know the gibbon's conservation status and behaviour. We were able to discuss the gibbon situation with one of the leaders of the tourist site. He agreed that gibbons cold be a tourist attraction, and he said he would like to contribute to gibbon conservation. A project including a training course to the tour guides, the installation of billboards, production of brochures and a management plan for the captive gibbons is needed. Not only northern white-cheeked gibbons would benefit from such a project, but other gibbon species in China as well.

Acknowledgements

We would like to thank the Gibbon Conservation Alliance for proposing and funding this survey, and Yunnan Forestry Bureau and Xishuangbanna Nature Reserve for permitting us to carry out this survey. We are grateful to Dr. Jiang Xue-long for his valuable help in obtaining the permission from Yunnan Forestry Bureau, and to Dr. Xiao Wen and Jimmy Chou for reading and commenting on the draft. We are greatful to Thomas Geissmann for editing this manuscript and the survey map. We also thank Yan Bing, Che Zhiyong, Bai Lingzhong, and Li Fuqiang for their help as guides and as interpreters during interviews in languages of local ethnic groups.

Fig. 7. Tourists attracted by the semi-wild gibbon pair in the "Wild Elephant Valley", Mengyang Nature Reserve. Photo: Fan Pengfei. – *Das weitgehend ausgewildert lebende Gibbonpaar im "Wild Elephant Valley" im Mengyang-Naturreservat zieht viele Besucher an.*

References

Fooden, J., Quan, G., and Luo, Y. (1987). Gibbon distribution in China. *Acta Theriologica Sinica* **7**: 161-167.

Gao, Y., Wen, H., and He, Y. (1981). [The change of historical distribution of Chinese gibbons (*Hylobates*)]. *Zoological Research* **2**: 1-8 (Chinese text, English summary).

Geissmann, T. (2007a). First field data on the Laotian black crested gibbon (*Nomascus concolor lu*) of the Nam Kan area of Laos. *Gibbon Journal* **3**: 56-65.

Geissmann, T. (2007b). Status reassessment of the gibbons: Results of the Asian Primate Red List Workshop 2006. *Gibbon Journal* **3**: 5-15.

Geissmann, T., Nguyen Xuan Dang, Lormée, N., and Momberg, F. (2000). *Vietnam primate conservation status review 2000 - Part 1: Gibbons (English edition)*, Fauna & Flora International, Indochina Programme, Hanoi, 130 pp.

Hu, Y., Xu, H. L., and Yang, D. (1989). [The studies on ecology in *Hylobates leucogenys*]. *Zoological Research* **10** (Supplement): 61-67 (Chinese text, English summary).

IUCN (2008). *2008 IUCN Red List of Threatened Species*. <www.iucnredlist.org>. Downloaded on 10 February 2009.

Ma, S., and Wang, Y. (1986). [The taxonomy and distribution of the gibbons in southern China and its adjacent region - with description of three new subspecies]. *Zoological Research* **7**: 393-410 (Chinese text, English summary).

Ma, S., and Wang, Y. (1988). [The recent distribution, status and conservation of primates in China]. *Acta Theriologica Sinica* **8**: 250-260 (Chinese text, English summary).

Tan, B. (1985). The status of primates in China. *Primate Conservation* **5**: 63-81.

Yang, D., Zhang, J., and Li, C. (1985). [A survey report on the number and distribution of gibbons in Yunnan]. *Medical Biological Research* **1985** (3): 22-27 (Chinese text).

Zusammenfassung

Der Nördliche Weisswangen-Schopfgibbon (*Nomascus leucogenys*) in China am Rande der Ausrottung

In den Naturreservaten von Mengla and Shangyong (in der Präfektur Xishuangbanna der Provinz Yunnan) werden Chinas letzte Rückzugsgebiete des bedrohten Nördlichen Weisswangen-Schopfgibbons (*Nomascus leucogenys*) vermutet, aber es ist unsicher, ob die Art in China tatsächlich noch überlebt. Wir haben in einen kurzen Interview-Survey Dorfbewohner in beiden Gegenden danach befragt, wann und wo sie zuletzt Gibbons gesehen oder ihre Rufe gehört haben. Die Interviews belegen, dass die Weisswangen-Schopfgibbons vor 1970 noch relativ häufig in Xishuangbanna vorkamen und um 29 der 34 von uns besuchten Dörfer herum verbreitet waren. Noch vor 1990 gingen die Gibbon-Populationen an den meisten dieser Orte zurück oder erloschen sogar völlig. Nur von drei Orten berichteten Dorfbewohner noch von Gibbonvorkommen für die Zeit von 2007 von 2008. Diese verbleibenden Gibbon-Populationen müssen, wenn die Angaben stimmen, sehr klein und am Rand des Aussterbens sein. Innerhalb der Naturreservate blieb das Gibbonhabitat noch weitgehend intakt, aber illegale Jagd durch chinesische und laotische Jäger stellt eine ernste Bedrohung für Gibbons und andere Wildtiere in den Reservaten dar.

In beiden Naturreservaten scheint es noch Populationen von Phayres Languren (*Trachypithecus phayrei*) und Makaken (*Macaca mulatta* oder *M. assamensis*, und *M. arctoides*) zu geben. Die Population der Plumploris (*Nycticebus* sp.) scheint während der letzten zwei Jahrzehnte zurückgegangen zu sein, weil Wald in den tiefer gelegenen Regionen den Gummibaum-Plantagen weichen musste. Schweinsaffen (*M. leonina*) sind sehr selten in den Reservaten.

Acht Nördliche Weisswangen-Schopfgibbons werden in dem bekannten Touristenziel, dem “Wild Elephant Valley”, im Mengyang Natur-Reservat gehalten und könnten zur Aufklärung der Öffentlichkeit über die Bedrohung dieser Gibbons beitragen.

Door slamming: Tool-use by a captive white-handed gibbon (*Hylobates lar*)

Thomas Geissmann

Anthropological Institute, University Zürich-Irchel,
Winterthurerstr. 190, CH–8057 Zürich, Switzerland
E-mail: thomas.geissmann@aim.uzh.ch

Gibbons often accompany their morning song bouts by spectacular locomotor displays that may include branch shaking and branch braking. These displays typically occur at the climax of the great-call, the most conspicuous and stereotyped song phrase of the female. Here I report on a captive female white-handed gibbon slamming the sliding door of her wooden sleeping box during the climax of her great-call. This special addition to her display produced a single, loud bang which acoustically accentuated the climax of the female's great-call, made her great-call sound unique, and possibly enhanced the call's effect on potential receivers (presumably female conspecifics). The female's use of a door to modify her duet contributions represents a novel behavioural variant, and one of the few cases of tool use in gibbons or small apes. Furthermore, behavioural innovations like this one may have played a role in the evolution of human music.

Introduction

Great apes have frequently been reported to use tools, both in captivity and in the wild, and these primates' propensity for tool use has been evaluated in various studies (*e.g.* Boysen *et al.*, 1999; Breuer *et al.*, 2005; Fontaine *et al.*, 1995; Köhler, 1927; McGrew, 1992; Nakamichi, 1999, 2004; Toth *et al.*, 1993; van Schaik *et al.*, 2003; Visalberghi *et al.*, 1995; Whiten *et al.*, 2001).

In contrast, tool use in gibbons has rarely been studied, and relatively few cases of tool use have been observed in the small apes (Anonymous, 1971; Baldwin and Teleki, 1976, p. 63; Beck, 1980; Cunningham, 2006; Cunningham *et al.*, 2006; Drescher and Trendelenburg, 1927; Rumbaugh, 1970). In his review of tool use in apes, McGrew (1992, p. 53) ranked gibbons "with their total of two anecdotes" among the non-tool users, together with gorillas.

One of the most interesting specialisations in gibbons are their loud morning vocalisations, commonly known as songs (Geissmann, 1993; 2000b; Haimoff, 1984; Marshall and Marshall 1977).

In many gibbon species, males produce one or several distinct types of short phrases, which often become gradually more complex (as seen, for instance, in the number of notes, the number of distinct note types or the degree of frequency modulation) as the song bout proceeds. In more or less regular intervals, females insert long, female-specific phrases, which are commonly referred to as great-calls. In most species, great-calls consist of a particularly rhythmic series of long notes uttered with increasing tempo and/or increasing peak frequency. Males usually stop vocalising at the beginning of each great-call and provide a special reply phrase (coda) at or after the climax of the great-call before resuming their more common short phrases. The combination of the female great-call and the male coda is termed a great-call sequence, and this sequence may be repeated many times during a single song bout (Geissmann, 2000b).

In addition, one or both partners often exhibit a locomotor display at the climax of the great-call, which may consist of a more or less acrobatic burst of locomotion through the crown of the tree and be accompanied by pilo-erection, branch shaking and branch braking (Deputte, 1982; Chivers, 1974, p. 238; Geissmann, 2000b; Kappeler, 1984, p. 381).

Here I report on a possible case of tool use observed in a captive female white-handed gibbon. The behaviour was typically preformed as part of her song bouts, usually as part of the locomotor display during her great-call phrases.

Animals, materials and methods

Study animals

The study animals included an adult female (*Si*) and an adult male (*Pu*) of white-handed gibbons (*Hylobates lar*). They were kept as a pair at the Zoo Seeteufel in Studen, Switzerland. They arrived at the zoo around 1971 from a private owner. Both were presumably wild-born, and reportedly adults upon arrival. Both were of the light colour phase, but the female was clearly darker and larger than the male (Fig. 1).

No conspecifics lived in the zoo, but three groups of siamangs were also kept there (Geissmann, 1986, 1999, 2000a, 2008). They were housed in the same type of cages. One of these siamang groups lived in a neighbouring cage to that of the gibbon pair.

All groups could hear each other throughout the year. During the summer, all hylobatid groups were kept in wire-mesh outdoor cages (area x height: 25 m^2 x 2.5 m) equipped with several horizontal metal bars, ropes, and a wooden sleeping box (Fig. 2). The sleeping box had an area of about 2 m x 0.6 m and a height of about 1 m. It contained two equal-sized sleeping compartments, each with a circle-shaped entrance that could be closed with a sliding door (Fig. 3).

During the winter, all gibbons were housed in a building. The gibbons were moved between summer and winter cages while inside their sleeping box. The main indoor cage of the white-handed gibbons had a glass front facing the visitors' area. A second, much smaller indoor cage was located above the first one. It contained the sleeping box and was not visible to the visitors.

Terms and definitions

Tool use: In this paper, I follow the definition of tool use as proposed by St. Amant and Horton (2008, p. 1203):

> "Tool use is the exertion of control over a freely manipulable external object (the tool) with the goal of (1) altering the physical properties of another object, substance, surface or medium (the target, which may be the tool user or another organism) via a dynamic mechanical interaction, or (2) mediating the flow of information between the tool user and the environment or other organisms in the environment."

Bioacoustic terms: Gibbon song bouts consist of "phrases" and occasional "single notes". "Great-calls" are the most stereotyped and most easily identifiable phrases of gibbon song bouts and are produced by females of all gibbon species. All other phrases are termed "short phrases" here. A particularly characteristic short phrase in gibbon duet songs is the male's "coda", which is produced at or near the end of the female's great-call. The combination of a female great-call and the corresponding coda is called a "great-call sequence". The short phrases occurring between the great-call sequences are termed "interlude sequences". A typical cycle of events occurring several times in a gibbon duet song bout begins with male short phrases (often accompanied by female short phrases), followed by the onset of a female great-call. The male falls silent during the build-up phase of the great-call and adds a coda at the climax. After that, he resumes the production of short phrases (again, with or without female short phrases). The first sonogram shown in Fig. 4 illustrates some of the terms used in this paper: note, great-call, short phrase, and coda.

Data collection and equipment

Observations were carried out non-systematically in the time periods of 7–21 July 1981, 3–4 Sept. 1981, and 21–24 Nov. 1981. The gibbons were kept in their outdoor cage during the first two observation periods and in the indoor cage during the last period.

Thirty-seven duet song bouts and three isolated female solo great-calls with no male contribution were monitored during this study, and 32 of these

Fig. 1. The white-handed gibbon pair. The female sits on the left, the male on the right. Photo: Thomas Geissmann. – *Das Weisshand-Gibbonpaar: Weibchen links, Männchen rechts*.

Fig. 2. The cage of the adult white-handed gibbon pair (male above, female below) at the Seeteufel Zoo in Studen, Switzerland. Photo: Thomas Geissmann. – *Der Käfig des erwachsenen Weisshand-Gibbonpaares im Zoo Seeteufel in Studen, Schweiz. Das Männchen ist oben, das Weibchen unten sichtbar*.

Fig. 3. The sleeping boxes of the white-handed gibbons. The male is just leaving his box, while the female can be seen sitting in her box. Photo: Thomas Geissmann. – *Die Schlafboxen der Weisshand-Gibbons. Das Männchen (links) verlässt soeben seine Box, während das Weibchen (rechts) in seiner Box sitzt*.

song bouts, or parts of them, were recorded on tape, including 52 great-call sequences. A male solo song bout was heard only once during this study (at 04:00 a.m.) and is not included in these numbers.

Tape-recordings were made with a UHER 4200 Report Stereo S and a UHER 4200 Report Stereo IC reel tape recorder (with tape speed set at 9.5 cm/s), equipped with a AKG directional microphone.

The sound material was digitised with a sample rate of 44.1 kHz and a sample size of 32 bit. Time versus frequency displays (sonagrams) of tape-recorded vocalisations were generated using the Canary software version 1.2.4 on an Apple Power Book G4. The FFT (*Fast Fourier Transformation*) size of the sonagrams was 2048 points with an overlap of 75% and a frame length of 512 points (frequency resolution = 10.77 Hz) (Charif *et al.*, 1995).

Results

Duet song bouts of the white-handed gibbon (*Hylobates lar*) pair at the Seeteufel Zoo in Studen were usually very short and had an average duration (± standard deviation) of 5.6 ± 5.4 min (n = 40 song bouts, range = 0.3-30.0 min). These duet song bouts usually included 1.6 ± 1.1 great-calls (n = 32 song bouts, range = 1–5 great-calls).

The female often exhibited an unusual behaviour during her great-call phrases. This is illustrated in the sonagrams of Fig. 4. Just a few seconds before her great-call phrases, she moved to her sleeping box (while singing) and sat in it, continuing to call from there. She half shut the sliding door, which is audible on many of the tape-recordings. At the climax of her great-call, the female slammed the sliding door of the sleeping box open, jumped out of the box and performed a short locomotor display. As part of the display she usually brachiated vigorously around the cage and occasionally hit the wire-mesh with her feet.

The bang of the sliding door changed the female's great-call. It did not necessarily make the call much louder but it added a broad-band signal to the purely tonal call of the gibbon and registered on the sonagrams as a vertical line (Fig. 4).

The sliding door display was used in about 53% of the great-calls (Table 1). In the outdoor cage, the proportion of great-calls with the sliding door display was higher (71%) than in the indoor cage (30%). The difference is statistically significant (Chi-square test, $df = 1$, $p < 0.004$). The lower proportion of sliding door displays in the indoor cage probably results from the design of that cage and the gibbons' preference for spending most of their time in the large main part of the cage which has a glass front facing the visitors' area, whereas the sleeping box with the sliding doors is located in a small and relatively dark separate part of the indoor cage from which the gibbons cannot view the visitors. Therefore, much of their singing in the indoor cage occurred away from the sliding door.

Table 1. Proportion of sliding door displays in female great-calls produced in the outdoor and in the indoor cage. – *Verhältnis zwischen* great-call-*Strophen mit und ohne "Türknall-Display", sowie Vergleich dieser Verhältnisse bei Strophen, die im Aussenkäfig (Sommer) und im Innenkäfig (Winter) produziert wurden.*

Cage	Sliding door display		Total
	Present	Absent	
Outdoor (summer)	20 (71.4%)	8 (28.6%)	28
Indoor (winter)	7 (30.4%)	16 (69.6%)	23
Total	27 (52.9%)	24 (47.1%)	51

Occasionally, the female did not produce a bang although she opened the sliding door during the climax of the great-call (37% or 10 out of 27 sliding door displays). This possibly occurred because the wooden sliding door did not slide very easily or because she did not get a good grip on the door.

Between great-calls, while the female contributed short phrases to the interlude sequences, she usually went back to the sleeping box, sat inside the sleeping box and half-way closed the door, to be in position and ready to repeat her display during the next great-call. The sound of the closing door could be clearly heard preceding six of the tape-recorded great-calls. The time interval from the closing of the door until the bang of the sliding door display was 33±13 s (range 23-56 s).

In five out of 32 song bouts tape-recorded during this study, the female was heard slamming the sliding door (n = 7 slams) while producing short phrases after a great-call.

The female was only once observed using the sliding door display other than during song bouts. This occurred after the gibbons were presented with a play-back of one of their own song bouts tape-recorded on the previous day. As a result of the play-back, both gibbons became agitated. They produced soft hoots during several minutes, brachiated around their cage, and repeatedly exhibited locomotor displays during which they hit the wire mesh with their feet in the direction of the loud-speaker. The female also slammed the sliding door of her sleeping box once during this situation.

The male white-handed gibbon was not observed to include the sliding door in his displays and he rarely entered the sleeping box during the song bouts. The same applied to the three groups of siamangs that were kept at the zoo and that had access to the same type of sleeping boxes.

Discussion

The female gibbon's use of a door as a part of her regular display at the climax of her great-calls

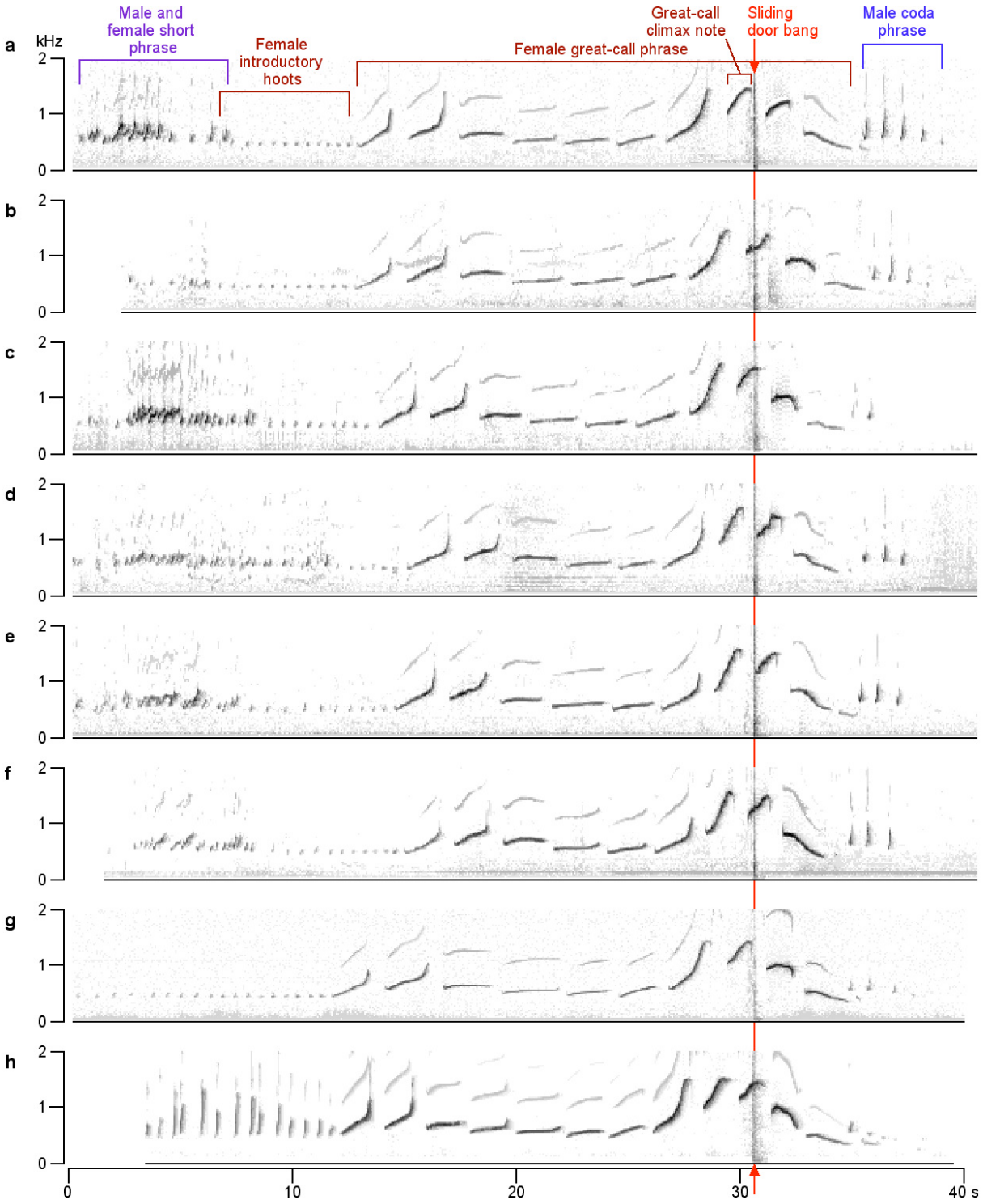

Fig. 4. Sonagrams showing short excerpts from duet song bouts by the pair of white-handed gibbons at the Seeteufel Zoo in Studen. At the climax of her great-calls (arrows), the female opens the sliding door of her sleeping box with a bang, which registers on the sonagrams as a vertical line. Sonagrams are aligned by this sound of the sliding door. Examples were tape-recorded in July (a-f) and September 1981 (g) in the outdoor cage, and in November 1981 (h) in the indoor cage. – *Sonagramme von Ausschnitten aus Duettgesängen des Weisshandgibbon-Paares im Zoo Seeteufel in Studen. Jeweils im Höhepunkt (*climax*) ihrer* great-call-*Strophe wirft das Weibchen die Schiebetür ihrer Schlafbox auf. Dieser Knall erscheint auf den Sonagrammen als vertikale Linie (Pfeil). In der Abbildung sind die Sonagramme untereinander nach diesem Knall ausgerichtet. Die Tonaufnahmen wurden im Juli (a-f) und September 1981 (g) vor dem Aussenkäfig und im November 1981 (h) vor dem Innenkäfig der Gibbons angefertigt*.

appears to be unique. I have carried out behavioural observations on all gibbon species, in captivity and in the wild, but I have not observed a comparable behaviour in other small apes.

The almost complete limitation of the female's door slamming behaviour to the song bout and to the climax of the great-call in particular suggests that her use of the door is functionally goal-directed and that the female may be consciously looking for the effect of this behaviour.

The only other use of the door slamming display occurred once in response to a play-back of a gibbon diet song. The play-back probably simulated the presence of a competitive second pair or even territorial intruders. The female's use of the door slamming display in response to the play-back may be functionally related to her displays in the duet song, which is also believed to be a signal directed at neighbouring groups and potential competitors (e.g. Geissmann, 2000b).

The door slamming of the gibbon female can be categorized as tool use according to the definition proposed by St. Amant and Horton (2008): The gibbon (tool user) controls a freely manipulable object (sliding door) as a tool to mediate the information perceived by potential competitors.

The case described in this study bears some similarity to observations of a wild male chimpanzee from the Gombe study site (Goodall, 1979, 1986; Kummer and Goodall, 1985; van Lawick-Goodall, 1965, p. 812f; 1971, p. 109f). In the early sixties there were occasionally a few empty four gallon paraffin cans lying about Jane Goodall's camp. "Mike", a low-ranking male, reportedly elevated his position to alpha rank within a four-month period by conducting a noisy display bellowing ferociously, rolling empty paraffin cans he found in the camp and banging them together as he came. "Goliath was the first alpha male that I knew. He lost his dominance in 1964 to Mike. A small male, Mike embellished his charging displays by banging empty kerosene cans and so intimidated the other males with the racket that in just a few months he bluffed his way to the top. We never saw him actually fight any of the other males, not even Goliath" (Goodall, 1979). According to Laland (cited in Milius, 1999), the case of the chimpanzee banging empty kerosene cans together is considered one of the textbook examples of behavioural innovations observed in animals.

The formal similarity between the gibbon example described in this study and the chimpanzee example reported by Goodall is obvious. In both cases, an ape puts extra whump in a threat display by banging objects together.

But the similarity may go deeper than pure analogy. Based on the detailed description provided by van Lawick-Goodall (1971, p. 109f), the display by chimpanzee "Mike" can be identified clearly as a "pant-hoot", which is homologous (i.e. phylogenetic equivalent) to the song of the gibbons in general and the great-call of gibbon females in particular (Geissmann, 2000b). Chimpanzee pant-hoots, gibbon song vocalizations, as well as the loud calls of other apes and Old World monkeys, and human singing are typically accompanied by locomotor displays and have been suggested to be homologous features that can be traced back to a behavioural pattern already present in the common ancestor of the catarrhine primates. This behaviour is originally believed to serve the purpose of displaying and possibly reinforcing the unity of a social group towards other groups (Geissmann, 2000b).

The human equivalent of the locomotor display (dancing) is often accentuated by tools (e.g. musical instruments in general and percussion instruments in particular). The locomotor displays of non-human primates (including gibbons) are often acoustically enhanced by branch-shaking, branch-breaking, or other movements through thick foliage (see review in Geissmann, 2000b). For instance, the locomotor display at the climax of chimpanzee pant-hoots may include dragging or flailing branches, throwing rocks or other loose material, slapping the ground with hands, stomping with feet, hitting or stamping at a tree (drumming display), seizing branches and swaying them vigorously from side to side, or showing exaggerated leaps or brachiation in a tree (Goodall, 1986). In captive primates (including gibbons), loud call displays are often accompanied by non-vocal acoustic signals such as banging the cage. None of these behaviours have been identified as tool use, although it may be worthwhile to consider them as potential starting points for tools use. Like the chimpanzee "Mike", the gibbon female of this study appears to use a tool to modify or accentuate the sound of loud calls. Events like these may have played a role in the evolution of human music.

The use of tin cans during the locomotor display of chimpanzee Mike has also been identified as tool use by McGrew (1992, p. 183). The author concluded that "[…] most non-subsistence tool use is poorly known. […] The repeated use of empty paraffin tins by a challenging adult male to enhance his agonistic display was similarly fascinating but idiosyncratic (Goodall, 1971). The tins were artificially introduced and then removed when their disruptive potential was realised."

Although there is an obvious similarity between the behaviour of chimpanzee Mike and that of the white-handed gibbon of this study, there is also a difference. Whereas the male chimpanzee reportedly gained an advantage (a raise in rank) through the use of the display-modifying tool, it is unclear whether the gibbon's tool use gave her an advantage compared to other females that did not use the tool.

Two other cases of tool use to modify primate calls have been reported. They are briefly summarised as follows:

(1) Wild orang-utans at Gunung Palung National Park, West Kalimantan, Indonesia were observed to use leaves as a tool to modify their kiss-squeak calls made during agonistic displays (including branch-

shaking and -braking) directed at the observer (Peters, 2001). The leaves were held against the mouth, in a half-folded hand. The behaviour was observed in 13 out of 15 observed individuals. The use of the leaves appeared to increase the intensity of the calls and the frequency range was also changed somewhat towards the higher frequencies.

(2) In a recent study at the Serra da Capivara National Park, Piaui state, north-eastern Brazil, capuchin monkeys (*Cebus apella libidinosus*) were observed to bang stones to produce sound in an aggressive display directed at the observer (Moura, 2007). This display was observed in six wild groups, and its primary function was suggested to be a predator-deterrent behaviour.

In both studies summarized above, the absence of the particular display in other populations of orangutans and capuchins, respectively, suggests that the behaviour could be a social tradition in the population studied.

Because the captive gibbon pair of this study was wild born and had no offspring, it was impossible to investigate social tradition of the female's unique display type.

As the female gibbon re-entered the sleeping box after producing a great-call and brought the sliding door to a half-closed position, it is also tempting to speculate that it was a pre-meditative act by which she prepared her next display in advance. The available evidence is not conclusive, however. Pre-meditative behaviour is known in chimpanzees (e.g. Osvath, 2009), but is apparently not known in gibbons.

In summary, the tool use in a female gibbon reported in this paper presents a singularity, as in several other reports on gibbon cognitive abilities. Small apes are underrepresented in cognitive research (Anderson, 2006). Yet, as suggested by this study, gibbons obviously have much to offer for our understanding of cognitive evolution in humans and apes. A renewal of interest in cognition in gibbons is urgently required, because it is very likely that gibbons still have some surprises left for us.

Acknowledgements

I thank the curators and staff members of the Seeteufel Zoo in Studen for permission to study the gibbons at their facility. I am grateful to Andrea Strasser and Natasha Arora for reading and commenting on this manuscript.

References

Anderson, J. R. (2006). Book review: Anne E. Russon, David R. Begun (eds). The evolution of thought: Evolutionary origins of great ape intelligence. Cambridge University Press, Cambridge, 2004. 384pp. *Primates* **47**: 180-181.

Anonymous (1971). Siamang also a tool user. Yerkes Newsletter (Yerkes Regional Primate Research Center) **8**(2, July 1971): 12.

Baldwin, L. A., and Teleki, G. (1976). Patterns of gibbon behavior on Hall's Island, Bermuda. A preliminary ethogram for *Hylobates lar*. In Rumbaugh, D. M. (ed.), *Gibbon and siamang, vol. 4*, Karger, Basel and New York, pp. 21-105.

Beck, B. B. (1967). A study of problem solving by gibbons. *Behaviour* **28**: 95-109.

Boysen, S. T., Kuhlmeier, V. A., Halliday, P., and Halliday, Y. M. (1999). Tool use in captive gorillas. In Parker, S. T., Mitchell R. W., and Miles, H. L. (eds.), *The mentalities of gorillas and orangutans: Comparative perspectives*, Cambridge University Press, Cambridge, pp. 179-187.

Breuer, T., Ndoundou-Hockemba, M., and Fishlock, V. (2005). First observation of tool use in wild gorillas. *Public Library of Science: Biology* **3:** 2041-2043.

Charif, R. A., Mitchell, S., and Clark, C. W. (1995). *Canary 1.2 user's manual*. Cornell Laboratory of Ornithology, Ithaca, NY., 191 pp.

Chivers, D. J. (1974). *The siamang in Malaya – A field study of a primate in tropical rain forest (Contributions to primatology vol. 4)*, Karger, Basel and New York, 335 pp.

Cunningham, C. L. (2006). Cognitive flexibility in gibbons (Hylobatidae): Object manipulation and tool-use, PhD thesis, Department of Psychology, University of Stirling, U.K., vii+257 pp.

Cunningham, C. L., Anderson, J. R., and Mootnick, A. R. (2006). Object manipulation to obtain a food reward in hoolock gibbons, *Bunopithecus hoolock*. *Animal Behaviour* **71**: 621-629.

Deputte, B. L. (1982). Duetting in male and female songs of the white-cheeked gibbon (*Hylobates concolor leucogenys*). In Snowdon, S. T., Brown, C. H., and Petersen, M. R. (eds.), *Primate communication*, Cambridge University Press, Cambridge, pp. 67-93.

Drescher, K., and Trendelenburg, W. (1927). Weiterer Beitrag zur Intelligenzprüfung an Affen (einschliesslich Anthropoiden). *Zeitschrift für vergleichende Physiologie* **5**: 613-642.

Fontaine, B., Moisson, P. Y., and Wickings, E. J. (1995). Observations of spontaneous tool making and tool use in a captive group of western lowland gorillas (*Gorilla gorilla gorilla*). *Folia Primatologica* **65:** 219-223.

Geissmann, T. (1986). Mate change enhances duetting activity in the siamang gibbon (*Hylobates syndactylus*). *Behaviour* **96:** 17-27.

Geissmann, T. (1993). *Evolution of communication in gibbons (Hylobatidae)*, Ph.D. thesis, Anthropological Institute, Philosoph. Faculty II, Zürich University, 374 pp.

Geissmann, T. (1999). Duet songs of the siamang, *Hylobates syndactylus*: II. Testing the pair-bonding hypothesis during a partner exchange. *Behaviour* **136:** 1005-1039.

Geissmann, T. (2000a). Duet songs of the siamang, *Hylobates syndactylus*: I. Structure and organisation. *Primate Report* **56:** 33-60.

Geissmann, T. (2000b). Gibbon songs and human music from an evolutionary perspective. In Wallin, N. L., Merker, B., and Brown, S. (eds.), *The origins of music*, MIT Press, Cambridge, Massachusetts, pp. 103-123.

Geissmann, T. (2008). Inter-group conflict in captive siamangs (*Symphalangus syndactylus*). *Gibbon Journal* **4:** 51-55.

Goodall, J. (1979). Life and death at Gombe. *National Geographic* **155** (5, May 1979): 592-621.

Goodall, J. (1986). *The chimpanzees of Gombe. Patterns of behavior*. The Bellknap Press of University Press, Cambridge, Massachusetts, and London, xi+673 pp.

Haimoff, E. H. (1984). Acoustic and organizational features of gibbon songs. In Preuschoft, H., Chivers, D. J., Brockelman, W. Y., and Creel, N. (eds.), *The lesser apes. Evolutionary and behavioural biology*, Edinburgh University Press, Edinburgh, pp. 333-353.

Kappeler, M. (1984). Vocal bouts and territorial maintenance in the moloch gibbon. In Preuschoft, H., Chivers, D. J., Brockelman, W. Y., and Creel, N. (eds.), *The lesser apes. Evolutionary and behavioural biology*, Edinburgh University Press, Edinburgh, pp. 376-389.

Köhler, W. (1927). *The mentality of apes, 2nd edition*. Harcourt, Brace & Co., New York, 336 pp.

Kummer, H., and Goodall, J. (1985). Conditions of innovative behaviour in primates. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, Vol. 308, No. 1135, Animal Intelligence. (Feb. 13, 1985), pp. 203-214.

Marshall, J. T., and Marshall, E. R. (1976). Gibbons and their territorial songs. *Science* **193**: 235-237.

McGrew, W. C. (1992). *Chimpanzee material culture. Implications for human evolution*. Cambridge University Press, Cambridge, xvi+277 pp.

Milius, S. 1999. The search for animal inventors. How innovative are other species? Science News Online 155 (23, June 5, 1999). Downloadable from www.sciencenewsmagazine.org/pages/sn_arc99/6_5_99/bob2.htm

Moura, A. C. de A. (2007). Stone banging by wild capuchin monkeys: An unusual auditory display. *Folia Primatologica* **78**: 36-45.

Nakamichi, M. (1999). Spontaneous use of sticks as tools by captive gorillas (*Gorilla gorilla gorilla*). *Primates* **40:** 487-498.

Nakamichi, M. (2004). Tool-use and tool-making by captive, group-living orangutans (*Pongo pygmaeus abelii*) at an artificial termite mound. *Behavioural Processes* **65:** 87-93.

Osvath, M. (2009). Spontaneous planning for future stone throwing by a male chimpanzee. *Current Biology* **19** (5): R190-R191, Internet: www.cell.com/current-biology/abstract/S0960-9822(09)00547-8.

Peters, H. (2001). Tool use to modify calls by wild orang-utans. *Folia Primatologica* **72**: 242-244.

Rumbaugh, D. M. (1970). Learning skills in anthropoids. In Rosenblum, L. A. (ed.), *Primate behavior: Development in field and laboratory research, vol. 1*, Academic Press, New York and London, pp. 1-70.

St. Amant, R. and Horton, T. E. (2008). Revisiting the definition of animal tool use. *Animal Behaviour* **75**: 1199-1208.

Toth, N., Schick, K. E., Savage-Rumbaugh, E. S., Sevcik, R. A., and Rumbaugh, D. (1993). *Pan* the tool maker: Investigation into the stone tool-making and tool-using capabilities of a bonobo (*Pan paniscus*). *Journal of Archaeological Sciences* **20:** 81-91.

van Lawick-Goodall, J. (1965). New discoveries among Africa's chimpanzees. *National Geographic* **128** (6, Dec. 1965): 802-831.

van Lawick-Goodall, J. (1971). *In the shadow of man*. William Collins & Sons, London, 256 pp.

van Schaik, C. P., Fox, E., and Fechtman, L. T. (2003). Individual variation in the rate of tree-hole tools among wild orang-utans: Implications for hominin evolution. *Journal of Human Evolution* **44:** 11-23.

Visalberghi, E., Savage-Rumbaugh, S., and Fragaszy, D. M. (1995). Performance in a tool-using task by common chimpanzees (*Pan troglodytes*), bonobos (*Pan paniscus*), an orangutan (*Pongo pygmaeus*) and capuchin monkeys (*Cebus apella*). *Journal of Comparative Psychology* **109:** 52-60.

Whiten, A., Goodall, J., McGrew, W. C., Nishida, T., Reynolds, V., Sugiyama, Y., Tutin, C. E. G., Wrangham, R. W., and Boesch, C. (2001). Charting cultural variation in chimpanzees. *Behaviour* **138:** 1481-1516.

Zusammenfassung

Tür-Schmettern: Werkzeuggebrauch bei einem weiblichen Weisshandgibbon (*Hylobates lar*)

Gibbons begleiten oftmals ihre Morgengesänge mit spektakulären Bewegungsdisplays und gelegentlichem Schütteln oder Abbrechen von Ästen der Baumkronen. Diese Displays finden normalerweise im Höhepunkt des *great-calls* statt, der auffälligsten und am meisten stereotyp verlaufenden Strophe des Weibchens. In dieser Studie wird ein in einem Zoo le-

bendes Weisshandgibbon-Weibchen untersucht, welches sich zum Singen seiner *great-call*-Strophen in eine hölzerne Schlafbox setzte, die Schiebetür der Box halb zuschob und den Höhepunkt der *great-calls* damit unterstrich, dass es mit einem Knall die Schiebetür der Schlafbox aufwarf. Der Knall verlieh den tonalen Rufen dieser Strophe einen einzigartigen, geräuschhaften Akzent und dürfte die Wirkung des Rufes auf die Empfänger (vermutlich weibliche Artgenossen) verstärkt haben. Der Einsatz einer Schiebetür zur Veränderung der Rufe stellt eine neuartige Verhaltensvariante dar and einen der wenigen Fälle von Werkzeuggebrauch bei kleinen Menschenaffen. Verhaltensinnovationen wie diese dürften eine Rolle bei der Evolution menschlicher Musik gespielt haben.

Hormonal correlates of the ovarian cycle in the yellow-cheeked crested gibbon (*Nomascus gabriellae*), and a review of ovarian cycles in gibbons (Hylobatidae)

Thomas Geissmann[1] and Gustl Anzenberger[2]

[1] Anthropological Institute, University Zürich-Irchel, Winterthurerstr. 190, CH–8057 Zürich, Switzerland
E-mail: thomas.geissmann@aim.uzh.ch

[2] Psychological Institute, Biomathematical Section, University Zürich, Attenhoferstr. 9, CH-8032 Zürich, Switzerland, and Zoo de Mulhouse, 51 rue jardin zoologique, F-68100 Mulhouse, France

Ovarian cycles were determined for two captive females of the yellow-cheeked crested gibbon (*Nomascus gabriellae*) using urinary sex steroids. The mean cycle length was 21.1±1.2 days (n = 7 cycles). The interval between any peak in oestrone concentration and the corresponding oestradiol peak had a range of 0-1 days, and cycle lengths determined with oestrone differed from those determined with oestradiol by 0-2 days. Neither hormone tended to peak earlier than the other. In female 1, menarche probably occurred just before or around the beginning of the colour transition from the black juvenile to the adult yellow fur coloration, whereas the older female 2 apparently began to exhibit regular cycles during this study, years after changing to adult fur colouration. Mean cycle lengths determined in this study for *N. gabriellae* were virtually identical to those for those of other gibbons determined in previous studies applying endocrinological methods (*Hylobates* spp.: 20.0-25.4 days, *N. leucogenys*: 21.9, *Symphalangus syndactylus*: 21.8). These values are, in most cases, similar to intervals determined between peaks of sexual swellings. On the other hand, published cycle lengths based on intervals between menstrual bleedings or between copulations tend to be considerably longer. Because some cycles may easily remain undetected with the latter two methods, the resulting intervals may not be reliable indicators of the duration of menstrual cycles in gibbons. Cycles of gibbons appear to be shorter than those of other primates, apart from some – but not all – New World monkeys.

Introduction

Monitoring ovarian cycles is of considerable importance for managing breeding in captive primates. Most previous publications dealing with endocrinology of reproduction in gibbons (Hylobatidae) have referred to *Hylobates lar* (Barelli *et al.*, 2007; Czekala *et al.*, 1985; Nadler *et al.*, 1993) or other members of the genus *Hylobates*. These gibbons differ from gibbons of other genera in several respects, including body weight (*Hylobates*: c.5 kg, *Nomascus* and *Hoolock*: c.7-8 kg, *Symphalangus*: c.11 kg) (Geissmann, 1993, 1998). Therefore, information on the reproductive endocrinology of *H. lar* may not necessarily apply to gibbons of the other genera.

Crested gibbons (genus *Nomascus*) are all endangered or critically endangered in the wild by the IUCN's Red List assessment (Geissmann, 2007; IUCN, 2008), and captive populations of most species, including the yellow-cheeked crested gibbon (*N. gabriellae*), are very small (Geissmann, 1995a; Lernould, 1993; Moisson and Prieur, 2007). Information on the reproductive biology of this group is of pivotal importance for successful captive breeding.

The aims of the present study were to: (1) characterize the ovarian cycle by urinary sex steroid levels in the yellow-cheeked crested gibbon (*N. gabriellae*); (2) compare these hormonal cycles with those reported in the literature but determined using other methods; and (3) compare the ovarian cycles of the genus *Nomascus* to those of other gibbon genera.

Animals, materials and methods

Animals

Taxonomic treatment of the Hylobatidae follows Geissmann (2007). International Studbook numbers of study animals refer to Lernould (1993).

The following three females were included in this study:

Female 1 ("Robin", International Studbook No. 0122) was born on 15 Jul. 1981 at the Los Angeles Zoo (U.S.A.) (parents 0064 "Koo" x 0065 "Bahmetoo"). The adult female was loaned to Mulhouse Zoo (France) on 10 Jan. 1992, and, during 1993, was intermittedly paired there with an adult male ("Charlot", Fig. 1). By Feb. 1994 (the beginning of urine sampling), the female had been moved to the quarantine quarters of the Zoo Mulhouse waiting for her transfer to the Osnabrück Zoo. During the period

of urine sampling, the female was kept singly but adjacent to the also singly housed subadult male "Dorian" (*N. siki*, 0221). On 31 Jan. 1995, the female was transferred to Osnabrück Zoo (Germany), where she was paired with the adult male "Chang", starting on 8 Feb. 1995. Between 2 Jan. 1997 and 15 Oct. 1999, the pair had four offspring at Osnabrück, but none of them was reared. The pair was transferred to the Hannover Zoo (Germany) on 6 Sep. 2001.

Fig. 1. Female 1 ("Robin", right) and male "Charlot" (left) on 3 July 1993 at the Mulhouse Zoo. Photo: Thomas Geissmann. – *Das Weibchen "Robin" (rechts) mit Männchen "Charlot" im Zoo von Mulhouse am 3 Juli 1993*.

Female 2 ("Tsickó" or "Chicho", International Studbook No. 0158) was initially identified as *N. siki* based on unpublished karyological studies using the criteria proposed by Couturier *et al.* (1991) (Lernould, personal communication to TG) and was listed as *N. siki* in the studbook by Moisson and Baudier (2005). However, she is identified here as *N. gabriellae* on the basis of species-specific characteristics of fur coloration (described in Geissmann, 1994, 1995b; Geissmann *et al.* 2000) as documented during various stages of her development. This identification is further supported by the female's song vocalizations tape-recorded in Budapest, Osnabrück and Hannover (Geissmann, unpublished data) and mitochondrial DNA sequences from the control region which clearly group the female with *N. gabriellae* and not with *N. siki* (Geissmann and Kressirer, unpublished data).

Female 2 was kept solitary in adjacent indoor/outdoor cages at the Budapest Zoo (Hungary). Although visual contact was ruled out, the study animal could hear and probably smell another unrelated, solitary female *N. gabriellae* kept in a neighbouring cage (adut female 3 of this study, see below).

Female 2 was wild-born. She was imported from Vietnam and arrived at Budapest Zoo on 4 Nov. 1987. She exhibited a black fur coloration, and, based on photographs, she was estimated to be about 1.3 years old when she arrived in Budapest. By June 1993, her nipples had grown to adult size. After June 1993, the female began to change her fur colouration. At about the time of sexual maturity (at around 5-8 years of age), female gibbons of the genus *Nomascus* are known to lose the black fur colouration typical of juveniles and adopt the yellowish or buff coloration with black cap typical of adult females (Geissmann, 1993). In Oct. 1993, light fur became conspicuous above the study female's ears, in the shoulder area on the back, in the genital region and around the ischial callosities.

During the study (Jan.–May 1994), the female was of adult size, her canines appeared to be fully erupted, and she had an estimated age of 7.5-7.8 years. At the end of this study (on 8 May 1994), the female was about halfway through the transition from juvenile to adult fur colouration: Her back was light yellow-grey, but the ventrum, lower arms and lower legs were still dark grey (Fig. 2a). Her colour change was progressing rapidly (Fig. 2b) and by Sep. 1994, her fur was essentially yellow, only the upper (cranial) part of her ventrum was still dark grey.

After this study, the female was kept as a pair with an adult male *N. leucogenys* and produced several hybrid offspring, the first of which was born on 25 Dec. 1995. On 20 May 1997, the female was transferred to Nyíregyháza Zoo (Hungary), where she died on 30 May 1997.

Female 3 (Júska, International Studbook No. 0168) was wild-born, reportedly circa 1986 in Vietnam (Moisson and Baudier, 2005). She arrived at Moscow Zoo on 18 Feb. 1987 as a black juvenile and was named "Yuyu" there. Photographs made in Nov. 1988 show her with a light grey fur colouration, about halfway through the transition from juvenile to adult fur colouration (Fig. 3a). As this colour change should be expected to occur at a later age than two years, it is likely that her age at arrival in Moscow was underestimated and her birth date may have been closer to 1984 than to 1986. On 16 March 1991, the female was transferred to Budapest Zoo. The female was in the adult yellow coat on arrival in Budapest (Fig. 3b), where she was renamed "Júska" and kept solitary in the cage adjacent to that of female 2 (Tsickó). On 28 June 1994, she was transferred to Bojnice Zoo (Slovakia), on 11 Sep. 1996 to Bratislava Zoo (Slovakia), an on 12 June 2002 back to Bojnice. In Slovakia, the female was renamed "Jozefina" and successively paired with two males. Her only offspring was deadborn prematurely on 16 July 2005. The female suffered from chronic diarrhea and died of Crohn's disease in June 2008 (P. Luptak, personal comm. 30 Apr. 2009).

a  b 

Fig. 2. Female 2 ("Tsickó") at the Budapest Zoo on 8 May 1994 (a) and in June 1994 (b) showing rapidly progressing change of fur colouration when she was about 7 years old. Photos: Krisztina Vasarhelyi and Janos Tardi. – *Das Weibchen "Tsickó" im Zoo von Budapest durchlief im geschätzten Alter von 7 Jahren einen raschen Wechsel der Fellfärbung: (a) 8. Mai 1994, (b) Juni 1994*.

a  b 

Fig. 3. Female 3 ("Júska") during her change of fur colouration at the Moscow Zoo in Nov. 1988 (a) and in her adult coat at the Budapest Zoo on 13 June 1993 (b). Photos: Vladimir Spitsin and Krisztina Vasarhelyi. – *Das Weibchen "Júska" (a) während des Wechsels der Fellfärbung im Zoo von Moskau im November 1988 und (b) im gelben Erwachsenenkleid im Zoo von Budapest am 13. Juni 1993*.

During the period when urine sampling took place, study females 2 and 3 were kept in adjacent cages at Budapest Zoo. On 13 June 1993, while female 2 still was in the black juvenile coat, the zoo tried to keep both animals in the same cage. The older female 3 did not exhibit any aggression and appeared

to be calm. The younger female, however, immediately fled from the older one, crouched on the cage floor, appeared to be very frightened and continued to produce shrill alarm calls until the females were separated again.

Collection of Urine Samples

Urine samples from female 1 (Robin) at the Mulhouse Zoo were collected in intervals of two to four days from 4 Feb. to 14 June 1994 between 09:00 amd 11:00 h. Samples from females 2 and 3 (Tsickó and Júska) at Budapest Zoo were collected almost daily from 7 Jan. to 8 May 1994 between 07:30 and 07:55 h.

Urine samples were aspirated from the cage floor with disposable glass pipettes. The urine was transferred to 2 ml vials and frozen at –20°C until analysis.

Radioimmunoassay of Urinary Samples

Throughout the analysis, pipetting was done manually using glass constriction pipettes. Steroid conjugates were hydrolyzed by incubation of 100 µl of urine sample in 150 µl of Sörensen buffer (66.7 mM, pH 6.0) with 50 µl of enzyme solution (β-Glucuronidase / Arylsulfatase, EC 3.2.1.31 / EC 3.1.6.1; Boehringer Mannheim, Cat. No. 127.060; working dilution 1:20 in Sörensen buffer) in a water bath at 37°C for 14 hours. Based on pilot studies, 700 µl of PBS-Gel (0.1 % gelatine in 0.14 M NaCl, 0.01 M phosphate buffer, pH 7.0) were added to the original incubate to give 1000 µl of working solution with a final concentration of 100 µl of urine per 1,000 µl of diluents.

Oestradiol-17β was measured with a commercial radioimmunoassay (RIA) kit using an iodinated tracer and DCC-separation (Sorin Biomedica S.p.A., I-13040 Saluggia, Italy; distributed by Sodiag SA, Via Locarno 76, CH-6616 Losone, Switzerland; Cat. No. ER 155). Oestrone was determined with a commercial RIA kit using tritiated oestrone and DCC-separation (Api-Bio-Mérieux, 51 Avenue Blanc, CH-1202 Geneva, Switzerland; Cat. No. 66100).

Creatinine was measured in each urine sample to control for variation in liquid intake and its effects on urinary metabolite concentration, within and between study animals, and concentrations of urinary hormones were expressed as mass mg^{-1} creatinine. A Beckman Creatinine Analysor 2 (Beckman Instruments, Inc, Fullerton, CA) was used. All samples were diluted 1:20 prior to creatinine determination.

Results

Hormonal cycles of *Nomascus gabriellae*

Variations in oestrone and oestradiol levels were monitored over a period of 131 days for female 1 and 122 days for females 2 and 3 (Fig. 4). Only female 1 and 2 exhibited distinct cyclical patterns in the urinary concentrations of oestrone and oestradiol, showing a series of six periods of elevated hormone levels which can reasonably be considered to represent ovarian cycles. Individual peaks are clearly separated from each other by intervening phases of about two weeks with markedly lower hormone levels. No regular cycles were apparent in female 3.

The time interval between a peak in oestrone concentration and the corresponding oestradiol peak had a range of -1 to +1 days, and neither hormone tended to peak first.

The cycle length was calculated from the highest hormone concentration of a cyclical peak to that of the next. Female 1 did not exhibit clear and regular cycles during the first half of the study, but began cycling during the second half. Two cycles lengths could be determined, each of which had a duration of 22 days, independently of whether oestrone or oestradiol peaks were used as markers.

In female 1, peaks in oestrone and oestradiol concentrations coincided exactly, but this may be an artefact of the relatively long time intervals between urinary samples that were collected of this individual.

In female 2, cycle lengths determined with oestrone differed from those determined with oestradiol by a duration of 1-2 days. The mean cycle length for five complete oestrone cycles of female 2 was 20.8±1.3 days (range 19-22 days), and 21.2±1.3 days (range 20-23 days) in the corresponding oestradiol cycles.

If the results from females 1 and 2 are combined, the mean cycle length for seven complete oestrone cycles is 21.1±1.2 days (range 19-22 days), and 21.4±1.1 days (range 20-23 days) in the corresponding oestradiol cycles.

Although female 2 exhibited regular cycles and female 3 did not, oestrone levels of the two neighbouring females were correlated, and the relationship was statistically significant (Pearson correlation $r = 0.322$, $p < 0.005$). High oestrone levels of female 2 were often mirrored by female 3, but not necessarily *vice versa*. Urinary concentrations of two other hormones (oestradiol, testosterone) were not significantly correlated between the two individuals.

Comparison among studies

Table 1 summarizes data collected from various reports on the duration of menstrual cycles in gibbons. Many of the reported cycle lengths are based on observations of more-or-less periodical copulations between mated gibbons, menstrual bleedings, and genital swellings in females. Most of the observations listed in Table 1 refer to white-handed gibbons (*Hylobates lar*), or to other closely related species within the genus *Hylobates* (such as *H. albibarbis*, *H. moloch*, *H. muelleri* and *H. pileatus*). Only limited data are available for gibbon genera other than *Hylobates*.

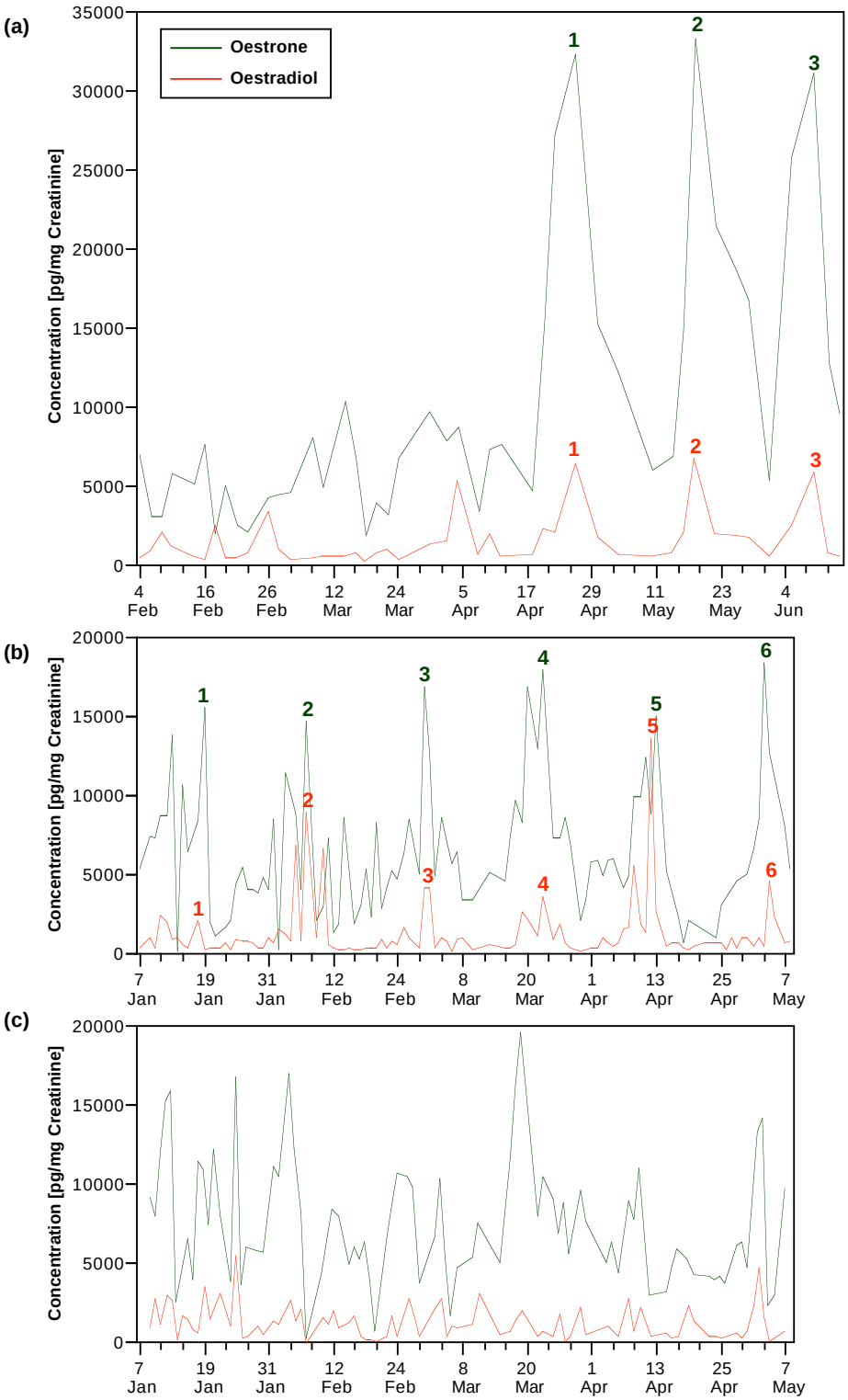

Fig. 4. Oestrone and oestradiol urinary levels in three female yellow-cheeked crested gibbons. Cyclical peaks in hormone concentrations are indicated by numbers. (a) Three consecutive cycles of adult female 1 ("Robin") during the second half of a period of 131 days. During the first two study months, no clear cycles are evident in this female. (b) Six consecutive cycles of maturing female 2 ("Tsickó") over a period of 122 days. (c) No regular cycles are apparent in adult female 3 ("Júska") over a period of 122 days. – *Konzentrationen von Östron- und Östradiol-Metaboliten im Urin bei drei weiblichen Gelbwangen-Schopfgibbons. Regelmässig wiederkehrende Spitzenwerte der Hormonkonzentrationen sind mit Ziffern gekennzeichnet. (a) Drei aufeinander folgende Zyklen des Weibchens "Robin", über einen Zeitraum von 65 Tagen. Während der ersten zwei Monate sind bei diesem Weibchen keine regelmässigen Zyklen erkennbar. (b) Sechs aufeinander folgende Zyklen des Weibchens "Tsickó", über einen Zeitraum von 122 Tagen. (c) Beim erwachsenen Weibchen "Júska" sind über einen Zeitraum von 122 Tagen keine regelmässigen Zyklen zu erkennen.*

Table 1. Ovarian cycle duration in gibbon females. – *Dauer des Ovulationszyklus bei Gibbonweibchen*.

Cycle duration (days)		Menses duration (days)	Sample size (*n*)		Monitored marker[1]	References
Mean ±SD	**Range**		**Females**	**Cycles**		
Hoolock						
H. hoolock						
27.8 ±4.1	20-33	2-4	1	6	B	Matthews (1946)
Hylobates						
H. albibarbis and H. muelleri						
23.8	–		17	?	S	Cheyne and Chivers (2006)
H. lar						
29.8 ±4.1	21-43	2-5	2	17	B	Carpenter (1941)
36.1 ±36.1	3-366	1.8±1.8 (1-26)	32	385	B	AFRIMS study 1968-1974 [2]
30.0	–		1	1	C	Ellefson (1974, p. 91)
30.0	22-44	1-3	20	?	B, S	Breznock *et al*. (1977)
22.0	–		?	?	H	Czekala *et al*. (1985)
?	23-33		3	12	H, S	Chaiyabutr and Maharrnop (1987)
21.2–22.0	15-25		4	36	S	Dahl and Nadler (1992b)
20.2 ±1.6	19-22		4	5	H, B, S	Nadler *et al*. (1993)[3]
21.0	15-27		5	c.100	S	Dahl *et al*. (cited in Nadler *et al*., 1993)
19.3 ±3.1	–		3	?	S	Ebert (1999)
21.1 ±0.5	19-25		5	15	B	Barelli *et al*. (2007)
20.7 ±5.1	15-27		5	6	H	Barelli *et al*. (2007)
H. moloch						
?	21-36	3	3	?	H, B, S	Maheshwari (2006), Maheshwari *et al*. (2005)
25.4 ±8.4	15-38		4	10	H	Hodgkiss (2007)
26.0 ±10.0	–		7	162	B	Hodgkiss (2007)
25.4 ±11.9	–		11	234	S	Hodgkiss (2007)
H. muelleri						
31.0	–		?	?	NS	Brody and Brody (1974)
H. pileatus						
?	21-30		?	?	B	Badham (1967)
26.1 ±12.9	6-70	2.1±1.1 (1-5)	1	60	B	AFRIMS study 1968-1974 [2]
21.1 ±0.8	–		1	7	H	Morikaku *et al*. (2006)
Hylobatidae spp.						
?	15-47		4	?	B	Muschamp (pers. comm. cited in Chivers, 1978)
Nomascus						
N. concolor						
25.6	19-72	1-3	1	71	B	Zhen (1989, and pers. comm. to TG)
N. gabriellae						
21.1 ±1.2	19-22		2	7	H	Geissmann and Anzenberger, this study
N. hainanus						
c.30.0	–	2-3	1	?	B	Pocock (1905)
N. nasutus						
30.0	–		?	?	NS	Le (1973, cited in Dao Van Tien, 1993)
45.0	41-49	3-5	1	2	B	Fischer (1980)
N. leucogenys						
23.8	16-37		1	19	B	Bachmann and Sodaro (2000)
21.9 ±2.9	12-27		1	38	H	Lukas *et al*. (2002)
Symphalangus						
S. syndactylus						
21.8 ±4.4	19-34	1-2	1	12	H, B	Knott (pers. comm. to TG), Knott *et al*. (1993)
c.28.0	–		?	?	B	Von Hegel (pers. comm. cited in Orgeldinger, 1989, p. 229)
?	42-49		1		C	Alberts (1983)

[1] B = Menstrual bleeding; H = Hormonal data; C = Copulations; S = Genital swellings; NS = not specified.

[2] Mean and standard deviation were calculated by one of us (TG) from published individual values of of a long-term study carried out at the Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand (AFRIMS). The original data were published in Vick *et al*. (1968), Chaicumpa *et al*. (1969), Johnsen *et al*. (1970), and Tingpalapong *et al*. (1971, 1973, 1974). One individual (B-85) of the study animals was reported to be *H. pileatus*.

[3] Means and standard deviations were calculated from published individual values in Table 1 of Nadler *et al*. (1993).

Table 2. Comparison of mean average ovarian cycle durations in gibbons determined with different markers (summarizing data from Table 1). – *Vergleich der mit verschiedenen Methoden bestimmten durchschnittlichen Dauer des Ovulationszyklus bei Gibbonweibchen (Zusammenfassung der Mittelwerte aus Tabelle 1)*.

Monitored marker [1]	Cycle duration (days) Mean ±SD	SE	Range of means	Number of studies	References
H	21.7 ±1.5	0.5	20.0-25.4	9	Barelli *et al*. (2007); Chaiyabutr and Maharrnop (1987); Czekala *et al*. (1985); Geissmann and Anzenberger (this study); Hodgkiss (2007); Lukas *et al*. (2002); Morikaku *et al*. (2006); Nadler *et al*. (1993); Knott (pers. comm. to TG), Knott *et al*. (1993)
S	23.5 ±3.8	1.6	19.3-30.0	6	Breznock *et al*. (1977), Cheyne and Chivers (2006); Dahl and Nadler (1992b); Dahl *et al*. (cited in Nadler *et al*., 1993); Ebert (1999); Hodgkiss (2007)
C	30.0	–	–	1	Ellefson (1974, p. 91)
B	29.8 ±6.3	1.9	23.8-45.0	10	AFRIMS studies 1968-1974[2], Bachmann and Sodaro (2000); Carpenter (1941); Fischer (1980); Hodgkiss (2007); Matthews (1946); Pocock (1905); Von Hegel (pers. comm. cited in Orgeldinger, 1989, p. 229); Zhen (1989, and pers. comm. to TG)
NS	30.5	–	30.0-31.0	2	Brody and Brody (1974); Le (1973, cited in Dao Van Tien, 1993)

[1] B = Menstrual bleeding; H = Hormonal data; C = Copulations; S = Genital swellings; NS = not specified.

[2] Mean and standard deviation were calculated by one of us (TG) from published individual values of of a long-term study carried out at the Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand (AFRIMS). The original data were published in Vick *et al.* (1968), Chaicumpa *et al*. (1969), Johnsen *et al*. (1970), and Tingpalapong *et al.* (1971, 1973, 1974).

Table 2 summarises average cycle durations in gibbons determined with different markers. Mean values of studies applying endocrinological methods (hormonal data) are lowest, and values based on genital swellings are only slightly higher. Values based on other markers (menstrual bleeding or copulations) are much higher. A statistical comparison of all studies listed in Table 2 using ANOVA revealed statistically significant differences among the markers ($df = 4$, $p = 0.004$). A *post-hoc* test revealed a significant difference between the markers menstrual bleedings and hormone data (Bonferroni-Dunn, $p = 0.0006$). A simple comparison between mean values based on hormone concentrations and all other mean values also found a significant difference (Mann-Whitney *U*-test, $p = 0.007$).

Discussion

This study presents the first data on the ovarian cycle of the yellow-cheeked crested gibbon (*Nomascus gabriellae*). Most previous publications on menstrual cycles in crested gibbons (genus *Nomascus*) either determined cycle length by using intervals between menstrual bleedings (Fischer, 1980; Pocock, 1905; Zhen, 1989) or did not mention the method by which cycle length was assessed (Le, 1973, cited in Dao Van Tien, 1993). In these publications, average cycle duration was reported to be 25.6 or 30 days (Le, 1973, cited in Dao Van Tien, 1993; Pocock, 1905; Zhen, 1989) or ranging from 41 to 49 days (Fischer, 1980). In the only previous study on the hormonal cycle length of *Nomascus* (Lukas *et al*., 2002), a duration of 21.9±2.9 was determined for one white-cheeked crested gibbon (*N. leucogenys*). A virtually identical hormonal cycle length of 21.1±1.2 days was determined for two females of *N. gabriellae* in the present study, suggesting that the ovarian cycle of the genus *Nomascus* is much shorter than indicated by earlier studies using markers other than endocrinological values.

Similar to the situation in crested gibbons (genus *Nomascus*), previously published data on the duration of menstrual cycles in other gibbon genera show a broad range (Table 1). Although most values range between 20 and 40 days, maximum values of up to 49 days have been reported. It is noteworthy that most mean values greater than 22 days are based either on observations of menstrual bleedings or on copulations. The only study that found longer hormonal cycles in a gibbon species reported an average of 25.4±8.4 days for four females of the Javan silvery gibbon (*Hylobates moloch*), including some unusually long cycles of up to 38 days (Hodgkiss, 2007) which seem to be outliers and need further explanantion.

A statistical comparison reveals that cycles based on hormonal data are significantly shorter than the pooled cycle data based on other markers and shorter than cycles based on menstrual bleedings. The reason for this discrepancy is that monitoring of menstrual bleedings or copulations may not yield sufficiently reliable estimates of cycle length.

Monitoring gibbon copulations is particularly problematic: copulations are short and easily escape detection if a pair is not under daily observation from dawn to dusk. Furthermore, the possibility remains that some copulations may even occur during the

night. This may explain why very long cycles may be determined when using this marker.

If menstrual bleedings are monitored, some cycles may also remain undetected: Breznock *et al*. (1977) reported that the character of menstrual flow, lasting 24-72 hours in *H. lar*, was very variable and "ranged from an overt flow of blood to an amount visualized only with the aid of a cotton swab". After having monitored over 20 individuals of *H. lar*, Tingpalapong *et al*. (1971) noted that "the degree of variation in the length of the menstrual cycle … confirms previous observations that regularity in the gibbon is a yet to be discovered exception to the rule that the gibbon has a completely irregular menstrual cycle." After another year of daily observation and vaginal swabbing of 11 of these gibbons, Tingpalapong *et al*. (1973) wrote that "in nearly all animals, periods of amenorrhea two or three months in duration or longer were noted". In *H. albibarbis* and *H. muelleri*, menstrual bleeding was observed only rarely (1% of observations) (Cheyne and Chivers, 2006). In a study of the ovarian cycle of *H. moloch*, Hodgkiss (2007) determined the cycle length based on sexual swellings in all 11 study animals, but only in seven of them could cycle length be determined based on menstrual bleeding – in the remaining four individuals, this marker was not observed at all or was not observed regularly enough. In order to limit the high variability of their results when using genital swellings or menstrual bleedings as markers, Hodgkiss (2007, p. 19) ignored all intervals that were shorter than seven days or longer than 60 days.

Gibbons have been reported to exhibit cyclical swellings of vulval tissues. Although the degree of these genital swellings shows considerable individual variation, the average pattern indicates a significant level of swelling for 6.3 days on average (range 4–8 days) (Cheyne and Chivers, 2006; see also Barelli *et al*., 2007; Breznock *et al*., 1977; Carpenter, 1941; Dahl and Nadler, 1992a, b; Kollias and Kawakami, 1981; Nadler *et al*., 1993). In two studies on *H. lar*, genital swellings were found to reach their maxima in association with mid-cycle peaks in oestrogens and with ovulation, and appeared to be a useful marker for monitoring progress of the menstrual cycle (Barelli *et al*., 2007; Nadler *et al*., 1993). In a study of *H. moloch*, however, the sexual swellings of four females did not coincide with the fertile periods (Hodgkiss, 2007, p. 50).

In summary, ovarian cycles determined with hormonal data appear to produce more homogenous results than cycles based on other markers. Results of the present study, combined with those of Lukas *et al*. (2002) suggest an ovarian cycle in crested gibbons (genus *Nomascus*) of 20-22 days on average ($n = 3$ individuals). A study on hormonal cycles of one siamang female (*Symphalangus syndactylus*) also found an average cycle length of about 22 days (Knott *et al*., 1993; Knott, personal communication to TG). Most endocrinological studies on gibbon ovarian cycles have been conducted on the genus *Hylobates*. In *H. lar* ($n = 10+$ females), average cycles lengths were reported to range from 19-25, with a mean of 21 days (Barelli *et al*., 2007; Czekala *et al*., 1985; Nadler *et al*., 1993). The hormonal cycle length of one *H. pileatus* was found to be 21.1 days on average (Morikaku *et al*., 2006). Only the results for *H. moloch* appear to be less uniform. Maheshwari (2006) found averages of 21-24 ($n = 3$ females), which appears to conform to the results of the other studies discussed here, but the results of a second study (Hodgkiss, 2007) exhibit a surprisingly wide range (15-38 days) with a relatively high average of 25.4 days ($n = 4$ females). In general, however, hormonal cycles in gibbons appear to average around 20-22 days.

Interestingly, the cycles of gibbons are apparently shorter than those of other Old World monkeys and great apes, which reportedly range from 25-40 days. They are also shorter than those of many other primates including most strepsirrhines (29-50 days) and tarsiers (24 days). Only some – but not all – New World monkeys (7-36 days) appear to have cycles which are as short as, or distinctly shorter than, those of gibbons (Barelli *et al*., 2007; Dixson, 1998; Hrdy and Whitten, 1987; Martin, 1990; Robinson and Goy, 1986; van Schaik *et al*., 1999).

Although the adaptive significance of this finding is poorly understood, the duration of the follicular phase has been reported to be the main source of variability and diversity of ovarian cycle length among catarrhine primates (Old World monkeys and apes) (van Schaik *et al*., 2000). It has also been suggested, that long follicular phases in primates may be a female adaptation to confuse paternity and thus reduce the risk of infanticide (van Schaik *et al*., 2000). This would be particularly adaptive in those primates where females have a high need for paternity manipulation, i.e. in females that live in groups with several males and that are subject to high sexual coercion. Sexual coercion is particularly high in species with high sexual dimorphism in body weights and canine dimensions (van Schaik *et al*., 2000). None of these criteria apply to gibbons, where both sexes are almost identical in body weights and canine dimensions, where the mean number of mates per cycle is very low, and where females have total control over their mating behaviour. As a result, there should be little need for paternity confusion in gibbons, and their follicular phase – and thus their ovarian cycle – should be expected to be shorter than that of other catarrhine primates, which is exactly what we find.

Although the paternity confusion hypothesis described above provides a plausible explanation for why the ovarian cycles of gibbons are shorter than those of other catarrhine primates, the explanation does not appear to be comprehensive. According to the hypothesis, the shortness of the gibbon cycle results from the short duration of the follicular phase, whereas the luteal phase should be similar to that of other catarrhines. However, in a comparison of female reproductive hormone patterns among hominoids (apes and humans), Czekala *et al*. (1988) noticed that the duration of the luteal phase is similar in

most species with the exception of the gibbon, in which it is abbreviated. In catarrhines, the average duration of the follicular and luteal phases are 14.99±3.37 days and 14.94±1.58 days, respectively (van Schaik *et al.*, 2000, p. 374). Based on previously published data (Barelli *et al.*, 2007, Czekala *et al.*, 1985; Hodges *et al.*, cited in van Schaik *et al.*, 2000, p. 382, and Hodgkiss, 2007), we calculate an average duration of the follicular phase in gibbons of 11.91±4.02 days, and of the luteal phase of 9.48±2.01 days (Table 3). A comparison reveals that the average follicular phase in gibbons is about 3.1 days shorter, and the luteal phase is 5.5 days shorter than the respective values of catarrhines. Whereas the difference in the follicular phase is predicted by the paternity confusion hypothesis, the apparently more pronounced difference in the luteal phase is not. We conclude that the paternity confusion hypothesis does not fully explain the shortness of the gibbon ovarian cycle. Other (as yet unidentified) factors appear to be involved.

Table 3. Published durations of the follicular and luteal phases in gibbon ovarian cycles. For comparison, average values for catarrhine primates are provided in the last row. – *Literaturwerte für die Dauer der follikulären und der lutealen Phase in den Ovulationszyklen von Gibbons. Vergleichswerte für catarrhine Primate (Altweltaffen und Menschenaffen) sind in der letzten Tabellenzeile eingetragen*.

Species	Follicular phase (days)			Luteal phase (days)			Sample size (*n*) cycles/ females	Reference
	Mean	SD	Range	Mean	SD	Range		
Unknown species	8.4							Hodges *et al.*, cited in van Schaik *et al.* (2000, p. 382)
Unknown species			11-14			10-11	10/1	Lasley *et al.* (1984), cited in Hayssen *et al.* (1993, p. 222)
Hylobates lar	13.0			9.0				Czekala *et al.* (1985)
H. lar						9-10	12/3	Chaiyabutr and Maharrnop (1987)
H. lar	9.2	2.4	7-13	11.8	3.1	8-15	6/4	Nadler *et al.* (1993)[1]
H. lar	10.6	3.44	5-18	10.1	1.98	6-14	9/5	Barelli *et al.* (2007)
H. moloch			11-18			8-48	?/3	Maheshwari *et al.* (2005)
H. moloch	18.4	7.09	9-28	7.0	1.89	4-10	10/4	Hodgkiss (2007)
Hylobatidae mean	11.91	4.02		9.48	2.01			
Catarrhines mean	14.99	3.37		14.94	1.58			Hodges *et al.*, cited in van Schaik *et al.* (2000, p. 374)

[1] Means and standard deviations were calculated by one of us (TG) from published individual values in Table 1 of Nadler *et al.* (1993, p. 452).

It may be interesting to note that the three females of this study considerably differed in the expression of the ovarian cycles. Female 1 (12.4 years old at the beginning of this study) exhibited regular hormonal cycles only during the second half of this study. Female 2, the youngest of the study animals and estimated here to be about 7.5 years old at the beginning of this study, exhibited regular hormonal cycles throughout the study period. Female 3, estimated here to be about 10 years old at the beginning of the study, did not exhibit a regular cyclic pattern in her urinary hormone concentrations during the study period. As female 3 was clearly dominant over female 2, it is unlikely that her cycles were somehow suppressed by the presence of female 2 in the neighbouring cage. In any case, it appears that the age at which cycling begins in crested gibbons may exhibit considerable variability, and the reasons for this may be manifold. At the same time, a female might cease ovarian activity even after having undergone the normal process of menarche during ontogeny.

At the age of about 5-8 years, females of the genus *Nomascus* change their fur coloration from black to light yellow or buff and adopt the coloration typical of adult females (Geissmann, 1993; Geissmann *et al.*, 2000). These colour changes have been equated with the onset of sexual maturity by Delacour (1951), but were also found to be very variable by Deputte and Leclerc-Cassan (1981). The variability of the onset and the duration of colour transition still remain to be documented in females whose ages are known precisely. It is therefore interesting to note that female 2 of this study exhibited constant cycles, although she had not fully completed her colour change at the end of the study, suggesting that menarche probably set in before or near the beginning of the colour transition. The opposite order of events seems to have occurred in female 1. The exact timing of her colour change is not known, but she was already in her adult coat when she arrived at Mulhouse Zoo (i.e. more than two years before the observed onset of her regular hormonal cycles).

The oestrone levels of females 2 and 3 (kept in neighbouring cages) show a statistically significant correlation, although only one of the two females exhibited clear cycles. It is tempting to speculate that gibbon females living in close proximity may influence each other's ovarian cycles, but much better data would be required to test such a hypothesis. Ovarian cycle synchrony among group-living females has

been reported in several mammalian species, especially primates (McClintock, 1971, 1984; Wallis, 1985) and has been suggested to be mediated by female-female olfactory signalling (McClintock, 1978, 1984; Russell *et al*., 1980). However, re-examination the evidence for synchrony revealed that many reports of synchrony were spurious, resulting from systematic methodological errors and biases in the measurement and statistical analyses of synchrony (Schank, 2001; Yang and Schank, 2006).

Conclusions

1. The mean cycle lengths for seven complete oestrone cycles in two female *N. gabriellae* are 21.1±1.2 days (range 19-22 days).

2. The time interval between a peak in oestrone concentration and the corresponding oestradiol peak had a range of 0-1 days, and cycle lengths determined with oestrone differed from those determined with oestradiol by a duration of 0-2 days. Neither hormone tended to peak earlier than the other.

3. In study female 2, menarche must have set in at or before the beginning of the colour transition from the black juvenile to the adult light fur coloration, whereas the opposite order may have occurred in study female 1.

4. The average hormonal cycle lengths of *N. gabriellae* (21 days, this study) are nearly identical with most hormonal cycle lengths determined for other gibbons (including one *N. leucogenys*, one *S. syndactylus*, and individuals of several species of the genus *Hylobates*). The typical average duration of ovarian cycles in gibbons appears to be 20-22 days.

5. Cycle lengths based on sexual swellings are usually similar to those based on sex hormone concentrations.

6. Cycle lengths based on hormonal data are often considerably shorter than those based on intervals between menstrual bleedings or between copulations. The latter two may not be reliable indicators of menstrual cycle duration, because some cycles may easily remain undetected with these methods.

7. Gibbon cycles are apparently shorter than those of other primates, with the exception of some – but not all – New World monkeys.

Acknowledgements

The studies have been initiated and supervised independently by TG (Budapest Zoo) and GA (Zoo de Mulhouse). Photographs of the study animals at various stages of their development were kindly provided by György Kapocsy, Thomas Kovacs, Ute Rathfelder, Vladimir Spitsin, Janos Tardi, and Krisztina Vasarhelyi. Peter Luptak supplied information on the later history of our study female "Júska". We thank Janos Tardi, Katja Schlegel, Krisztina Vasarhelyi, and Ilma Bogsch for their help in the collecting of the urine samples in Budapest Zoo, as well as Katja Schlegel and the animal keepers in Mulhouse Zoo. Max Döbeli, kindly enough, conducted, the radioimmunoassays. We are grateful to Cheryl D. Knott for generously giving permission to use her unpublished data on hormonal cycles in *Symphalangus syndactylus*. We are particularly indebted to Robert D. Martin, Jacob E. Steiner and Chris R. Pryce for reading and commenting upon earlier versions of this manuscript. This study was financially supported by the Anthropological Institute, University of Zürich-Irchel (to TG), and the Psychological Institute, University Zürich (to GA).

References

Alberts, S. (1983). *Parenting and infant development in captive siamang (*Symphalangus syndactylus*)*, Honor's thesis, Reed College, Portland, Oregon, vi+83 pp.

Bachmann, J., and Sodaro, C. (2001). Birth management of a pair of white-cheeked gibbons at Brookfield Zoo. In Chicago Zoological Society (ed.), *The apes: Challenges for the 21st century. Brookfield Zoo, May 10-13, 2000, Conference Proceedings*, Chicago Zoological Society, Brookfield, Illinois, U.S.A., pp. 96-98.

Badham, M. (1967). A note on breeding the pileated gibbon (*Hylobates lar pileatus*) at Twycross Zoo. *International Zoo Yearbook* **7**: 92-93.

Barelli, C., Heistermann, M., Boesch, C., and Reichard, U. H. (2007). Sexual swellings in wild white-handed gibbon females (*Hylobates lar*) indicate the probability of ovulation. *Hormones and Behavior* **51**: 221-230.

Breznock, A. W., Harrold, J. B., and Kawakami, T. G. (1977). Successful breeding of the laboratory-housed gibbon (*Hylobates lar*). *Laboratory Animal Science* **27**: 222-228.

Brody, E. J., and Brody, A. E. (1974). Breeding Müller's Bornean gibbon, *Hylobates lar muelleri*. *International Zoo Yearbook* **14**: 110-113.

Carpenter, C. R. (1941). The menstrual cycle and body temperature in two gibbons (*Hylobates lar*). *Anatomical Record* **79**: 291-296.

Chaicumpa, V., Johnsen, D. O., Pulliam, J. D., and Tanticharoenyos, P. (1969). Gibbon menstrual cycle and breeding. *Annual Progress Report, Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand* **April 1968 to March 1969**: 200-204.

Chaiyabutr, N., and Maharrnop, A. (1987). Ovarian hormone patterns in peripheral plasma and genital swelling during the menstrual cycle of white-handed gibbons, *Hylobates lar lar*. *International Journal of Primatology* **8**: 486 (Abstract only).

Cheyne, S. M., and Chivers, D. J. (2006). Sexual swellings of female gibbons. *Folia Primatologica* **77**: 345-352.

Chivers, D. J. (1978). Sexual behavior of wild siamang. In Chivers, D. J., and Herbert, J. (eds.), *Recent advances in primatology, vol. 1: Behaviour*, Academic Press, London and New York, pp. 609-610.

Couturier, J., and Lernould, J.-M. (1991). Karyotypic study of four gibbon forms provisionally considered as subspecies of *Hylobates* (*Nomascus*) *concolor* (Primates, Hylobatidae). *Folia Primatologica* **56**: 95-104.

Czekala, N. M., Shideler, S. E., and Lasley, B. L. (1985). A comparison of hominoid female reproductive physiology. *American Journal of Physical Anthropology* **66**: 161-162 (Abstract only).

Czekala, N. M., Shideler, S. E., and Lasley, B. L. (1988). Comparisons of female reproductive hormone patterns in the hominoids. In Schwartz, J. H. (ed.), *Orang-utan biology*, Oxford University Press, New York and Oxford, pp. 117-122.

Dahl, J. F., and Nadler, R. D. (1992a). Genital swelling in females of the monogamous gibbon, *Hylobates* (*H.*) *lar*. *American Journal of Physical Anthropology* **89**: 101-108.

Dahl, J. F., and Nadler, R. D. (1992b). The external genitalia of female gibbons, *Hylobates* (*H.*) *lar*. *Anatomical Record* **232**: 572-578.

Dao Van Tien (1993). Écologie et éthologie du gibbon de Hainan (*Hylobates concolor hainanus*, Primates, Hylobatidae) au Vietnam. In Lernould, J.-M. (ed.), *International studbook: Hylobates concolor (Harlan, 1826) 1990, 1st edition*, Parc Zoologique et Botanique, Mulhouse, pp. 35-50.

Delacour, J. (1951). Les gibbons. *Science et Nature* **1951**: 3-12.

Deputte, B. L., and Leclerc-Cassan, M. (1981). Sex determination and age estimation in the white-cheeked gibbon *Hylobates concolor leucogenys*. Anatomical and behavioural features. *International Zoo Yearbook* **21**: 187-193.

Dixson, A. F. (1998) *Primate sexuality. Comparative studies of the prosimians, monkeys, apes, and human beings*. Oxford University Press, Oxford, New York, and Tokyo, xiv+546 pp.

Ebert, J. (1999). *Paarungsverhalten weiblicher Weisshandgibbons (*Hylobates lar*)*, Diploma thesis, Fachbereich Biologie, Chemie, Pharmazie, Freie Universität Berlin, Berlin, iii+125 pp.

Ellefson, J. O. (1974). A natural history of white-handed gibbons in the Malayan Peninsula. In Rumbaugh, D. M. (ed.), *Gibbon and siamang, vol. 3*, Karger, Basel and New York, pp. 1-136.

Fischer, W. (1980). Einige Ergänzungen zur Haltung und Entwicklung des Schopfgibbons, *Hylobates* (*Nomascus*) *concolor* (Harlan). *Milu, Berlin* **5**(1/2): 167-193.

Geissmann, T. (1993). *Evolution of communication in gibbons (Hylobatidae)*, Ph.D. thesis, Anthropological Institute, Philosoph. Faculty II, Zürich University. 374 pp.

Geissmann, T. (1994). Systematik der Gibbons. *Zeitschrift des Kölner Zoo* **37**: 65-77 (German text, English abstract).

Geissmann, T. (1995a). Captive management and conservation of gibbons in China and Vietnam, with special reference to crested gibbons (*Hylobates concolor* group). *Primate Report* **42**: 29-41.

Geissmann, T. (1995b). Gibbon systematics and species identification. *International Zoo News* **42**: 467-501.

Geissmann, T. (1998). Body weight in wild gibbons (Hylobatidae). In, *Abstracts, XVIIth Congress of the International Primatological Society, August 10-14, 1998, abstract no. 282*, University of Antananarivo, Madagascar.

Geissmann, T. (2007). Status reassessment of the gibbons: Results of the Asian Primate Red List Workshop 2006. *Gibbon Journal* **3**: 5-15.

Geissmann, T., Nguyen Xuan Dang, Lormée, N., and Momberg, F. (2000). *Vietnam primate conservation status review 2000 - Part 1: Gibbons (English edition)*, Fauna & Flora International, Indochina Programme, Hanoi. 130 pp.

Hayssen, V., van Tienhoven, A., and Tienhoven, A. (1993). *Asdell's patterns of mammalian reproduction. A compendium of species-specific data*. Comstock Publishing Associates, Ithaca and London, viii+1023 pp.

Hodgkiss, S. (2007). *Characterising the physical and hormonal correlates of the ovarian cycle in female Javan gibbons (*Hylobates moloch*)*, MSc thesis in Primate Conservation, Oxford Brookes University, U.K., x+66 pp.

Hrdy S. B., and Whitten, P. L. (1987). Patterning of sexual activity. In Smutts, B. B., Cheney, D. L., Seyfarth, R. M., Wrangham, R. W., and Struhsaker, T. T. (eds.), *Primate societies*, Chicago, Illinois, University of Chicago Press, p. 370-384.

IUCN (2008). *2008 IUCN Red List of Threatened Species*. <www.iucnredlist.org>. Downloaded on 10 February 2009.

Johnsen, D. O., Tingpalapong, M., Chaicumpa, V., Hickman, R. L., Tanticharoenyos, P., and Wooding, W. L. (1970). Gibbon menstrual cycle and breeding study. *Annual Progress Report, Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand* **April 1969 to March 1970**: 210-215.

Knott, C. D., Rogers, R., and Czekala, N. M. (1993). Hormonal profiles of the captive siamang (*Hylobates syndactylus*). *American Journal of Physical Anthropology* **Supplement 16**: 126-127 (Abstract only).

Kollias, G. V., Jr., and Kawakami, T. G. (1981). Factors contributing to the successful captive reproduction of white-handed gibbons (*Hylobates lar*). *American Association of Zoo Veterinarians Annual Proceedings* **1981**: 45-47.

Lernould, J.-M. (1993). *International studbook:* Hylobates concolor *(Harlan, 1826) 1990, 1st edition*, Parc Zoologique et Botanique, Mulhouse, 127 pp.

Lukas, K. E., Barkauskas, R. T., Maher, S. A., Jacobs, B. A., Bauman, J. E., Henderson, A. J., and Calcagno, J. M. (2002). Longitudinal study of delayed reproductive success in a pair of white-cheeked gibbon (*Hylobates leucogenys*). *Zoo Biology* **21**: 413-434.

Maheshwari, H., Toelihere, M. R., Wijayakusuma, R., Sajuthi, D., Alikodra, H. S., Purwantara, B., Sjahfirdi, L., Astuti, P., Hodges, K., Heistermann, M. (2005). Urinary steroid and genital swelling during the ovarian cycle of the captived Javan gibbons (*Hylobates moloch*). *19th Annual Meeting of the Society for Conservation Biology, Book of Abstracts*. Universidade de Brasília, Brasília, DF, Brazil, 15-19 July 2005, p. 123.

Maheshwari, H. (2006). *Pengembangan teknik pengukuran metabolit steroid untuk monitoring status reproduksi Owa Jawa (*Hylobates moloch*) sebagai upaya pelestarian satwa terancam punah*, Pusat Penelitian Sumberdaya Hayati & Bioteknologi – LPPM, Bogor Agricultural University, Bogor. [Indonesian language]. Internet: http://web.ipb.ac.id/~lppm/EN/index.php?view=research/hasilcari&status=buka&id_haslit=HB/021.06/MAH/p

Martin, R. D. (1990). *Primate origins and evolution: A phylogenetic reconstruction*, Chapman and Hall, London, xiv+804 p.

Matthews, L. H. (1946). Notes on the genital anatomy and physiology of the gibbon (*Hylobates*). *Proceedings of the Zoological Society, London* **116**: 339-364.

McClintock, M. K. (1971). Menstrual synchrony and suppression. *Nature* **229**: 244-245.

McClintock, M. K. (1978). Estrous synchrony and its mediation by airborne chemical communication (*Rattus norvegicus*). *Hormones and Behavior* **10**: 264-276.

McClintock, M. K. (1984). Estrous synchrony: Modulation of ovarian cycle length by female pheromones. *Physiology and Behavior* **32**: 701-705.

Moisson, P., and Baudier, F. (2005). *European studbook Number 1 (data 31.12.2004): Northern white-cheeked gibbon* - Nomascus leucogenys, *southern white-cheeked gibbon* - Nomascus siki, *red-cheeked gibbon* - Nomascus gabriellae, Zoo Mulhouse, Mulhouse, Sud-Alsace, 71 pp.

Moisson, P., and Prieur, C. (2007). *European studbook Number 3 (data 31.12.2007): Northern white-cheeked gibbon* – Nomascus leucogenys, *southern white-cheeked gibbon* – Nomascus siki, *red-cheeked gibbon* – Nomascus gabriellae, Zoo Mulhouse, Mulhouse, Sud-Alsace, 54 pp.

Morikaku, K., Somura, H., Kusuda, S., Kawanishi, T., Arai, K., Ogawa, E., Ogimura, A., Yamaji, Y., Ishikawa, S., Iwamoto, C., Endo, H., Date, M. (2006). Changes in urinary gonadal steroid hormone concentrations in pileated gibbon, *Hylobates pileatus* conceived by artificial insemination. In *Joint International Symposium of the 12th Annual Meeting of the Japanese Society of Zoo and Wildlife Medicine and the 21st Century COE Program of Gifu University – Evaluation of environmental condition based on ecology and pathology of wild animals, 25-28 Sep. 2006, Gifu, Japan*, pp. 110-111 (Abstract only).

Nadler, R. D., Dahl, J. F., and Collins, D. C. (1993). Serum and urinary concentrations of sex hormones and genital swelling during the menstrual cycle of the gibbon. *Journal of Endocrinology* **136**: 447-455.

Orgeldinger, M. (1989). *Untersuchungen zum Verhalten von Siamangs (*Hylobates syndactylus, *Raffles 1821) in zoologischen Gärten unter besonderer Berücksichtigung des Sozialverhaltens*, Diploma thesis, Fakultät für Biologie, Ruprecht-Karls-Universität Heidelberg. x+417 pp.

Pocock, R. I. (1905). Observations upon a female specimen of the Hainan gibbon (*Hylobates hainanus*), now living in the Society's Gardens. *Proceedings of the Zoological Society, London* **1905**(2): 169-180, + 1 plate.

Robinson, J. A., and Goy, W. R. (1986). Steroid hormones and the ovarian cycle. In: Dukelow, W. R., and Erwin, J. (eds.) *Comparative primate biology, volume 3: Reproduction and development*, Alan R. Liss, Inc., New York, pp. 63-91.

Russell, M. J., Switz, G. M., and Thompson, K. (1980). Olfactory influences on the human menstrual cycle. *Pharmacology Biochemistry and Behavior* **13**: 737- 738.

Schank, J. C. (2001). Measurement and cycle variability: Reexamining the case for ovarian-cycle synchrony in primates. *Behavioral Processes* **56**: 131-146.

Tingpalapong, M., Hickman, R. L., Johnsen, D. O., and Tanticharoenyos, P. (1971). Gibbon menstrual cycle and breeding study. *Annual Progress Report, Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand* **April 1970 to March 1971**: 175-176.

Tingpalapong, M., Rozmiarek, H., Johnsen, D. O., Tanticharoenyos, P., and Davidson, D. E. (1973). Studies on the growth, development and reproduction of gibbons in captivity. *Annual Progress Report, Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand* **April 1972 to March 1973**: 164-166.

Tingpalapong, M., Rozmiarek, H., Davidson, D. E., and Tanticharoenyos, P. (1974). Gibbon menstrual cycle and breeding study. *Annual Progress Report, Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand* **April 1973 to March 1974**: 212-215.

van Schaik, C. P.; van Noordwijk, M. A., and Nunn, C. L. (1999): Comparative primate socioecology. In Lee, P. C. (ed.), *Sex and social evolution in primates*, Cambridge University Press, Cambridge, pp. 204-240.

van Schaik, C. P., Hodges, J. K., and Nunn, C. L. (2000). Paternity confusion and the ovarian cycles of female primates. In van Schaik, C. P., and Janson, C. H. (eds.), *Infanticide by males and its implications*, Cambridge University Press, Cambridge, pp. 361-387.

Vick, W. E., Buchanan, R. D., Pulliam, J. D., Iber, P. K., Stanton, J. S., and Tanticharoenyos, P. (1968). Gibbon menstrual cycle and breeding study. *Annual Progress Report, Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand* **April 1967 to March 1968**: 255-257.

Wallis, J. (1985). Synchrony of estrous swelling in captive group-living chimpanzees (*Pan troglodytes*). *International Journal of Primatology* **6**: 335-350.

Yang, Z., and Schank, J. C. (2006). Women do not synchronize their menstrual cycles. *Human Nature* **17**: 433-447.

Zhen, R. (1989). [Observations of the menstrual cycles of black gibbon (*H. concolor concolor*)]. *Zoological Research* **10**(2): 154 + 162 (Chinese text).

Zusammenfassung

Hormonelle Korrelate zum Ovulationszyklus von Gelbwangen-Schopfgibbon (*Nomascus gabriellae*), und eine Übersicht der Ovulationszyklen bei Gibbons (Hylobatidae)

Ovulationszyklen wurden bei zwei zoo-lebenden Gelbwangen-Schopfgibbons (*Nomascus gabriellae*) anhand urinärer Steroidmetaboliten bestimmt. Die durchschnittliche Zyklusdauer betrug 21.1±1.2 Tage (n = 7 Zyklen). Der zeitliche Abstand zwischen Maximalwerten der Östron-Konzentration und den entsprechenden Östradiol-Maxima betrug 0–1 Tage, und die mit Östron bestimmten Zyklusdauern unterschieden sich von den mit Östradiol bestimmten um 0–2 Tage. Keines der beiden Hormone erreichte die Maxima konsistent früher als das andere. Beim ersten Weibchen begann die Geschlechtsreife (regelmässige Ovulationszyklen) vor oder während der Umfärbung vom schwarzen Juvenilkleid zum gelben Adultkleid, während das ältere zweite Weibchen anscheinend erst im Verlauf dieser Studie begann, regelmässige Zyklen zu zeigen, also Jahre nach ihrer Umfärbung zum Adultkleid. Die in dieser Studie bestimmte durchschnittliche Zyklus-Dauer für *N. gabriellae* ist praktisch identisch mit den auf Hormondaten basierenden Ovulationszyklen, die in früheren Studien bei anderen Gibbons bestimmt wurden (*Hylobates* spp.: 20.0-25.4 Tage, *N. leucogenys*: 21.9, *Symphalangus syndactylus*: 21.8). Diese Werte stimmen meistens auch ziemlich gut mit den Zyklusdauern, die mit Hilfe der Sexualschwellungen bestimmt wurden, überein. Sie sind dagegen meist deutlich kürzer als Zyklusdauern, die auf Menstruationsblutungen oder der Häufigkeit von Paarungen basieren. Das dürfte daran liegen, dass mit den letzteren beiden Methoden oft einzelne Zyklen übersehen werden und dass die so bestimmten Zyklen keine verlässlichen Indikatoren für den Ovulationszyklus bei Gibbons darstellen. Zyklen von Gibbons scheinen kürzer zu sein als die von anderen Primaten, mit Ausnahme einiger – wenn auch nicht aller – Neuweltaffen.

Comparing the role of androgens in paternal care between gibbon species

Michelle Rafacz[1], Sue Margulis[1], Rachel Santymire[2]

[1] Committee on Evolutionary Biology, University of Chicago, 1025 E. 57th Street, Culver Hall 402, Chicago, IL 60637, 773-32-4622. E-mail: mrafacz@uchicago.edu
[2] Davee Center for Epidemiology and Endocrinology, Lincoln Park Zoo, Chicago, IL 60614

Gibbons are often perceived as a relatively uniform group of apes: Its members share highly specialized modes of suspensory and bipedal locomotion, elongated limbs, live in monogamous family groups and form strong pair-bonds. A remarkable variation in the degree of bi-parental care has been reported, however. Siamang (*Symphalangus syndactylus*) fathers are the only gibbons to provide regular direct paternal care (infant-carrying), whereas fathers in the white-handed gibbons (*Hylobates lar*) and all other gibbon species, fathers play a more indirect role in paternal care through infant protection and territory defence. This study is the first to investigate patterns of steroid hormones in male hylobatids and to compare these patterns between a white-handed gibbon and a siamang male both paired with pregnant females. Faecal samples collected from both males beginning four weeks prior to parturition and continuing four weeks post-partum were analysed for androgen metabolites, and patterns were compared between species. Results demonstrate similar mean faecal androgen metabolite values, but the hormonal pattern around mate's pregnancy differed between the two study animals. The white-handed gibbon showed a U-shaped pattern with concentrations peaking at Week 4 pre-partum and Week 4 post-partum, while the siamang showed an inverted U-shaped pattern of androgen secretion across the eight week peri-partum period, with highest concentrations at birth. Both males showed elevated androgen values during the week of birth. If these results can be replicated in a larger sample of animals of each species, it would suggest that the pattern of change in androgens is related to differences in the degree of paternal care across species and reflects evolutionary and biological aspects.

Introduction

The gibbons or small apes (family Hylobatidae) are the most basal group of the living apes (Fleagle, 1984; Groves, 2001) and native to the tropical rainforests of south-east Asia (Chivers, 2001). Gibbons are often perceived as a relatively uniform group of apes, because its members share highly specialized modes of suspensory and bipedal locomotion, elongated limbs, live in small, monogamous family groups and form strong pair-bonds (Chivers, 2001; Fleagle, 1984; Groves, 2001). The role of the father in parental care differs, however, between siamangs (genus *Symphalangus*) and all other gibbons (genera *Hylobates*, *Nomascus*, and *Hoolock*). The siamang (*Symphalangus syndactylus*), on one hand, is the only gibbon species in which males regularly exhibit direct paternal care in the form of infant carrying, beginning around 6 to 12 months post-partum (Chivers, 1972, 1974, 2001). In the white-handed gibbon (*Hylobates lar*) and other gibbons, on the other hand, males are not known to provide direct paternal care regularly, but invest in protection and defence of the family group and surrounding territory (Dielentheis *et al.*, 1991; Reichard, 2003). Little is known, however, about factors that may influence reproduction and parental care in this family.

Hormones are known to be involved in mediating reproductive and parental behaviour in a range of mammalian taxa (Pryce, 1992). Historically, most investigations have focused on clarifying the role of these hormones in pregnancy and maternal care, particularly in laboratory rodent species (Fahrbach and Pfaff, 1982; Numan and Sheehan, 1997; Rosenblatt *et al.*, 1979; Stack *et al.*, 2002). More recently, however, a number of researchers have turned their attention to the role of hormones in paternal care, not only in rodents (Wynne-Edwards and Timonin, 2007), but also in callitrichids (Dixson and George, 1982; Nunes *et al.*, 2000) and humans (Storey *et al.*, 2000; Fleming *et al.*, 2002). Although fathers do not experience changes in hormones as dramatic as those for new mothers, specifically because they do not lactate and do not have a steroidogenic placenta, steroid hormones may still play a role in either stimulating or mediating the expression of paternal behaviour (Wynne-Edwards and Timonin, 2007).

Many studies have supported an association between androgens, particularly testosterone, and the degree of paternal care across bi-parental species (i.e. species with bi-parental care). The nature of this relationship varies greatly, however, and can be positive or inverse. Moreover, not all species examined were found to exhibit a relationship between androgens and paternal care (Table 1). Obviously several factors may be involved in the mediation of paternal care. Regardless of causality, the majority of results indicates that the role of hormones and changes in these hormones, specifically androgens, across pregnancy

Table 1. Type of relationship between androgens, particularly testosterone, and the degree of paternal care across bi-parental mammal species. – *Beziehung zwischen Androgenkonzentrationen (vor allem Testosteron) und dem Anteil an väterlicher Hilfe bei der Jungenaufzucht bei verschiedenen Säugetierarten, bei denen sich beide Eltern an der Jungenaufzucht beteiligen.*

Relationship	Species	Reference
Positive	Cotton-top tamarin (*Saguinus oedipus*)	Ziegler and Snowdon (2000)
	California mouse (*Peromyscus californicus*)	Trainor and Marler (2001)
Inverse	Humans	Fleming *et al*. (2002), Nunes *et al*. (2000), Storey *et al*. (2000)
	Wied's tufted-eared marmoset (*Callithrix kuhlii*)	Nunes *et al*. (2001)
	Djungarian hamster (*Phodopus campbelli*)	Reburn and Wynne-Edwards (1999)
	Mongolian gerbil (*Meriones unguiculatus*)	Brown *et al*. (1995), Clark *et al*. (1997)
None	Common marmoset (*Callithrix jacchus*)	Dixon and George (1982)
	California mouse (*Peromyscus californicus*)	Gubernick and Nelson (1989)

and the post-partum period might also vary in gibbon males.

The present study examines faecal androgen metabolites in a male white-handed gibbon (Fig. 1a) and a male siamang (Fig. 1b), each paired with a pregnant mate. If androgens play a role in the expression of paternal care, then we might expect to find hormonal differences between these two species given the differences in the degree of active paternal care between these two species. As part of larger study on parental behaviour and associated hormone changes in gibbons, here we describe the results of hormonal analyses conducted using samples collected four weeks prior to and four weeks following birth of an infant. Specifically, the objectives of this study were to determine the influence of pregnancy and birth of an infant on father's androgen patterns, and to compare patterns of androgens between a male white-handed gibbon and a male siamang. This is the first study to examine patterns of androgens in male gibbons in general and in the context of species differences.

Based on previous research with bi-parental rodents, callitrichids and human fathers, we predicted that: 1) mean faecal androgen metabolite concentrations would decrease immediately following birth of an infant in both the male white-handed gibbon and male siamang, as elevated androgens are associated with aggressive behaviour. Maintaining a low level of aggression around birth would help to ensure the safety of the infant and would be an evolutionarily stable strategy; and 2) in the several weeks following birth, when there is a greater need for protection and defence of the infant, mean faecal androgen metabolite concentrations would increase in the white-handed gibbon, but begin to decrease in the siamang, because continued low levels of aggression would provide a suitable social environment for the development of a stronger father-infant bond, needed later on when infant transfer from the mother to the father occurs.

Methods

Animals and sample collection

One white-handed gibbon male and one siamang male participated in the study. Each was housed with a pregnant mate at separate Association of Zoos and Aquariums (AZA)-accredited institutions in North America. Their ages were 21 and 35 years old, respectively. All research and sample collection complied with protocols approved by the University of Chicago's IACUC, the Research Committee of each zoo, adhered to all local, state and federal requirements, and was determined not to have any animal welfare impact because samples were collected opportunistically. Fresh, faecal samples (uncontaminated by urine) were collected three to seven times per week beginning four weeks prior to parturition and continuing through four weeks post-partum in 2007 (white-handed gibbon) and 2008 (siamang). Food colouring was used as a faecal marker to identify the target faecal samples. Samples were placed into plastic storage bags, labelled with the subject's identification number, the date and time of collection and any additional notes. These samples were then stored at -20°C until shipped to Lincoln Park Zoo for processing and hormonal analysis.

Faecal sample preparation

Faecal samples were lyophilized (Labconco Lyophilizer, Kansas City, MO) and steroids were extracted as described for other species (Brown *et al.*, 1994). Briefly, dried samples were pulverized and 5 ml of 90% ethanol:distilled water were added to ~0.2 g (± 0.02 g) of faecal powder. The samples were agitated on a mixer (Glas-col, Terre Haute, IN) on setting 60 for 30 min. After centrifugation (1500 rpm, 20 min), the supernatant was recovered and the faecal pellet was re-suspended in 5 ml of 90% ethanol: distilled water, vortexed for 1 min and re-centrifuged (1500 rpm, 15 min). Both supernatants were combined and evaporated with air and heat at 60°C. Extracted samples were reconstituted in 1 ml methanol, vortexed for 1 min, sonicated for 20 min and diluted (1:250) in dilution buffer (0.2M NaH_2PO_4, 0.2M Na_2HPO_4, NaCl) before analysis by enzyme-immunoassay (EIA).

a  b 

Fig. 1. The male white-handed gibbon (right) with mate and infant (a) (Photo: Karen Caster), and male siamang (b) (Photo: Melissa Barton). – *Die in dieser Studie untersuchten Gibbon-Männchen: (a) erwachsenes Männchen des Weisshandgibbons (helles Tier rechts im Bild) mit dem Weibchen und Jungtier, und (b) erwachsener Siamang*.

Enzyme-immunoassays

Faecal androgen metabolites were analysed using a testosterone EIA. The horseradish peroxidase (HRP; 1:30,000) and polyclonal antiserum (R156/7; 1:10,000) were provided by C. Munro. Antiserum cross-reactivities for testosterone were: testosterone, 100%; 5α-dihydrotestosterone, 57.37%; androstenedione, 0.27%; androsterone, 0.04%; DHEA, 0.04%; cholesterol, 0.03%; β-estradiol, 0.02%; progesterone, pregnenolone, hydrocortisone, cholic acid, chenodeoxycholic acid, cholic acid methyl ester, dehydrocholic acid, deoxycholic acid, lithocholic acid, glycholic acid, taurodeoxycholic acid, taurocholic acid, taurochenodeoxycholic acid, and glychochenodeoxycholic acid, <0.02%. The testosterone EIA was validated for the male white-handed gibbon and male siamang by demonstrating: 1) parallelism between binding inhibition curves of faecal extract dilutions (1:2-1:2,048) and the testosterone standards (white-handed gibbon, $R^2 = 0.925$; siamang, $R^2 = 0.993$); and 2) significant recovery (>90%) of exogenous testosterone (2.3–600 pg/well) added to faecal extracts (white-handed gibbon, $y = 1.03x + 8.78$; $R^2 = 0.998$; siamang, $y = 0.94x + 5.97$; $R^2 = 0.998$). Assay sensitivity was 2.3 pg/well and intra- and inter-assay coefficients of variation were <10%.

Data analyses

Standard descriptive statistics were used to summarize results. For weekly means, the day of infant birth was included in the weekly mean for one week pre-partum so that it would include any significant hormonal patterns leading up to parturition. A curvilinear trend-line was fitted to each of the observed patterns for weekly mean faecal androgen metabolites for both the male white-handed gibbon and siamang.

Results

For the male white-handed gibbon across the eight-week peri-partum period, weekly mean faecal androgen metabolites were highest at Week 4 pre-partum (518.7 ± 160.5 ng/g dry faeces) and Week 4 post-partum (651.4 ± 100.4 ng/g dry faeces) and lowest the three weeks surrounding birth (range: 296.7-417.1 ng/g dry faeces), although there was an increase in faecal androgen metabolites during the week preceding birth. This resulted in a curvilinear U-shaped trend (Fig. 2a). Conversely, for the siamang male weekly mean faecal androgen metabolite concentrations across the eight-week period were highest at Week 1 pre-partum (469.6 ± 51.8 ng/g dry faeces) compared to Week 4 pre-partum (347.9 ± 13.7 ng/g dry faeces) and Week 3 (258.7 ± 24.5 ng/g dry faeces) and Week 4 (261.4 ± 39.9 ng/g dry faeces) post-partum, resulting in an inverted U-shaped trend (Fig. 2b).

Discussion

Our results, although preliminary, suggest that there might be an association between androgen values and the degree of paternal care in both the male white-handed gibbon and the male siamang. Studies with bi-parental species have demonstrated a positive relationship, an inverse relationship and even no relationship at all between androgens and paternal care, indicating a highly variable role of androgens in male parental care (Wynne-Edwards and Timonin, 2007), and our results appear to support these findings.

The pattern of androgens from four weeks pre-partum to four weeks post-partum differed noticeably between the male white-handed gibbon and the male siamang. The observed increase in weekly mean faecal androgen metabolite concentrations in the white-handed gibbon by Week 4 post-partum can be explained by the need for facilitation of infant and mate protection and territory defence and a trade-off with parenting effort. Male cotton-top tamarins, for instance, carry their infants at birth, and in this species a gradual increase in testosterone during preg-

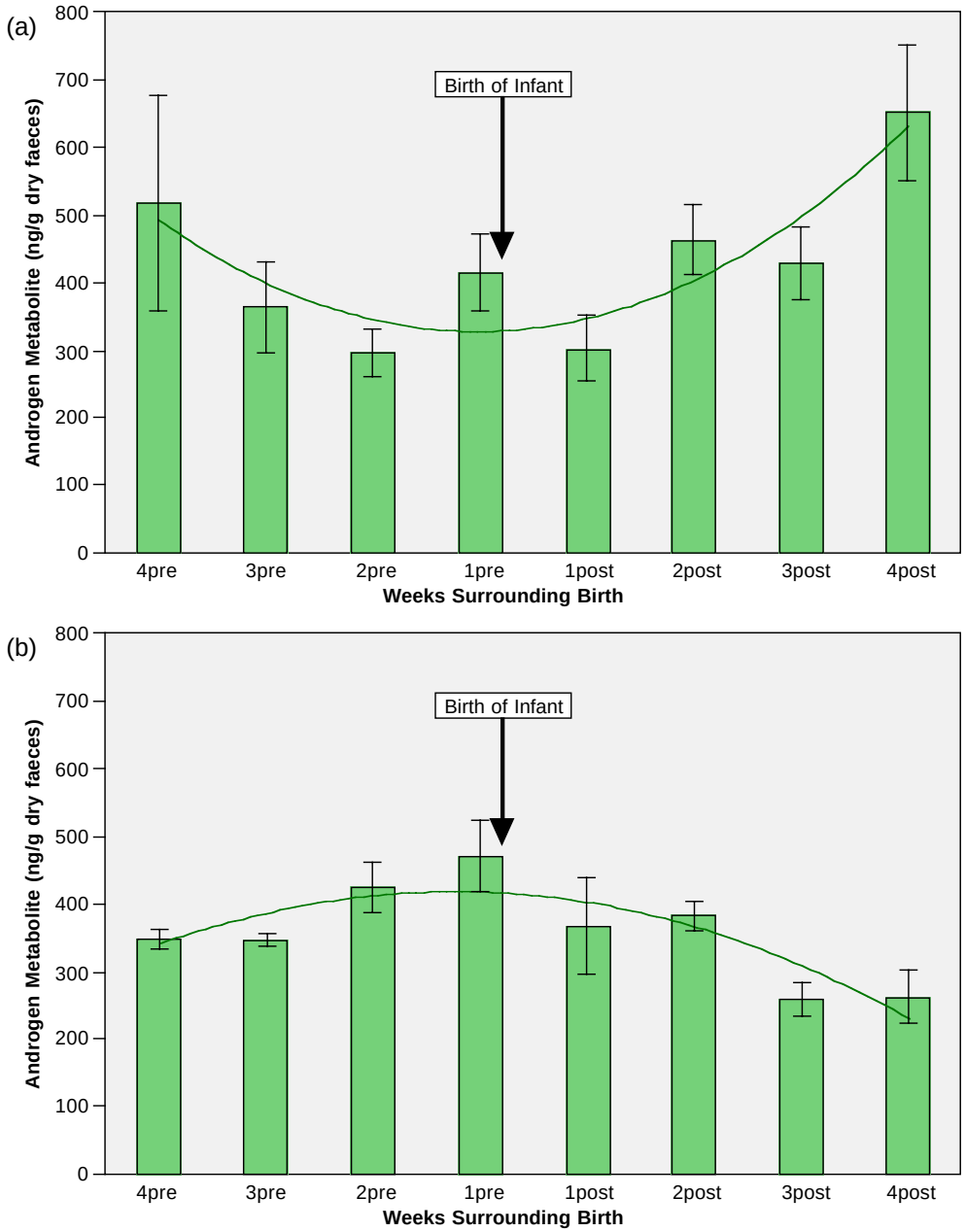

Fig. 1. Weekly mean androgen metabolite concentrations (ng/g dry faeces) during the peri-partum period of four weeks pre- and post-partum for the white-handed gibbon male (a) and the siamang male (b). – *Androgen-Metabolitenkonzentrationen (ng/g Trocken-Faeces) während vier Wochen vor und nach einer Geburt bei je einem erwachsenen Männchen des Weisshandgibbons (a) und des Siamangs (b)*.

nancy and sustained elevated testosterone after parturition have been suggested to promote paternal care (Ziegler and Snowdon, 2000). Results of other studies have indicated that there may be a trade-off between parenting effort and aggression in many bi-parental mammalian species, suggesting that behaviours such as mate-guarding and defence of the family group are more important to the male than caring for his offspring (Wynne-Edwards and Timonin, 2007). Perhaps the pattern observed in the male white-handed gibbon is related to this trade-off and therefore supports the observation that the role of paternal care is more indirect in this species.

Interestingly, the pattern of change in androgens in the siamang in the eight-week peri-partum period showed the opposite trend, an inverted U-shape. Storey *et al*. (2000) reported that androgens decrease with an increase in paternal care several weeks following birth in human fathers, and a decrease in testosterone levels following birth of offspring has also been reported in Wied's tufted-ear marmosets (Nunes *et al*., 2000, 2001), Djungarian hamsters (Reburn and Wynne-Edwards, 1999), and Mongolian gerbils (Brown *et al*., 1995; Clark *et al*., 1997). This could explain the decrease in androgen concentrations in the siamang through Week 4 post-partum and suggests that perhaps there is an inverse relationship

between androgens and paternal care. We might predict then, that androgen concentrations might stay low or even decrease further in the male siamang around six months post-partum when the infant-transfer typically occurs in siamangs (Dielentheis *et al.*, 1991). Although we have not presented data past Week 4 post-partum in this report, we are in the process of analyzing these data. It is possible that a hormonal milieu facilitating non-aggressive behaviour is important for the eventual display of direct paternal care in the form of infant-carrying. Continued sample collection and analysis throughout the post-partum period is needed to examine whether or not the siamang male will exhibit even further decreased androgen levels around the time of infant carrying.

The expected increase in weekly mean faecal androgen metabolite concentrations immediately prior to and including the week of birth in male white-handed gibbon and siamang is similar to trends reported in humans (Fleming *et al.*, 2002; Nunes *et al.*, 2000; Storey *et al.*, 2000), Wied's tufted-ear marmosets (Nunes *et al.*, 2000, 2001), Djungarian hamsters (Reburn and Wynne-Edwards, 1999) and Mongolian gerbils (Brown *et al.*, 1995; Clark *et al.*, 1997). Reburn and Wynne-Edwards (1999) suggest that this pattern could be related to mate-guarding behaviours. Interestingly, this would make the most sense if females experienced a post-partum oestrous, since elevated testosterone can be associated with aggressive behaviour towards extra-pair suitors. Gibbons are not known to exhibit post-partum oestrus, and so elevated androgen concentrations leading up to birth may be explained by other phenomena.

As predicted, mean weekly androgen concentrations decreased immediately following birth in both the male white-handed gibbon and male siamang. This could be explained by the fact that elevated androgens are associated with aggressive behaviour and again suggests an inverse relationship between androgens and paternal care (Wynne-Edwards and Timonin, 2007). Testosterone levels also decrease following birth of offspring in humans (Storey *et al.*, 2000), bi-parental Djungarian hamsters (Brown *et al.*, 1995), Mongolian gerbils (Clark *et al.*, 1997; Reburn and Wynne-Edwards, 1999), and Wied's tufted-ear marmosets (Nunes *et al.*, 2000). Such a pattern suggests that androgens interfere with paternal care in these species by potentially mediating aggression toward infants and mates and reducing parenting behaviours. This might explain the current findings for both the white-handed gibbon and siamang regardless of the degree of paternal care, given that their reproductive success ultimately depends on infant survival, especially in the early stages of life.

In conclusion, our preliminary findings suggest that white-handed gibbon and siamang fathers exhibit a difference in androgen patterns surrounding birth, and that this could be associated with the degree of paternal care eventually displayed in these species. The pattern of androgen change around birth for the male white-handed gibbon was a U-shaped trend, whereas for the male siamang the pattern of androgen change was an inverted U-shaped trend. Further data collection and analysis are required (and are currently underway) to examine if these trends continue and reflect true species differences, particularly around six months post-partum when the infant transfer begins in siamang males.

Previous studies with humans, callitrichids, and rodents are supported by the results of our study. However, the relationship between androgens and the expression or degree of paternal care is clearly not a universal one (Wynne-Edwards and Timonin, 2007). Androgens can facilitate, interfere with, or have no effect on paternal care. To further elucidate this point, studies have even reported variation in the role of androgens in mediating paternal behaviour within the same species. Trainor and Marler (2001) found a positive relationship between testosterone and paternal care in California Mice, while Gubernick and Nelson (1989) found there to be no relationship. This clearly illuminates the preliminary nature of our findings. Because we examined only one individual of each of our two study species, it cannot be decided whether the differences we found are related to species-specific traits or to individual variation. Additional individuals of each species will need to be studied in order to verify our results.

Gibbons may be particularly suited for studying the relationship between androgen levels and paternal care. Whereas paternal help is virtually obligatory in marmosets (genus *Callithrix*), it is variable not only among, but also within gibbon species (e.g. Fischer and Geissmann, 1990). This should make it easier to predict androgen levels of individual male gibbons of the same species that differ in their inclination to provide paternal care, and to , and test the prediction, as compared to individuals of a marmoset species.

Acknowledgements

We thank Drs Elizabeth Lonsdorf, Martha McClintock and Dario Maestripieri for their valuable critique of the project and Diana Armstrong for her assistance with laboratory procedures. We also thank the Davee Center for Epidemiology and Endocrinology and Lester E. Fisher Center for the Study and Conservation of Apes at Lincoln Park Zoo. We thank Karen Caster and Jay Tetzloff for participation in sample collection. This project would not be possible without assistance from Jay Petersen, Gibbon SSP Coordinator for AZA, in finding suitable study participants. Results from part of this study were presented at the 2008 annual meeting of the Midwest Primate Interest Group and the Association of Zoos and Aquariums. This study was partially supported by a grant to M. Rafacz by the University of Chicago Hinds Fund.

References

Berg, S. J., and Wynne-Edwards, K. E. (2001). Changes in testosterone, cortisol, and estradiol levels in men becoming fathers. *Mayo Clinic Proceedings* **76**: 582-592.

Brown, R. E., Murdoch, T., Murphy, P. R., and Moger, W. H. (1995). Hormonal responses of male gerbils to stimuli from their mate and pups. *Hormones and Behavior* **29**: 474-491.

Chivers, D. J. (1972). The siamang and the gibbon in the Malay peninsula. In Rumbaugh, D. M. (ed.), *Gibbon and siamang, vol. 1*, Karger, Basel and New York, pp. 103-135.

Chivers, D. J. (1974). *The siamang in Malaya – A field study of a primate in tropical rain forest (Contributions to primatology vol. 4)*, Karger, Basel and New York, 335 pp.

Chivers, D. J. (2001). The swinging singing apes: Fighting for food and family in far-east forests. In Chicago Zoological Society (ed.), *The apes: Challenges for the 21st century. Brookfield Zoo, May 10-13, 2000, Conference Proceedings*, Chicago Zoological Society, Brookfield, Illinois, U.S.A., pp. 1-28.

Clark, M. M., Desousa, D., Vonk, J. M., and Galef, B. G., Jr. (1997). Parenting and potency: alternative routes to reproductive success in male Mongolian gerbils. *Animal Behaviour* **54**: 635-642.

Dielentheis, T. F., Zaiss, E., and Geissmann, T. (1991). Infant care in a family of siamangs (*Hylobates syndactylus*) with twin offspring at Berlin Zoo. *Zoo Biology* **10**: 309-317.

Dixson, A. F., and George, L. (1982). Prolactin and parental behaviour in a male New World primate. *Nature* **299**: 551-553.

Fahrbach, S. E. and Pfaff, D. W. (1982). The physiological mechanisms of motivation. In D. W. Pfaff (ed.), *Hormonal and neural mechanisms underlying maternal behavior in the rat.* Springer-Verlag, New York, p 253-285.

Fischer, J. O., and Geissmann, T. (1990). Group harmony in gibbons: Comparison between white-handed gibbon (*Hylobates lar*) and siamang (*H. syndactylus*). *Primates* **31**: 481-494.

Fleagle, J. G. (1984). Are there any fossil gibbons? In Preuschoft H., Chivers D. J., Brockelman W. Y., Creel N. (eds.), *The Lesser Apes: Evolutionary and behavioural biology*. Edinburgh University Press, Edinburgh, p 431-447.

Fleming, A. S., Corter, C., Stallings, J., and Steiner, M. (2002). Testosterone and prolactin are associated with emotional responses to infant cries in new fathers. *Hormones and Behavior* **42**: 399-413.

Groves, C. P. (2001). *Primate Taxonomy*. Smithsonian Institution Press, Washington, D.C. viii+350 pp.

Gubernick, D. J., and Nelson, R. J. (1989). Prolactin and paternal behavior in the biparental California mouse, *Peromyscus californicus*. *Hormones and Behavior* **23**: 203-210.

Numan, M., and Sheehan, T. P. (1997). Neuroanatomical circuitry for mammalian maternal behavior. *Ann NY Acad Sci* **807**: 101-125.

Nunes, S., Fite, J. E., and French, J. A. (2000). Variation in steroid hormones associated with infant-care behaviour and experience in male marmosets (*Callithrix kuhlii*). *Animal Behaviour* **60**: 857-865.

Nunes, S., Fite, J. E., Patera, K. J., and French, J. A. (2001). Interactions among paternal behavior, steroid hormones, and parental experience in male marmosets (*Callithrix kuhlii*). *Hormones and Behavior* **39**: 70-82.

Reburn, C. J., and Wynne-Edwards, K. E. (1999). Hormonal changes in males of a naturally biparental and a uniparental mammal. *Hormones and Behavior* **35**: 163-176.

Reichard, U. (2003). Social monogamy in gibbons: The male perspective. In Reichard, U. (ed.), *Monogamy: Mating strategies and partnerships in birds, humans and other mammals*, Cambridge University Press, Cambridge, pp. 190-213.

Rosenblatt, J. S., Siegel, H. I., and Mayer, A. D. (1979). Advances in the study of behavior. In Rosenblatt, J. S., Hinde, R. A., Beer, C., and Busnel, M. C. (eds.), *Progress in the study of maternal behavior in the rat: Hormonal, nonhormonal, sensory, and developmental aspects, vol. 10*. Academic Press, New York, pp. 225-311.

Stack, E. C., Balakrishnan, R., Numan, M. J., and Numan, M. (2002). A functional neuroanatomical investigation of the role of the medial preoptic area in neural circuits regulating maternal behavior. *Behavioural Brain Research* **131**: 17-36.

Storey, A. E., Walsh, C. J., Quinton, R. L., and Wynne-Edwards, K.E. (2000). Hormonal correlates of paternal responsiveness in new and expectant fathers. *Evolution and Human Behavior* **21**: 79-95.

Svare, B., Bartke, A., and Gandelman, R. (1977). Individual differences in the maternal behavior of male mice: no evidence for a relationship to circulating testosterone levels. *Hormones and Behavior* **8**: 372-376.

Trainor, B. C., and Marler, C. A. (2001). Aromatization of testosterone to estradiol is an important mechanism of paternal behavior in the California mouse (*Peromyscus californicus*). *Hormones and Behavior* **39**: 42-52.

Trainor, B. C., and Marler, C. A. (2002). Testosterone promotes paternal behaviour in a monogamous mammal via conversion to oestrogen. *Proceedings of the Royal Society of London* **269**: 823-829.

Wynne-Edwards, K. E., and Timonin, M. E. (2007). Paternal care in rodents: weakening support for hormonal regulation of the transition to behavioral fatherhood in rodent animal models of biparental care. *Hormones and Behavior* **52**: 114-121.

Ziegler, T. E., and Snowdon, C. T. (2000). Preparental hormone levels and parenting experience in male cotton-top tamarins, *Saguinus oedipus*. *Hormones and Behavior* **30**: 59-167.

Zusammenfassung

Vergleich von Androgen-Werten und väterlicher Jungenfürsoge zwischen Gibbon-Arten.

Gibbons werden oft als eine relativ einheitlich Gruppe der Menschenaffen betrachtet: Alle Mitglieder zeichnen sich zum Beispiel durch hochspezialisierte hangelnde und zweibeinige Fortbewegungsweisen, verlängerte Gliedmassen, Organisation in monogamen Familiengruppen und starke Paarbindung aus. Es ist jedoch bekannt, dass Gibbons grosse Unterschiede in der Verteilung der elterlichen Fürsorge aufweisen. Nur beim Siamang (*Symphalangus syndactylus*) beteiligen sich die Väter regelmässig direkt an der Jungenaufzucht, in dem sie die Jungtiere tragen, während der Beitrag der Väter bei Weisshandgibbons (*Hylobates lar*) und anderen Gibbons eher indirekt erfolgt dadurch, dass sie Schutz für die Kinder bieten und das Territorium verteidigen. In dieser Studie werden zum ersten mal Konzentrationsänderungen von Steroidhormonen bei verpaarten männlichen Gibbons während der Schwangerschaft ihrer Partnerinnen untersucht. Die Hormonkonzentrationen eines Weisshandgibbons und eines Siamangs wurden verglichen. Zu diesem Zweck wurden Faecesproben beider Väter während vier Wochen vor und nach der Geburt des Jungtieres gesammelt und die Konzentration der Androgen-Metaboliten darin bestimmt. Dabei zeigte sich, dass beide Tiere zwar ähnliche Mittelwerte aufwiesen, sich aber im Muster der Konzentrationsveränderungen während der Schangerschaft ihrer Partnerinnen unterschieden. Beim Weisshandgibbon folgten die Androgen-Konzentrationen etwa einer *u*-Form, in der die höchsten Werte in Woche 4 vor der Geburt und in Woche 4 nach der Geburt auftraten. Beim Siamang folgten die Androgen-Änderungen im selben Zeitraum dagegen eher einem n-förmigen Verlauf, in welchem die höchsten Werte bei der Geburt auftraten. Beide Männchen zeigten erhöhte Androgen-Werte während der Woche gleich nach der Geburt. Fall sich diese Resultate auch bei einer grösseren Stichprobe von Individuen beider Arten wiederholen lassen, würde dies die Annahme unterstützen, dass die Veränderungen der Androgenkonzentrationen mit dem unterschiedlichen Grad der väterlichen Jungenfürsorge beider Gibbonarten zusammenhängen und evolutive und biologische Merkmale spiegeln.

Longevity in gibbons (*Hylobatidae*)

Thomas Geissmann[1], Katja Geschke[2] and Barbara J. Blanchard[2]

[1] Anthropological Institute, University Zürich-Irchel,
Winterthurerstr. 190, CH–8057 Zürich, Switzerland
E-mail: thomas.geissmann@aim.uzh.ch

[2] Wellington Zoo Trust, 200 Daniell Street,
Newtown, Wellington 6021, New Zealand

A longevity record of 60 years spent in captivity by a Mueller's gibbon (*Hylobates muelleri*) is reported here. This appears to be the second-highest age so far reported for a non-human primate, but it is especially remarkable when adjusted for body size. It is well known that longevity in mammals correlates with body weight. Small apes should, therefore, be expected to exhibit lower longevity than the great apes because of their lower body weight. However, the longevity record for *Hylobates* reverses this expectation for great apes like orangutans (*Pongo*) and gorillas (*Gorilla*). This study further found a significant correlation between the captive population size of primate genera and their recorded longevity. A comparison of longevity and captive population size suggests that recorded longevity in the gibbon genera *Hoolock*, *Nomascus* and *Symphalangus* is lower than that of the genus *Hylobates* because *Hylobates* is kept in captivity in much higher numbers. As a result, data on *Hylobates* longevity are obtained from larger sample sizes than that of all other gibbons. This suggests that all gibbon genera may eventually be revealed to exhibit an elevated longevity in relation to their body weight when larger amounts of data become available. Longevity data for great apes, in contrast, are based on larger samples than those for most genera of the small apes, and an increase in sample size for great ape genera may less likely produce a substantial increase in the longevity record.

Introduction

Longevity is an essential variable for research on the biology of ageing (Sacher, 1975). It may also be of practical use to zoos and other breeding facilities in order to assess the breeding potential of animals of known age. Longevity of captive mammals in general, and primates in particular, has repeatedly been tabulated (Carey and Judge, 2000; Flower, 1931; Jones 1962, 1968, 1979, 1982; Weigl, 2005).

Longevity is closely related to several other constitutional dimensions, including body weight, brain weight, metabolic rate, and body temperature, which account for about 70% of the lifespan variance in mammals (Sacher, 1975). Longevity also correlates with the size of various other body organs (Austad and Fischer, 1992). Some taxonomic groups are particularly long-lived. Primates, for instance, are long-lived mammals, the great apes have been identified as long-lived primates, and humans are long-lived apes (Carey and Judge, 2000). Gibbons, however, have not been identified previously as particularly long-lived primates, and even less as long-lived hominoids. Our case study on a Mueller's gibbon (*Hylobates muelleri*) kept at the Wellington Zoo, suggests that exactly this may be the case.

We provide detailed documentation that is as complete as possible on the past life of our study animal, a male Mueller's gibbon, with the aim of verifying his unusually high age. This is necessary, as various reports on unusual longevity in apes are not supported by convincing evidence (Puschmann and Federer, 2008). The most illustrious among these apes is "Cheeta", the chimpanzee (*Pan troglodytes*) who was awarded a certificate for being "the world's oldest living primate, aged 69 years and one month" by the Guinness Book of World Records in 2001. The chimpanzee was allegedly brought in 1932 as a young animal from Liberia to the U.S.A. and co-starred as Cheeta with Johnny Weissmuller in MGM's Tarzan movies of the 1930s and '40s. According to numerous newspaper and internet reports, "Cheeta" has been reported to have reached 76 years of age in 2008 (e.g. Adams, 2008; Martinez, 2008; Nash, 2008; Neate, 2008; Wikipedia contributors, 2008), although this age cannot be supported by concise information. This long life span differs considerably from the values reported in primate longevity studies (59 years 5 months, e.g. Weigl, 2005). The high age of Cheeta is unlikely for several reasons: Various chimpanzees with the same official name were trained together for the same film roles. None of the film chimpanzees exhibited facial features that could linked with the current Cheeta. The published age of Cheeta has repeatedly gone up and down in subsequent reports. Based on the ape's external features, his birth date was more likely to have been in the 1960's than in the 1930's (Rosen, 2009; Puschmann and Federer, 2008; Weigl, 2009; Weigl, personal communication to TG, Aug. 2008).

This article is part of a series of papers reassessing vital statistics of gibbons, such the age of sexual maturation and gestation length (Geissmann, 1991), neonatal body weight (Geissmann and Orgeldinger, 1995), and adult body weight (Geissmann, 1998, in prep.), and ovarian cycle duration (Geissmann and Anzenberger, 2009).

Methods

Longevity data used in this study were extracted from Weigl (2005). Only for two primate species were other sources used because their longevity values were considerably higher than those reported by Weigl (2005). These species include *Hylobates muelleri* (this study, see Results), and the chimpanzee (*Pan troglodytes*). The oldest chimpanzee is believed to be 76 years old (Adams, 2008; Martinez, 2008).

For each genus, the species with the longest known longevity was determined. The body weight of that species was extracted from Gordon (2006). The body weights used in this study are from adult, wild-caught primates, and are an average of mean male body weight and mean female body weight.

Several primate genera were excluded from the study because their longevity data were considered unrealistically low. Low longevity estimates usually occur in taxa that are rarely kept in captivity. The excluded primate genera are: *Avahi*, *Indri*, *Hapalemur*, *Prolemur*, *Lepilemur*, *Euoticus*, *Arctocebus*, *Brachyteles*, *Oreonax*, *Piliocolobus*, *Procolobus*, *Nasalis*, and *Presbytis*. The genus *Homo* was also excluded because its current longevity is not believed to be comparable to that of non-human primates. Additional genera were also excluded because no reliable body weight data appear to be available for the species with the highest longevity (Gordon, 2006). These genera are *Allocebus*, *Callimico*, *Cacajao*, *Callicebus*, *Allenopithecus*, *Lophocebus*, and *Pygathrix*. A total of 48 genera were included in the analysis.

We also wanted to test whether longevity data were influenced by the sample size of individuals used to determine longevity. Although the captive population size of each genus was unknown, numeric proportions among the genera can be estimated by using the numbers of animals of each genus currently living in ISIS (International Species Information System) member institutions (ISIS, 2008). These institutions include 735 zoos and aquariums in 73 countries. The captive population size of each genus was extracted from the ISIS website on 23 July 2008.

Statistical calculations were carried out using JMP v. 7.0 software.

Three tape-recordings of the study animal "Nippy" at Wellington Zoo were available for this study: (1) Recording on audio cassette, unknown recordist, carried out c.1974, made available by Graeme Strachan. Recording duration 1'08", short section of a song bout. (2) Recording on audio cassette, by Graeme Strachan, carried out in August 2001. Recording duration 31'36", virtually complete song bout. (3) Recording on microcassette carried out by one of us (BJB) on 4 Aug. 2008 at about 12:00 hrs, using a SONY recorder M-607V. Recording duration 1'32", short fragments of a song bout of about 30 minutes duration.

Sonagrams of fully developed male song phrases were generated and measured by one of us (TG) using Raven 1.3 software (Cornell Laboratory of Ornithology, Ithaca, NY, U.S.A.) on a Macintosh PowerBook G4. The following spectrogram parameters were selected: Hann window, size = 39.8 ms = 1756 samples, 3 dB bandwidth = 36.1 Hz, time grid overlap = 75%, grid size = 9.95 ms, DFT (Discrete Fourier Transformation) size = 4096 samples (Charif *et al.*, 2007).

Results

Nippy: A biographical summary

Nippy arrived at Wellington Zoo on 2 Dec. 1949 as an 18" (46 cm) high youngster, together with a mate (Anonymous, 1949a). They arrived on the freighter Wairata coming "from Rangoon, Calcutta, Singapore, Java, and Sourabaya, via Auckland, with a variety of animals for the Wellington zoo".

The gibbons' exact origin is unknown, because the zoo's records were water damaged after a fire in the 1970's (Hill, 1999). According to one source, the two gibbons were rumoured to have been obtained from the Sultan of Johore (Anonymous, 2008). According to another they were bought from "the director of the Singapore Zoo" for £ 180 (Anonymous, 1950), but the Singapore Zoo has been in existence since only 1973. Probably there was a zoo in Singapore before that and the director acquired animals locally for overseas orders, so there could be some truth in both stories, though we can't derive any conclusions.

Upon arrival, the young pair of gibbons was described as "two agile long-armed gibbons" (Anonymous, 1949b), and Nippy was described later as a gibbon with a "solemn black face and grey fur" (Anonymous, 1954a).

Apparently, Nippy was originally identified as an agile gibbon (*Hylobates agilis*). His origin was suggested to be Borneo (Anonymous, 1950, 1953, 1954b, 1999) or Assam (Anonymous, 1954a). In 1995, his identification was changed to white-bearded gibbon (*H. albibarbis*) (G. Strachan, cited in Anonymous, 2008). In 2001, Nippy was identified by one of us (TG) as a Müller's gibbon (*H. muelleri*, probably *H. muelleri abbotti*) from Borneo, based on tape-recordings of his calls and photographs provided by Graeme Strachan. In 2004, this identification was confirmed and specified as Grey Müller's gibbon (*H. muelleri abbotti*) from northwestern Borneo, based on a new set of photographs.

Nippy's old accession number at Wellington Zoo was 0051; he was re-entered as M10 on 14 July 1981.

Nippy featured in the news and other media repeatedly (Anonymous 1949a, b, 1950, 1953, 1954a, b, 1987, 1997, 1999, 2004; 2005; Henderson, 2002; Hill, 1999; NZPA, 2004; Strachan, 2001; Wellington City Council, 2004). The earliest photograph of one of the two gibbons available to us was published in a newspaper of 1950 (Anonymous, 1950), but the quality of the preserved copy does not allow to recognize much more than the gibbon's shape. Two better newspaper photos were published in 1954 (Anonymous, 1954a, b), when Nippy was about 6 years old (Fig. 1). Two photographs from later press reports are shown in Figs. 2 and 3.

Fig. 1. Gibbon male Nippy, c.1954, at an estimated age of 6 years. Photo: unknown, previously published in Anonymous (1954b). – *Das Gibbon-Männchen Nippy um 1954, im geschätzten Alter von 6 Jahren*.

Fig. 2. Gibbon male Nippy in 1961, at an estimated age of 13 years. Photo: Rod Blanchard. – *Das Gibbon-Männchen Nippy im Jahr 1961, im geschätzten Alter von 13 Jahren*.

Fig. 3. Gibbon male Nippy, c.1987, at an estimated age of 39 years. Photo: unknown, previously published in Anonymous (1987). – *Das Gibbon-Männchen Nippy um 1987, im geschätzten Alter von 39 Jahren*.

A newspaper article from December 1953 reported that Nippy had recently fallen from a perch, breaking three ribs and other bones, but was fully recovered at the time of the report (Anonymous, 1953).

Nippy's first mate died about a year after arrival (Hill, 1999). Although the date of her death is unknown, it is known that the male was residing in solitary state at least since 1954 and possibly earlier (Anonymous, 1954a).

Around the year 1970, a new partner for Nippy arrived from Winnipeg Zoo (Canada). This female was reportedly a capped gibbon (*H. pileatus*) and was diagnosed as epileptic on 4 March 1970. She gave birth prematurely to a still-born offspring on 15 Nov. 1972, and was found dead on 31 March 1979.

Around January 1981, a female spider monkey ("Goldie", M24) – identified in the zoo records as a Geoffroy's spider monkey (*Ateles geoffroyi*) – was put together with Nippy to give each other company, and they lived together amicably.

Nippy was originally kept in a cage of the "old gibbon block", until he was moved to the former chimpanzee cage around 1981. After that cage was condemned around 1982, Nippy and Goldie were taken off display. They were housed in the quarantine unit around 1990. As they didn't seem to be happy there, they were moved to the hospital soon after where they got frequent visits from staff, friends and visiting groups, though off-limits for the normal zoo

visitor. The indoor cage (area 2.21 x 2.8 m) had fiberglass insulation and a black heater, set no lower than 20°C. The outdoor part (area 4.5 x 9.3 m, height 2.5 m) had "porch" areas and was divisible into two, but usually Nippy and Goldie had access to both parts, unless the cage was needed for another inmate of the hospital.

The spider monkey Goldie died on 16 Oct. 1996 from an infection. After that, Nippy was kept solitary.

Nippy had various health problems over the years, and some of them were probably related to his progressing age. These are described in one of the following sections.

Nippy was euthanised on 2 Sep. 2008. He had been found in the morning of the same day unable to move and with clinical signs of a stroke. The autopsy revealed signs of a geriatric animal with general muscle atrophy and worn teeth. His organs showed signs of degenerative lesions in the liver, kidney and heart. The histopathology results of the brain were not conclusive.

Nippy's death was commented upon in numerous internet and newspaper reports (e.g. Anonymous, 2008b, c, d, e, f, g, h; Ikram, 2008; Ling, 2008; Nagpal, 2008).

Nippy's age at death

Previously published reports differ as to how old Nippy was on arrival, ranging from 1 year (Anonymous, 2008b, f; Ling, 2008), 1.5 years (Anonymous, 1997), 2 years (Henderson, 2002), to 2-3 years (Strachan, 2001). For many years, the gibbons were cared for by Mr Frank Coles who knew Nippy since 1949 (Anonymous 2004, NZPA, 2004). He remembers that Nippy did not need bottle feeding when he arrived and estimates the gibbon's age at arrival to have been just over a year old (F. Coles, personal communication to BJB, 23 April 2009). Nippy's height measurement at arrival (46 cm, Anonymous, 1949a) seems to confirm this estimate, if the measurement refers to standing height and not sitting height. In a study on the development of captive agile gibbons (*H. agilis*), an individual of 1.23 years of age had a standing height (determined by combining sitting height and leg length) of 47.5 cm (Suzuki *et al.*, 2003). As this height is nearly identical to Nippy's, 1.2 years may be a reasonable estimate for Nippy's age at arrival.

Nippy lived in Wellington from 2 Dec. 1949 to 2 Sep. 2008. This is a time span of 58 years and 10 months or 58.83 years. If Nippy was 1.2 years old at arrival, he was 60 years old when he died.

Health problems and age-related changes

Already in 1987, Nippy was described as the "old man of the zoo" (Anonymous, 1987).

In June 1991, Nippy's upper canines were removed. He had worn incisors and a missing lower incisor before his upper canine teeth were extracted. Ever since the upper canines were removed, he had opaque mucoid discharge from eyes and nostrils sporadically, probably due to a chronic infection in the lacrymal gland. As a result, Nippy's nose and eyes were often congested and with crusting around eyes (see photographs in Figs. 4 – 11). As treatment under anesthesia was considered risky due to Nippy's age, and as his nasal/ocular congestion/discharge did not appear to affect him adversely, he was permanently treated with antibiotics for this condition. Goldie, the spider monkey, cleaned up Nippy's face regularly, and in return he teased her regularly by touching her as he swung past, or pulling her tail a little. Basically they got on very well.

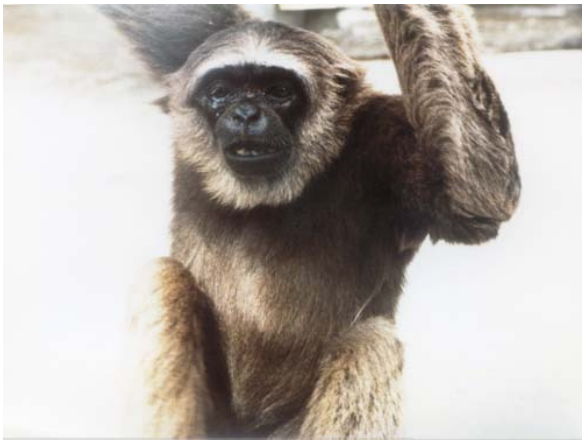

Fig. 4. Gibbon male Nippy on 26 Mar. 1996, at an estimated age of 48 years. Photo: Richard Weigl. – *Das Gibbon-Männchen Nippy am 26. März 1996, im geschätzten Alter von 48 Jahren.*

Fig. 5. Gibbon male Nippy on or near 2 Dec. 1998, at an estimated age of 50 years. Photo: unknown photographer, probably from Wellington City Council. – *Das Gibbon-Männchen Nippy im Dezember 1998, im geschätzten Alter von 50 Jahren.*

Fig. 6. Gibbon male Nippy yawning, c.1999, at an estimated age of 51 years. Notice worn dentition and loss of several teeth (including lower incisors). Photo: courtesy of Wellington City Archives, previously published in Anonymous (1999). – *Das Gibbon-Männchen Nippy um 1999, im geschätzten Alter von 51 Jahren. Die Bezahnung ist stark abgenutzt und mehrere Zähne fehlen, darunter die unteren Schneidezähne*.

Fig. 7. Gibbon male Nippy on 23 Nov. 1999, at an estimated age of 51 years. Photo: Neil Price. – *Das Gibbon-Männchen Nippy am 23 November 1999, im geschätzten Alter von 51 Jahren*.

Although Henderson (2002) suggested that Nippy's "fur may be getting greyer" as a result of his old age, it is unknown whether this is a speculation by the newspaper reporter or based on actual observations by his informants. The colour photos we were able to examine do not provide reliable evidence to prove or disprove that an age-related change in Nippy's fur colouration occurred. None of these colour photographs predate 1996, however.

Fig. 8. Gibbon male Nippy at foraging tray on 14 Oct. 2002, at an estimated age of 54 years. Photo: Pauline Wirihana. – *Das Gibbon-Männchen Nippy an seiner Futterkiste am 14 Okt. 2002, im geschätzten Alter von 54 Jahren*.

Fig. 9. Gibbon male Nippy on 31 Mar. 2004, at an estimated age of 56 years. Photo: Pauline Wirihana. – *Das Gibbon-Männchen Nippy am 31 März 2004, im geschätzten Alter von 56 Jahren*.

Fig. 10. Gibbon male Nippy on 28 Aug. 2006, at an estimated age of 58 years. Photo: Wellington Zoo. – *Das Gibbon-Männchen Nippy am 28 Aug. 2006, im geschätzten Alter von 58 Jahren*.

Fig. 11. Gibbon male Nippy in foraging tray on 18 July 2007, at an estimated age of 59 years. Photo: probably by Pauline Wirihana. – *Das Gibbon-Männchen Nippy in seiner Futterkiste am 18 Juli 2007, im geschätzten Alter von 59 Jahren.*

Although Nippy's teeth were very worn down by 1996, he was still able to catch and eat fully able sparrows (e.g. in Jan. 2001, and Feb. 2008).

On 14 August 2001, Graeme Strachan (personal communication to TG) reported that "Nippy's condition usually got worse in cold weather. He got a chill several weeks ago and although he has recovered he is spending a lot of time now inside next to his heater and is not very active. During previous winters we have been concerned about his making it through to summer but being the gibbon that he is he has always bounced back. We have had some warm winter weather but he rarely sings, so caretakers are understandingly concerned about his future."

Nippy's thin arms suggested age-related muscle loss (Fig. 10), but the thin aspect of his arms may also have been influenced by fur loss. Nippy was much more agile in warmer weather. This was most likely a reaction to his low body mass and very little subcutaneous fat tissue. He clearly seeked warm and sheltered places in his outside area.

Nippy sang less often than in his younger days, but he still occasionally produced his long and loud solo song bouts. His activity levels varied from day to day. Sometimes he just rested in the sun and the next day he could be very active and vocalizing (Strachan, 2001). His songs could still be heard occasionally as late as 4 April 2008, when he produced a song bout of 30 minutes duration at noon.

Tape-recordings of three of Nippy's song bouts dating from 1974, 2001 and 2008, respectively, were available for analysis. Two phrases from each song bout are shown in Fig. 12. The three song bouts differ significantly in several time and frequency variables (Table 1). Due to variation in recording devices, poor recording quality, and the small sample size available for analysis, it is not clear what caused the differences. Causes could be Nippy's age, context of the song bout, recording equipment, or random variability among Nippy's vocal output.

Nippy was named after his passion for biting people. Numerous people have been bitten by the in-

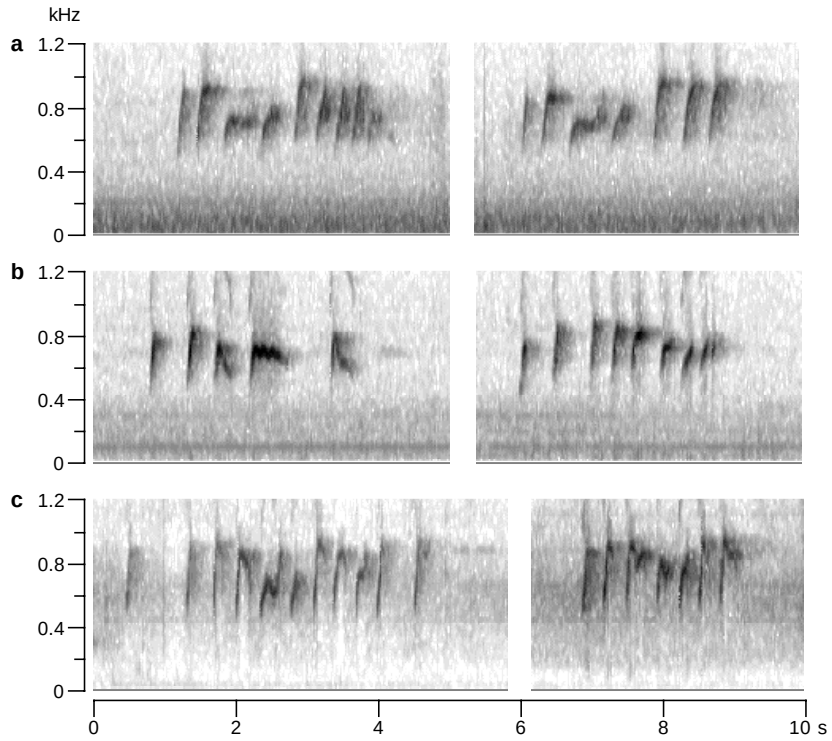

Fig. 12. Sonagrams of two fully developed short phrases each from three solo song bouts of the adult gibbon male Nippy. The song bouts were tape-recorded (a) c.1974, (b) Aug. 2001, and (c) 4 Aug. 2008. – *Sonagramme von je zwei voll ausgeprägten Strophen aus drei Solo-Gesängen des adulten Männchens Nippy. Das Datum der Tonaufnahmen ist circa 1974 (a), August 2001 (b), und 4. August 2001 (c).*

Table 1. Variables measured in sonagrams of three solo song bouts of adult male Nippy, and results from statistical comparison among the three recordings. Values shown include mean ± standard deviation, range (in parentheses), and sample size (i.e. number of analysed phrases). – *Verschiedene Variablen, die an Sonagrammen von Gesangsstrophen des Männchens Nippy bestimmmt wurden. Von den Messwerten sind Mittelwert ± Standardabweichung, Spannweite (in Klammern) und Anzahl ausgewertete Strophen angegeben. Die zwei letzten Spalten der Tabelle liefern die Resultate der statistischen Vergleiche zwischen den drei Tonaufnahmen*.

Variable	Recording date of song bout			ANOVA	Significant Bonnferroni / Dunn *post-hoc* tests ($p < 0.017$)
	c.1974	Aug. 2001	4 Aug. 2008		
Lowest frequency of phrase (Hz)	467±31 (401-519) $n = 10$	366±19 (328-400) $n = 20$	385±45 (326-442) $n = 8$	$p < 0.0001$	1974 *vs*. 2001 1974 *vs*. 2008
Highest frequency of phrase (Hz)	997±27 (936-1027) $n = 10$	1071±41 (1000-1157) $n = 20$	996±31 (922-1008) $n = 8$	$p < 0.0001$	1974 *vs*. 2001 2001 *vs*. 2008
Frequency range of phrase (Hz)	530±45 (466-599) $n = 10$	703±35 (643-778) $n = 20$	589±68 (490-682) $n = 8$	$p < 0.0001$	1974 *vs*. 2001 1974 *vs*. 2008 2001 *vs*. 2008
Main frequency of phrase (Hz)	828±80 (668-894) $n = 10$	708±48 (681-818) $n = 20$	610±61 (506-689) $n = 8$	$p < 0.0001$	1974 *vs*. 2001 1974 *vs*. 2008 2001 *vs*. 2008
Number of notes (without inspiration notes)	8.0±2.2 (5-11) $n = 10$	4.9±1.3 (3-8) $n = 20$	8.4±4.0 (4-15) $n = 8$	$p < 0.0001$	1974 *vs*. 2001 2001 *vs*. 2008
Phrase duration (s)	2.9±0.6 (1.5-3.3) $n = 10$	2.8±0.7 (1.8-4.7) $n = 20$	3.7±1.4 (1.6-4.7) $n = 8$	$p < 0.0001$	1974 *vs*. 2008
Notes / second	3.7±0.9 (2.2-5.5) $n = 10$	1.9±0.4 (1.3-3.0) $n = 20$	3.0±0.8 (2.2-4.7) $n = 8$	$p < 0.0001$	1974 *vs*. 2001 1974 *vs*. 2008

famous Nippy but as time passed, Nippy's habit mellowed, and from the time he barely had any front teeth remaining (Fig. 6), his nips were not as effective as they once had been (Anonymous, 2004; NZPA, 2004).

Nippy's body weight was determined on 19 July 2003 to be 5 kg. Since then, his weight diminished slightly (18 Mar. 2004: 5 kg, 6 Sep. 2004: 4.68 kg, 23 Oct. 2007: 4.75 kg, 21 Nov. 2007: 4.75 kg, 19 Aug. 2008: 4.71 kg, 26 Aug. 2008: 4.735 kg).

In January 2003, it was first noticed that Nippy's hearing had deteriorated, and his deafness seemed more pronounced in 2004. Quite often he either did not hear when spoken to or if he did hear and the speaker was not in Nippy's view it was necessary to make more noise, such as banging on the cage mesh, to get his attention.

One of us (KG) first assessed Nippy in March 2003. At that point, he was a geriatric non-human ape and showed the typical symptoms of age related involuntary weight loss, muscle atrophy and worn teeth. There was a distinct dextro-convex thoracic scoliosis (= lateral, right curvature in the upper region of the spine) which made him appear bent and small (Fig. 13).

He had bilateral entropium (inversion of both eyelids) which caused chronic production of discharge from both eyes. Entropium is commonly seen in old animals and humans and is usually produced by a increasing relaxation of the smooth muscle around the eyes. In newspaper photographs published in June 1987 (Anonymous, 1987), Nippy's eyes still look healthy and seemingly without entropium (Fig. 3).

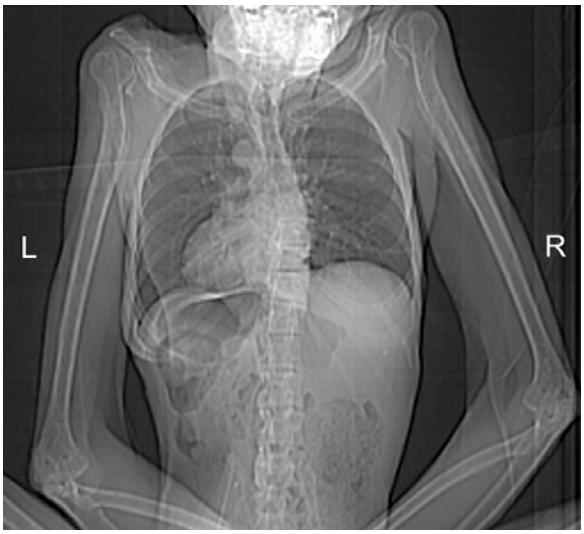

Fig. 13. Computer tomography scan of the chest of male *H. muelleri* Nippy, on 24 Sep. 2003, showing dextro-convex scoliosis of the vertebral column. – *Computer-Tomographie des Brustbereichs des Gibbon-Männchens Nippy vom 24. Sept. 2003. Die rechts-konvexe Skoliose der Wirbelsäule ist deutlich zu erkennen*.

In September 2003 Nippy underwent a computer tomography (CT) scan which revealed erosion of the medial wall of the left orbit and an abnormal soft tissue mass which extends to the medial canthus (in-

side corner of the eye) where it measures approximately 8 mm (Fig. 14). The erosion had well defined sclerotic margins, suggesting that it was an indolent process. An aspiration of the cavity contained a bacterial culture of *Pseudomonas aeruginosa* which was resistant to relevant antibiotics. Nippy had been on and off systemic antbiotics for a long time, and after consultation with human and veterinary specialists, the Wellington Zoo veterinary and curatorial team decided to discontinue the treatments because it was unlikely that they would reach the abscess inside the bone in sufficient dosages. Surgical treatment was not selected because of fear that his facial bones might collapse. Nippy was put on a supportive treatment with additional high caloric and palatable food items as well as medication. Daily he received ¼ of an effervescent Berocca tablet (vitamin supplement; Bayer), 0.25ml Alpha-Lactulose (contains laculose 3.34 mg/5ml), ¼ Echinacea tablet and 1 tablespoon of Nutrigel (high calorie nutritional support; Ethical Agents Ltd.).

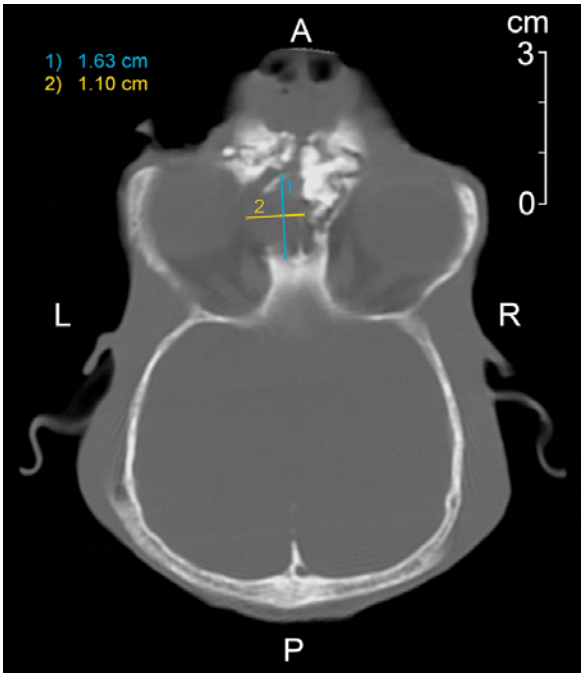

Fig. 14. Computer tomography scan of the head of gibbon male Nippy, on 24 Sep. 2003, showing erosion of the medial wall of the left orbit. – *Computer-Tomographie des Kopfes des Gibbon-Männchens Nippy vom 24. Sept. 2003. Sie zeigt die Auflösung der medialen Wandung der linken Augenhöhle*.

Longevity and body weight

The longevity of the genus *Hylobates*, as represented by the male *H. muelleri* appears to be exceptionally high. Fig. 15 shows the relationship between log body weight and log longevity in various groups of primates. Each dot represents one genus.

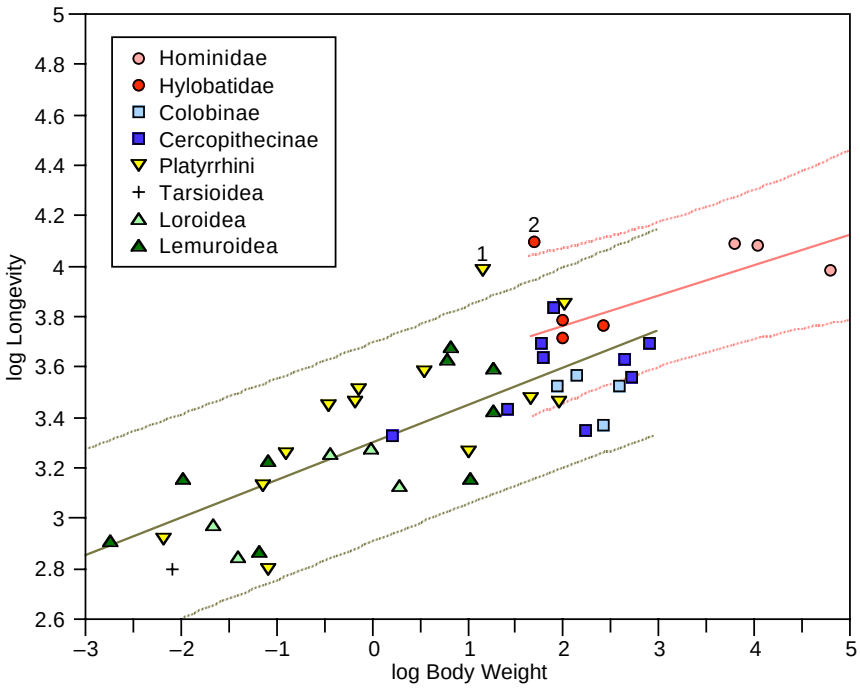

Fig. 15. Relationship between body weight and longevity in various groups of primates. Each dot represents one genus. The linear regressions were calculated under exclusion of the genus *Hylobates*. The regression line and confidence curves apply to non-hominoid primates. The one to the right applies to hominoids. The two variables are significantly correlated ($p < 0.001$, and $p < 0.05$, respectively). Only two samples lie outside (and above) their respective confidence limits: *Cebus* (1) and *Hylobates* (2). – *Beziehung zwischen Körpergewicht und Langlebigkeit bei Primaten. Jeder Punkt stellt eine Primatengattung dar. Die Gattung* Hylobates *wurde bei den Regressionsberechnungen ausgeklammert. Die linke Regressionsgerade mit* Konfidenzintervallen *gilt für die Nicht-Menschenaffen, die rechte für die Menschenaffen. Die beiden Variablen sind statistisch signifikant miteinander korreliert* ($p < 0.001$, *beziehungsweise* $p < 0.05$). *Nur zwei Stichproben liegen ausserhalb (und oberhalb) der Konfidenzintervalle: Die Kapuzineraffen, Gattung* Cebus *(1) und die Kleingibbons, Gattung* Hylobates *(2)*.

A first linear regression with confidence limits was calculated for non-hominoid primates. The two variables are highly correlated ($p < 0.001$). Only one genus (*Cebus*, capuchin monkeys) appears to lie outside the confidence limits that cover 95% of all data points. Primates of the genus *Cebus* appear to exhibit a higher longevity than other primates of this body size. An extension of the regression line and limits to the right would also include all apes except gibbons of the genus *Hylobates*. The latter also exhibit a higher longevity than what should be expected from their body weight.

A second regression line with confidence limits was calculated for hominoid primates. The genus *Hylobates* was excluded from this calculation. Again, the two variables are correlated ($p < 0.05$). As the regression line for apes is based on solely six data points, it should be considered with caution. An extension of the regression line and confidence limits to the left would also include the genus *Cebus*, but again exclude the genus *Hylobates*.

In a regression line with confidence limits including all primate genera (graph not shown), the genera *Cebus* and *Hylobates* both are situated above the confidence limits.

Although the total number of apes living in captivity is not known, numeric proportions among the species or genera can be estimated by using the numbers of animals of each genus that are currently living in ISIS (International Species Information System) member institutions (Table 2).

Table 2. Numbers of apes of each genus kept in ISIS institutions.[1] – *Die Individuenzahl der Menschenaffen, aufgegliedert nach Gattung, die in ISIS-Mitgliedsinstitutionen gehalten werden*.

Genus	Numbers in captivity
Small apes, Hylobatidae:	
Hoolock gibbon (*Hoolock*)	0
Crested gibbon (*Nomascus*)	284
Siamang (*Symphalangus*)	324
Dwarf gibbon (*Hylobates*)	682
Great apes, Hominidae:	
Orangutan (*Pongo*)	654
Gorilla (*Gorilla*)	767
Chimpanzee (*Pan*)	1'357

[1] Source: http://app.isis.org/abstracts/abs.asp [consulted on 23 July 2008]

Among ape genera, log longevity correlates significantly with log numbers in captivity ($p = 0.034$), as shown in Fig. 16. For this calculation, the genus *Hoolock* was excluded, as it was not kept in any of the ISIS member institutions and the logarithm for a population size of zero is not defined. The correlation between log Longevity and log Numbers in captivity is even more significant ($p < 0.0001$) if non-hominoid genera are included as well (plot not shown).

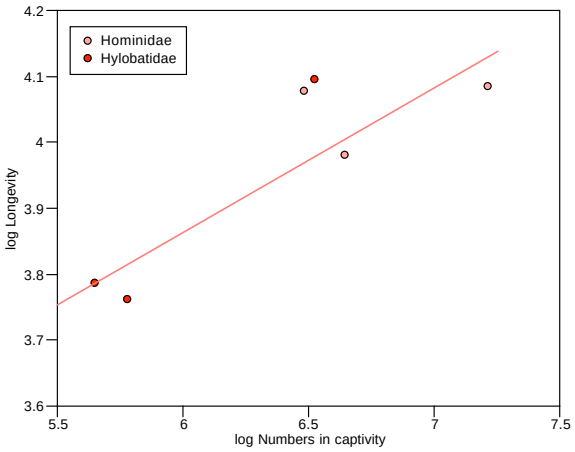

Fig. 16. Relationship between longevity and numbers of apes of each genus kept in ISIS institutions (as listed in Table 1). The linear regression was calculated under exclusion of the genus *Hoolock*, because its captive population size of zero could not be converted to a logarithm. The two variables are significantly correlated ($p = 0.034$). – *Beziehung zwischen Langlebigkeit und in ISIS-Mitgliedsinstitutionen gehaltenen Individuen der Menschenaffen. Die Gattung* Hoolock *wurde nicht berücksichtigt, da der Logarithmus für eine Populationsgrösse von Null nicht definiert ist. Die beiden Variablen sind statistisch signifikant miteinander korreliert (*p = *0.034)*.

A comparison of log Body weight with log Numbers in captivity does not reveal a significant correlation among primate genera ($p > 0.05$).

Discussion

With an estimated age at death of 60 years, Nippy the Mueller's gibbon (*Hylobates muelleri*) attained one of the highest known life spans among non-human primates, including the great apes. Currently the proven longevity record for a living ape is held by a male chimpanzee, Kongo, who is still alive at 60 years and 7 months (Weigl, 2009). As shown by the results of this study, the genus *Hylobates* exhibits a higher longevity than what can be expected for a primate of this body weight.

How can this result be interpreted? (1) The genus *Hylobates* could be truly exceptional, similar to the genus *Cebus*. (2) The seemingly elevated longevity of *Hylobates* could be an artefact based on coincidence or on sampling size. These two interpretations will be briefly evaluated below.

The reason why *Cebus* exhibits an elevated longevity is poorly understood. This genus is also exceptional among Neotropical primates in a number of other characteristics, including longer period of skeletal development, extended nursing duration, delayed onset of puberty, elevated brain size (Fedigan and Rose, 1995; Fragaszy and Bard, 1997; Harvey *et al*., 1987), high propensity for tool using behaviour, and a high variety of cognitive abilities (Fragaszy *et al*., 1990; Ottoni and Mannu, 2001; Visalberghi, 1990, 1997; Westergaard and Fragaszy, 1987). Within this set of specialities, an elevated longevity

would be plausible at least. So far, no such specialities, as compared to other hominoid primates, have been reported for the genus *Hylobates*, so far. An elevated longevity for this gibbon genus would seem to be more surprising than for the genus *Cebus*.

Alternatively, the result for the genus *Hylobates* could just be an artefact. For instance, Nippy could just be a singularity, an incredibly "tough" gibbon that is not representative of its genus.

Sample size could also have influenced the result. Longevity of genera or taxonomic groups that are rarely kept, or that are difficult to keep, in captivity, such as members of the Loroidea, Tarsioidea or the Colobinae, may be under-explored. This may be one reason why most or all data points of these primate groups lie below the regression line (Fig. 15).

Among gibbons, the genus *Hylobates* is by far the best represented in captivity. It may, therefore, be no coincidence that the highest longevity is found in a member of this genus. Consequentially, the lowest longevity value is reported for the genus *Hoolock*, which is by far the least represented in captivity (Table 2).

Because we found reported longevity in primates to be correlated with the number of individuals of each genus in captivity (Fig. 16), it is plausible to assume that considerably higher longevity may eventually be recorded for gibbon genera other than *Hylobates* as more data become available. This may not necessarily apply, however, to genera of the great apes. To judge by their body weight, they should exhibit higher longevity than all of the small apes, but the longevity value reported in this study for the genus *Hylobates* is one of the highest known longevity values among non-human primates including the great apes. However, the numbers of great apes kept in captivity are of similar size or even considerably larger than those of *Hylobates*, which is the most common gibbon genus in captivity (Table 2). As a result, a lack of data does not appear to be responsible for the relatively modest longevity in great apes like orangutans (*Pongo*) and gorillas (*Gorilla*), as compared to the small apes. An increase in sample size may produce only a moderate increase in the longevity recorded for these great ape genera.

If zoos had a preference for keeping primates of large body size, this would also produce a correlation between population size and longevity. Such a preference, however, was not found in our study. We found no correlation between log Body weight and log Numbers in captivity. This suggests that the observed correlation between the captive population size and longevity does not result from a preference of zoos for large-sized primates.

In summary, *Hylobates* is too long-lived for its body weight, and a similar result may eventually be confirmed for the other gibbon genera when larger numbers of individuals are surveyed. Traditionally, the great apes are identified as the long-lived apes (Carey and Judge, 2000), but when adjusted for body size, longevity in small apes appears to be even more exceptional. Elevated longevity is a feature gibbons appear to share with the Neotropical monkeys (*Cebus*) and humans, but how and why the feature evolved in gibbons will require further investigation.

Acknowledgements

We are grateful to Neil Price, Richard Weigl and Pauline Wirihana for photographs, to Graeme Strachan for providing two tape-recordings of Nippy's song bouts, and to Frank Coles and Graeme Strachan for helpful information on Nippy's previous history. Michael Biggs kindly provided a photograph from the Wellington City Archives. We thank Richard Weigl for information on chimpanzee "Cheeta" and Karin Isler for helpful discussions regarding the statistical analyses.

References

Adams, G. (2008). Monkey business: Has Cheeta been cheated out of a star on Hollywood's Walk of Fame? *The Independent* (Internet, 20 June 2008) www.independent.co.uk/arts-entertainment/film-and-tv/features/monkey-business-has-cheeta-been-cheated-out-of-a-star-on-hollywoods-walk-of-fame-850942.html

Anderson, L. (1987). Zoo announces record gibbon birth. *AAZPA (American Association of Zoological Parks and Aquariums) Newsletter* **28**(9): 25.

Anonymous (1949a). Zoo animals arrive. *The Evening Post, Wellington*, 2 Dec. 1949.

Anonymous (1949b). New feature for the zoo. *Evening Post, Wellington*, 28 Dec. 1949.

Anonymous (1950). Zoo animals cost a lot. *The Evening Post, Wellington*, 5 April 1950.

Anonymous (1953). Wonderful show at zoo. *The Evening Post, Wellington*, 3 Dec. 1953.

Anonymous (1954a). Percy Pelican is oldest pet at Wellington zoo. *New Zealand Free Lance*, 8 Sep. 1954, pp. 18-20.

Anonymous (1954b). From the Binturong down… Zoo represents big investment. *The Evening Post, Wellington*, 12 Dec. 1954.

Anonymous (1987). Old man of the zoo. *The Evening Post, Wellington*, 2 June 1987.

Anonymous (1997). It's a gibbon's life: Nippy turns 50. *CNN interactive*, 4 Dec. 1997 (Internet): www.cnn.com/EARTH/9712/04/gibbon.bday/

Anonymous (1999). Nippy happy in his nifty fifties. *Absolutely Positively Wellington, W.C.C. Newsletter*, Dec. 1999, p. 8.

Anonymous (2002). Title unknown. *The Dominion Post, Wellington*, 14 Oct. 2002.

Anonymous (2004). Old buddies (Internet report, *Wellington Zoo*, 2 Dec. 2004) www.wellingtonzoo.com/inform/news/nr1101935522.html

Anonymous (2005). Older and wiser… but still Nippy. *The Dominion Post, Wellington*, 15 Sep. 2005.

Anonymous (2008a). *ARKS specimen report for Wellington Zoo / M10*. Unpublished, consulted: 24 July 2008.

Anonymous (2008b). A fond farewell to Nippy the gibbon. *Absolutely Positively Wellington*, Oct. 2008, p. 16. Internet: www.wellington.govt.nz/publications/pdfs/2008-10-apw.pdf

Anonymous (2008c). Nippy no more. (Internet report, 2 Sep. 2008) www.stuff.co.nz/4678286a11.html

Anonymous (2008d). Nippy the gibbon put down. *TVNZ*, 2 Sep. 2008 (Internet): http://tvnz.co.nz/view/page/423466/2052837

Anonymous (2008e). Nippy, oldest known gibbon in captivity, dies. *Earth Times*, 2 Sep. 2008 (Internet): www.earthtimes.org/articles/show/229343, nippy-oldest-known-gibbon-in-captivity-dies.html

Anonymous (2008f). R.I.P. Nippy. *Wellington Zoo*, 23 Sep. 2008 (Internet): www.wellingtonzoo.com/net/news/article.aspx?id=9

Anonymous (2008g). World's oldest gibbon passes away. (Internet report, 2 Sep. 2008) http://3news.co.nz/News/HealthNews/Worldsoldeststgibbonpassesaway/tabid/420/articleID/69709/cat/58/Default.aspx

Anonymous (2008h). Zoo's oldest resident dies. *Scoop*, 2 Sep. 2008 (Internet): www.scoop.co.nz/stories/AK0809/S00021.htm

Austad, S. N., and Fischer, K. E. (1992). Primate longevity: Its place in the mammalian scheme. *American Journal of Primatology* **28**: 251-261.

Carey, J. R., and Judge, D. S. (2000). *Longevity records: Life spans of mammals, birds, amphibians, reptiles, and fish*, Odense University Press, Odense, 241 pp.

Charif, R. A., Waack, A. M., and Strickman, L. M. (2008). *Raven Pro 1.3 user's manual*, Cornell Laboratory of Ornithology, Ithaca, NY, x+313 pp.

Fedigan, L., and Rose, L. (1995). Interbirth intervals in sympatric monkeys in Central America. *American Journal Primatology* **37**: 9-24.

Flower, S. S. (1931). Contributions to our knowledge of the duration of life in vertebrate animals. - V. Mammals. *Proceedings of the Zoological Society, London* **1931**: 145-234.

Fragaszy, D. M., and Bard, K. 1997. Comparison of development and life history in *Pan* and *Cebus*. *International Journal of Primatology* **18**: 683-701.

Fragaszy, D. M., Visalberghi, E., and Robinson, J. G. (1990). Variability and adaptability in the genus *Cebus*. *Folia Primatologica* **54**: 114–118.

Geissmann, T. (1991). Reassessment of age of sexual maturity in gibbons (*Hylobates* spp.). *American Journal of Primatology* **23**: 11-22.

Geissmann, T. (1998). Body weight in wild gibbons (Hylobatidae). In *Abstracts, XVIIth Congress of the International Primatological Society, August 10-14, 1998, abstract no. 282*, University of Antananarivo, Madagascar.

Geissmann, T., and Anzenberger, G. (2009). Hormonal correlates of the ovarian cycle in the yellow-cheeked crested gibbon (*Nomascus gabriellae*), and a review of ovarian cycles in gibbons (Hylobatidae). *Gibbon Journal* **5**: 61-73.

Geissmann, T., and Orgeldinger, M. (1995). Neonatal weight in gibbons (*Hylobates* spp.). *American Journal of Primatology* **36**: 179-189.

Gordon, A. D. (2006). Scaling of size and dimorphism in primates II: Macroevolution. *International Journal of Primatology* **27**: 63-105.

Harvey, P. H., Martin, R. D., and Clutton-Brock, T. H. (1987). Life histories in comparative perspective. In Smuts, B. B., Cheney, D. L., Seyfarth, R. M., Wrangham, R. W., and Struhsaker, T. T. (eds.), *Primate societies*, University of Chicago Press, Chicago and London, pp. 181-196.

Henderson, R. (2002). Oldest swinger in the zoo reaches 55. *The Evening Post, Wellington*, 30 Nov. 2002.

Hill, R. (1999). Still monkeying around. *Cook Strait News, Wellington*, 29 or 30 Nov. 1999, p. 5.

Ikram, A. (2008). Farewell Nippy the gibbon. *3News.co.nz* 3 Sep. 2008 (Internet): www.3news.co.nz/TVShows/Sunrise/AlisSmashHits/AlisBlog/tabid/834/articleID/69795/cat/592/Default.aspx

Jones, M. L. (1962). Mammals in captivity – Primate longevity. *Laboratory Primate Newsletter* **1**(3, July 1962): 3-13.

Jones, M. L. (1968). Longevity of primates in captivity. *International Zoo Yearbook* **8**: 183-192.

Jones, M. L. (1979). Longevity of mammals in captivity. *International Zoo News* **129** (26/3): 16-26.

Jones, M. L. (1982). Longevity of captive mammals. *Der Zoologische Garten (N.F.)* **52**: 113-128.

Ling, J. (2008). Farewell Nippy – Gibbon but not forgotten. *Dominion Post*, 3 Sep. 2008 (Internet): www.stuff.co.nz/dominionpost/4678570a23918.html

Martinez, M. (2008). Old but still a swinger. *Chicago Tribune*, 6 July 2008 (Internet): www.chicagotribune.com/news/nationworld/chi-cheeta-letter_bdjul06,0,2325289.story?track=rss

Nagpal, S. (2008). Nippy, oldest known gibbon in captivity, dies. *TopNews.in*, 2 Sep. 2008 (Internet): www.topnews.in/nippy-oldest-known-gibbon-captivity-dies-263970

Nash, E. (2008). Exclusive: Hollywood chimp Cheeta gets star on Walk Of Fame. *Mirror.co.uk: Celebs*, 6 July 2008 (Internet): www.mirror.co.uk/celebs/latest/2008/07/08/exclusive-hollywood-chimp-cheeta-gets-star-on-walk-of-fame-89520-20635735/

Neate, R. (2008). Cheeta, Tarzan star and world's oldest chimpanzee, hopes for Hollywood recognition. *Telegraph.co.uk.*, 8 July 2008 (Internet): www.telegraph.co.uk/news/newstopics/celebritynews/2267639/Cheeta,-Tarzan-star-and-world's-oldest-chimpanzee,-hopes-for-Hollywood-recognition.html

NZPA (2004). A special friendship *The Sidney Morning Herald*, 4 Dec. 2004 (Internet): www.smh.com.au/news/Unusual-Tales/A-special-friendship/2004/12/03/1101923341888.html

Ottoni, E. B., and Mannu, M. (2001). Semifree-ranging tufted capuchins (*Cebus apella*) spontaneously use tools to crack open nuts. *International Journal of Primatology* **22**: 347-358.

Puschmann, W., and Federer, E. (2008). Ein neuer Fertilitätsnachweis bei einer hoch betagten Schimpansin und Anmerkungen zum Höchstalter von *Pan troglodytes*. *Zoologischer Garten N.F.* **77**: 182-185.

Rosen, R. D. (2008). Lie of the jungle. *Washington Post*, Sunday, 7 Dec. 2008; Page W14. (Internet): www.washingtonpost.com/wp-dyn/content/article/2008/11/25/AR2008112500939.html?hpid=features1&hpv=national

Sacher, G. A. (1975). Use of zoo animals for research on longevity and aging. In *Research in Zoos and Aquariums*, pp. 191-197. National Academy of Sciences, Washington, D.C.

Strachan, G. (2001). The oldest living Mueller's gibbon (*Hylobates muelleri*). *The Gibbon's Voice* 5 (1, Dec. 2001): 4-5.

Suzuki, J., Kato, A., Maeda, N., Hashimoto, C., Uchikosi, M., Mizutani, T., Doke, C., and Matsuzawa, T. (2003). Plasma insulin-like growth factor-1, testosterone and morphological changes in the growth of captive agile gibbons (*Hylobates agilis*) from birth to adolescence. *Primates* **44**: 273-280.

Visalberghi, E. (1990). Tool use in *Cebus*. *Folia Primatologica* **54**: 146–154.

Visalberghi, E. (1997). Success and understanding in cognitive tasks: A comparison between *Cebus apell*a and *Pan troglodytes*. *International Journal of Primatology* **18**: 811-830.

Weigl, R. (2005). *Longevity of mammals in captivity; from the living collections of the world. A list of mammalian longevity in captivity*, Kleine Senckenberg-Reihe 48. E. Schweizerbart'sche Verlagsbuchhandlung Stuttgart, 214 pp.

Weigl, R. (2009). Cheeta – the world's oldest chimpanzee? *International Zoo News* **56** (1) (Jan./Feb. 2009, No. 370): 24-25.

Wellington City Council (2004). Presentation of long service award. In: *Wellington city council, Ordinary meeting, minutes, Wednesday 6 Oct. 2004*, pp. 3-5. Downloadable from www.wellington.govt.nz/haveyoursay/meetings/title/Council/2004/06Oct1730/pdf/20041006minutes.pdf

Westergaard, G. C., and Fragaszy, D. M. (1987). The manufacture and use of tools by capuchin monkeys (*Cebus apella*). *Journal of Comparative Psychology* **101**: 159-168.

Wikipedia contributors (2008). Cheeta. *Wikipedia, The Free Encyclopedia* (accessed 13 Aug. 2008): http://en.wikipedia.org/w/index.php?title=Cheeta&oldid=230275189

Zusammenfassung

Langlebigkeit von Gibbons (*Hylobatidae*)

Ein Langlebigkeits-Rekord von 60 Jahren bei einem Müllers Gibbon (*Hylobates muelleri*) im Zoo von Wellington (Neuseeland) wird vorgestellt. Dies scheint der zweitälteste nicht-menschliche Primat zu sein, der bisher bekannt ist, aber sein hohes Alter ist noch bemerkenswerter, wenn man es zur Körpergrösse dieser Gibbons in Beziehung setzt. Dass die Langlebigkeit von Säugetieren mit ihrer Körpergrösse korreliert, ist bekannt. Eigentlich sollte man daher erwarten, dass die Gattungen der Gibbons oder kleinen Menschenaffen aufgrund ihres geringeren Körpergewichtes durchgehend niedrigere Langlebigkeiten aufweisen als die grossen Menschenaffen. Die hier vorgestellte Langlebigkeit der Gibbon-Gattung *Hylobates* kehrt diesen erwarteten Befund aber zumindest für zwei Gattungen grosser Menschenaffen auf den Kopf: Orang-Utans (*Pongo*) und Gorillas (*Gorilla*).

Die Resultate dieser Studie zeigen weiter, dass es auch eine signifikante Korrelation zwischen der Populationsgrösse einer Primaten-Gattung in Gefangenschaft und deren maximaler bekannter Lebensdauer gibt. Ein Vergleich zwischen der Langlebigkeit und der Zahl der Tiere in Gefangenschaft lässt vermuten, dass die bisher belegte Langlebigkeit der Gibbon-Gattungen *Hoolock*, *Nomascus* und *Symphalangus* deshalb niedriger ist als diejenige der Gattung *Hylobates*, weil *Hylobates* viel häufiger in Gefangenschaft gehalten wird und daher die Langlebigkeit auf einer grösseren Datenmenge basiert. Die Resultate dieser Studie lassen vermuten, dass in Zukunft bei allen Gibbon-Gattungen erhöhte Langlebigkeit relativ zu ihrem Körpergewicht gefunden wird, wenn grössere Datenmengen zur Verfügung stehen. Bei grossen Menschenaffen, von denen bereits jetzt grössere Gefangenschafts-Populationen als bei *Hylobates* vorliegen, dürfte eine weitere Vergrösserung der Datenmengen eine bescheidenere Korrektur der beobachteten Langlebigkeit zur Folge haben als für die meisten Gibbon-Gattungen.

New Media 2008

Theses

Rokkam, D. (2008). *Study of synteny breakpoints in* Nomascus l. leucogenys *by creation of shotgun clones*. MSc thesis in Biological Sciences, California State University, East Bay, 124 pp.

Books and special publications

Campbell, C., Andayani, N., Cheyne, S., Pamungkas, J., Manullang, B., Usman, F., Wedana, M., and Traylor-Holzer, K. (Eds.). (2008). *Indonesian gibbon conservation and management workshop final report*, IUCN/SSC Conservation Breeding Specialist Group Apple Valley, MN, 96 pp.

Fellowes, J. R., Lau, M. W. N., Ng Sai Chit, Chan, B. P. L., Boonratana, R., and Brown, A. (2008). *Sustaining the pulse: Managing for biodiversity conservation in south China's forest nature reserves*, Kadoorie Farm and Botanic Garden, Hong Kong, iv+132 pp.

FFI China Programme (2008). *Western black crested gibbon conservation status and strategy workshop results and outputs*, FFI China Programme, Kunming, China, 9 pp.

Geissmann, T., Grindley, M., Momberg, F., Ngwe Lwin, and Saw Moses (2008). *Hoolock gibbon and biodiversity survey and training in southern Rakhine Yoma, Myanmar: Preliminary report*, Myanmar Primate Conservation Program, BANCA, FFI, PRCF and Yangon University, Yangon, Myanmar, 31 pp.

Jiao, Z. (2008). *Summary report on poster competition among the primary and middle schools in Jingxi, 9 November 2008*, Fauna and Flora International China Programme: Cao Vit Gibbon Conservation Project in Jingxi, 9 pp.

Shao, S. (2008). *Facilitating student exploration of the natural treasures of Hainan's rain forest*, Process report: Presented to SeaWorld & Busch Gardens Conservation Fund by Fauna & Flora International China Programme, 25 November 2008, 15 pp.

Journal articles and book chapters

Anonymous (2008). [Book review:] Hoolock: The ape of India. Dilip Chetry, Rekha Chetry and P.C. Bhattacharjee. *Zoos' Print Magazine* **23**(10): 8.

Anonymous (2008). [Hangzhou Animal World hoolock gibbon gives birth]. *new.xintv.com* **2 April 2008**: Internet: http://xnews.xintv.com/html/NEWS/SHEHUIJUJIAO/2008/04/02/474854.html (Chinese text).

Anonymous (2008). Augenblick mal. *SonntagsZeitung (Zürich)* **18 May 2008**: 92 (German text).

Anonymous (2008). Briefly [China loses its white-handed gibbons]. *Oryx* **42**: 471-480.

Anonymous (2008). Freedom and friend for five-year-old gibbon (Internet, 30 May 2008: www.sinlung.com/?p=1879 and http://northeastonline.blogspot.com/2008/05/freedom-and-friend-for-five-year-old.html.

Anonymous (2008). Wild to wild translocation training for hoolock gibbon held Assam. *Zoos' Print Magazine* **23**(11): 9.

Anonymous (2008). World's rarest ape population doubles. *FFI update (Newslatter of Fauna & Flora International)* **9**(Spring 2008): 1.

Anonymous (2008b). A fond farewell to Nippy the gibbon. *Absolutely Positively Wellington* **October 2008**: 16. (Internet): www.wellington.govt.nz/publications/pdfs/2008-10-apw.pdf

Anonymous (2008c). Nippy no more. *Internet report, 2 September 2008*: www.stuff.co.nz/4678286a11.html

Anonymous (2008d). Nippy the gibbon put down. *TVNZ* **2 September 2008** (Internet): http://tvnz.co.nz/view/page/423466/2052837

Anonymous (2008e). Nippy, oldest known gibbon in captivity, dies. *Earth Times* **2 September 2008** (Internet): www.earthtimes.org/articles/show/229343,nippy-oldest-known-gibbon-in-captivity-dies.html

Anonymous (2008f). R.I.P. Nippy. *Wellington Zoo* **23 September 2008** (Internet): www.wellingtonzoo.com/net/news/article.aspx?id=9

Anonymous (2008g). World's oldest gibbon passes away. *Internet report, 2 Sep 2008*: http://3news.co.nz/News/HealthNews/Worldsoldeststgibbonpassesaway/tabid/420/articleID/69709/cat/58/Default.aspx

Anonymous (2008h). Zoo's oldest resident dies. *Scoop* **2 September 2008** (Internet): www.scoop.co.nz/stories/AK0809/S00021.htm

ap (2008). Menschenaffen-Arten in China gefährdet. *Die Südostschweiz / Graubünden (Chur)* **16 May 2008**: 36 (German text).

Arbib, M. A., Liebal, K., and Pika, S. (2008). Primate vocalization, gesture, and the evolution of human language *Current Anthropology* **49**(6): 1053-1076.

Archives (2008). Brèves planète. *Le Temps (Genève)* **19 May 2008**: 16 (French text).

Avni-Magen, N., Elad, D., Friedman, M., Gati, I., Kaufman, E., and Lavy, E. (2008). Use of a sustained release preparation of clotrimazole to treat dermatophytosis in a siamang (*Hylobates syndactylus*). *Journal of Zoo and Wildlife Medicine* **39**(1): 115-117.

Barelli, C., Boesch, C., Heistermann, M., and Reichard, U. H. (2008). Female white-handed gibbons (*Hylobates lar*) lead group movements and have priority of access to food resources. *Behaviour* **145**: 965-981.

Barelli, C., Heistermann, M., Boesch, C., and Reichard, U. H. (2008). Mating patterns and sexual swellings in pair-living and multimale groups of wild white-handed gibbons, *Hylobates lar*. *Animal Behaviour* **75**: 991-1001.

Barker, M. K. (2008). Gibbon hand preference studies at the Endangered Primate Rescue Center, Vietnam. *Vietnamese Journal of Primatology* **2**: 41-45.

Bartlett, T. Q. (2008). Sex differences in foraging among white-handed gibbons. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, pp. 76-77 (Abstract only).

Bower, B. (2008). China was an ancient-ape paradise. Excavations uncover oldest known ancestral gibbon remains. *Science News* **173**(16, 10 May 2008): Downloadable from www.sciencenews.org/view/generic/id/31434/title/China_was_an_ancient-ape_paradise.

Carstensen, N., (signed "nc") (2008). Die Letzten ihrer Art. *Tier International (Stiftung Tierpark Hagenbeck)* **2008**(2): 16-27 (German text).

Chan, B. P. L., Tan, X.-F., and Tan, W.-J. (2008). Rediscovery of the critically endangered eastern black crested gibbon *Nomascus nasutus* (Hylobatidae) in China, with preliminary notes on population size, ecology and conservation status. *Asian Primates Journal* **1**(1): 17-25.

Chan, B. P. L., Tan, X.-f., and Tan, W.-j. (2008). Rediscovery of the critically endangered eastern black crested gibbon *Nomascus nasutus* (Hylobatidae) in China, with preliminary notes on population size, ecology and conservation status. *Asian Primates Journal* **1**(1): 17-25.

Channon, A. J., Vereecke, E. E., and Gunther, M. M. (2008). The morphology of the gibbon hind limb and a kinematic study of jumping gibbons. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 208 (Abstract only).

Chen, H.-C., and Kaplan, G. (2008). Vocal individuality in white-cheeked crested gibbons (*Nomascus leucogenys*): Acoustic features and song organization. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 238 (Abstract only).

Chen, H.-C., Kamolnorranath, S., and Kaplan, G. (2008). Female crested gibbons (genus *Nomascus*) sing male song. *Vietnamese Journal of Primatology* **2**: 47-53.

Chetry, D., Chetry, R., and Ghosh, K. (2008). Sleeping tree selection by sympatric primates in Gibbon Wildlife Sanctuary, Assam, India. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 151 (Abstract only).

Chetry, D., Chetry, R., Das, A., Loma, C., and Panor, J. (2008). New distribution records for *Hoolock leuconedys* in India. *Primate Conservation* **23**: 125-128.

Cheyne, S. M. (2008). Feeding ecology, food choice and diet characteristics of gibbons in a disturbed peat-swamp forest, Indonesia. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 323 (Abstract only).

Clemens, Z., Merker, B., and Ujhelyi, M. (2008). Observations on paternal care in a captive family of white-handed gibbons (*Hylobates lar*). *Gibbon Journal* **4**: 46-50.

Clements, T. J., Rawson, B. M., Pollard, E., Nut Meng, H., and An, D. (2008). Long-term monitoring of black-shanked douc langur (*Pygathrix nigripes*) and yellow-cheeked crested gibbon (*Nomascus gabriellae*) in the Seima Biodiversity Conservation Area, Cambodia. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 275 (Abstract only).

Clements, T., Rawson, B., Pollard, E., O'Kelly, H., and Nut Meng Hor (2008). Conservation status and monitoring of black-shanked douc, *Pygathrix nigripes* and yellow-cheeked crested gibbon, *Nomascus gabriellae* in the Seima Biodiversity Conservation Area, Cambodia. In Nadler, T., and Rawson, B. (eds.), *Conservation of primates in Indochina. International Symposium, Cuc Phuong National Park, 27-30 November 2008*, Cuc Phuong National Park, Vietnam, p. 18 (Abstract only).

DPA (2008). Gibbon-Art ausgerottet. *Aargauer Zeitung / Gesamt Regio (Aarau)* **16 May 2008**: 36 (German text).

Eberl, E. M. (2008). A primate "motor theory of sound perception": Three case studies with gibbons. *Gibbon Journal* **4**: 64-72.

Fedor, A., Skollár, G., Szerencsy, N., and Ujhelyi, M. (2008). Object permanence tests on gibbons (Hylobatidae). *Journal of Comparative Psychology* **122**(4): 403-417.

Fellowes, J. R., Chan, B. P. L., Zhou, J., Chen, S., Yang, S., and Ng, S. C. (2008). Current status of the Hainan gibbon (*Nomascus hainanus*): Progress of population monitoring and other priority actions. *Asian Primates Journal* **1**(1): 2-9.

Geissmann, T. (2008). [Gibbon songs and music]. In Koizumi, H., and Okanoya, K. (eds.), *[Symposium on Art and Brain Science II: Evolution of music and brain science. Phoenix Plaza, Ginza, Tokyo, 30 August 2008: Abstracts]*, Seizon-Kagaku Institute, Tokyo, pp. 8-9 (Japanese abstract only).

Geissmann, T. (2008). Auf der Suche nach Chinas letzten Weisshandgibbons: Ein Projektbericht aus dem Nangunhe-Naturreservat in der Provinz Yunnan [In search of the China's last white-handed gibbons: A project report from the Nangunhe Nature Reserve in Yunnan Province]. *Gibbon Conservation Alliance, Jahresbericht* **4**(May): 10-21 (German text, English summary).

Geissmann, T. (2008). Gibbon paintings in China, Japan, and Korea: Historical distribution, production rate and context. *Gibbon Journal* **4**: 1-38.

Geissmann, T. (2008). Inter-group conflict in captive siamangs (*Symphalangus syndactylus*). *Gibbon Journal* **4**: 51-55.

Geissmann, T. (2008). Song-diversity in a gibbon species: The silvery gibbon (*Hylobates moloch*) from Java (Indonesia). In Miyazaki, K., Hiraga, Y., Adachi, M., Nakajima, Y., and Tsuzaki, M. (eds.), *The 10th International Conference on Music Perception and Cognition, ICMPC 10: Abstracts. 25-29 August 2008, Sapporo, Japan*, Hokaido Printing Planning Co. Ltd., Sapporo, p. 30 (Abstract only).

Geissmann, T., and Manella, B. (2008). Steroid secretion in siamang (*Symphalangus syndactylus*) skin glands. *Gibbon Journal* **4**: 56-63.

Hallam, C., and Johnson, A. (2008). Gibbons as landscape species: Strategic planning for primate conservation in Lao PDR. In Nadler, T., and Rawson, B. (eds.), *Conservation of primates in Indochina. International Symposium, Cuc Phuong National Park, 27-30 November 2008*, Cuc Phuong National Park, Vietnam, p. 16 (Abstract only).

Hamard, M., Nijman, V., and Cheyne, S. M. (2008). Effects of habitat disturbance on relative densities of bornean agile gibbons (*Hylobates albibarbis*) in the peat-swamp forest of Sabangau, Central Kalimantan, Indonesia. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 138 (Abstract only).

Hoang Van Lam, and Nguyen Thi Thanh Nga (2008). Conservation of the western black crested gibbon, *Nomascus concolor* in Mu Cang Chai Species and Habitat Conservation Area, Vietnam. In Nadler, T., and Rawson, B. (eds.), *Conservation of primates in Indochina. International Symposium, Cuc Phuong National Park, 27-30 November 2008*, Cuc Phuong National Park, Vietnam, p. 22 (Abstract only).

Holden, C., (ed.) (2008). Grim outloook for Chinese apes. *Science* **320**(30 May 2008): 1139.

Ikram, A. (2008). Farewell Nippy the gibbon. *3News.co.nz* **3 September 2008** (Internet): www.3news.co.nz/TVShows/Sunrise/AlisSmashHits/AlisBlog/tabid/834/articleID/69795/cat/592/Default.aspx

Iskandar, E., Kyes, R. C., Alikodra, H., Mansjoer, S. S., and Bismark, M. (2008). Comparison of the Javan gibbon (*Hylobates moloch*) population at Gunung Halimun-Salak and Ujung Kulon National Park, Indonesia. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 203 (Abstract only).

Kenyon, M., Luong Van Hien, Cronin, A., Cronin, J., Pei, K., Tran Van Mui, and Tran Van Thanh (2008). Dao Tien Endangered Primate Species Centre, Cat Tien National Park, Vietnam. In Nadler, T., and Rawson, B. (eds.), *Conservation of primates in Indochina. International Symposium, Cuc Phuong National Park, 27-30 November 2008*, Cuc Phuong National Park, Vietnam, p. 30 (Abstract only).

Kenyon, M., Vo Thanh Binh, Tran Van Mui, and Tran Van Thanh (2008). Home range size and habitat quality of golden-cheeked crested gibbons, *Nomascus gabriellae* in Cat Tien National Park, Vietnam. In Nadler, T., and Rawson, B. (eds.), *Conservation of primates in Indochina. International Symposium, Cuc Phuong National Park, 27-30 November 2008*, Cuc Phuong National Park, Vietnam, p. 31 (Abstract only).

kmr (2008). Menschenaffe ausgestorben. *NZZ am Sonntag (Zürich)* **18 May 2008**: 81 (German text).

Ling, J. (2008). Farewell Nippy – Gibbon but not forgotten. *Dominion Post* **3 September 2008** (Internet): www.stuff.co.nz/dominionpost/4678570a23918.html

Ma Zhiheng (2008). [Gibbons almost disappeared in China]. *Beijing Science & Techology Report* **2008**(2 June): 34-35 (Chinese text).

Ma Zhiheng (2008). [Gibbons almost disppeared in China]. *Beijing Youth Daily* **2008**(2 June): C4 (Chinese text).

Misceo, D., Capozzi, O., Roberto, R., Dell'Oglio, M. P., Rocchi, M., Stanyon, R., and Archidiacono, N. (2008). Tracking the complex flow of chromosome rearrangements from the Hominoidea ancestor to extant gibbons *Nomascus* and *Hylobates* by high-resolution synteny mapping. *Genome Research* **18**: 1530-1537.

Müller, B. (2008), Weisshandgibbons in China ausgestorben, *Medienmitteilung, Universität Zürich, 15. Mai 2008* [Internet]: www.mediadesk.unizh.ch/mitteilung.php?text_id=294&grp=aktuell.

Nagpal, S. (2008). Nippy, oldest known gibbon in captivity, dies. *TopNews.in* **2 September 2008** (Internet): www.topnews.in/nippy-oldest-known-gibbon-captivity-dies-263970

Nguyen The Cuong, Yan Lu, Nong Van Tao, and Insua-Cao, P. (2008). How transboundary cooperation and field-based conservation have led to improved hope for survival of the cao vit gibbon, *Nomascus nasutus* on the Vietnam-China border. In Nadler, T., and Rawson, B. (eds.), *Conservation of primates in Indochina. International Symposium, Cuc Phuong National Park, 27-30 November 2008*, Cuc Phuong National Park, Vietnam, p. 34 (Abstract only).

Nguyen Xuan Dang, Nguyen Xuan Vinh, and Pham Huu Khanh (2008). Status of yellow-cheeked gibbon, *Nomascus gabriellae* in Cat Tien Biosphere Reserve. In Nadler, T., and Rawson, B. (eds.), *Conservation of primates in Indochina. International Symposium, Cuc Phuong National Park, 27-30 November 2008*, Cuc Phuong National Park, Vietnam, p. 35 (Abstract only).

Nijman, V. (2008). Welfare aspects of the illegal wildlife trade in asia as illustrated by the trade in pet gibbons in Indonesia. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 322 (Abstract only).

O'Brien, T., Kinnaird, M., Nurcahya, A., and Nusalawo, M. (2008). Response of siamang and agile gibbons to climate fluctuations in Indonesia. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 41 (Abstract only).

Orgeldinger, M. (2008). In China gibt es keine Weisshandgibbons mehr. *Fränkischer Sonntag* **15 August 2008**: 5 (German text).

Orgeldinger, M. (2008). Keine Weisshandgibbons mehr in China. *Darmstädter Echo* **14 August 2008**: 38 (German text).

Orgeldinger, M. (2008). Von den Verwandten verdrängt. *Der Tagesspiegel* **5 August 2008**: 21 (German text).

Orgeldinger, M. (2008). Weisshandgibbon in China ausgestorben. *Kieler Nachrichten* **10 September 2008**: 19 (German text).

Pamungkas, J., Paramastri, Y. A., Permanawati, P., Iskandar, E., Sajuthi, D., Budiarsa, I. N., and Manansang, J. (2008). *Ex-situ* captive breeding of Javan gibbon (*Hylobates moloch*) at the Primate Research Center of Bogor Agricultural University (PSSP-IPB), Bogor, Indonesia. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 98 (Abstract only).

Phan Channa, and Gray, T. (2008). Distribution and population of yellow-cheeked crested gibbon, *Nomascus gabriellae* in Phnom Prich Wildlife Sanctuary in Mondulkiri Province, Cambodia. In Nadler, T., and Rawson, B. (eds.), *Conservation of primates in Indochina. International Symposium, Cuc Phuong National Park, 27-30 November 2008*, Cuc Phuong National Park, Vietnam, p. 37 (Abstract only).

Phoonjampa, R., and Brockelman, W. Y. (2008). Survey of pileated gibbon *Hylobates pileatus* in Thailand: Populations threatened by hunting and habitat degradation. *Oryx* **42**(4): 600-606.

Phoonjampa, R., Savini, T., and Gale, G. A. (2008). Sleeping trees and sleep-related activities of pileated gibbons, *Hylobates pileatus* in southeast Thailand. In Nadler, T., and Rawson, B. (eds.), *Conservation of primates in Indochina. International Symposium, Cuc Phuong National Park, 27-30 November 2008*, Cuc Phuong National Park, Vietnam, p. 39 (Abstract only).

Rawson, B. (2008). Use and abuse of gibbon survey techniques: Shortcomings of auditory survey methods and future directions. In Nadler, T., and Rawson, B. (eds.), *Conservation of primates in Indochina. International Symposium, Cuc Phuong National Park, 27-30 November 2008*, Cuc Phuong National Park, Vietnam, p. 13 (Abstract only).

Reichard, U. H., and Barelli, C. (2008). Life history and reproductive strategies of Khao Yai white-handed gibbon females (*Hylobates lar*). *International Journal of Primatology* **29**: 823-844.

Reichard, U. H., Prime, J. M., and Barelli, C. (2008). Gibbons and great apes: Similarity in life history, hand manipulation skills and reproductive strategies. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 51 (Abstract only).

Reitz, E. (2008). Rescuing Robin Hood (Internet), 18 June 2008: http://docuproject.blogspot.com/.

Ruppell, J. (2008). The gibbons of Pu Mat National Park in Vietnam. *Gibbon Journal* **4**: 39-45.

Savini, T., Boesch, C., and Reichard, U. H. (2008). Home-range characteristics and the influence of seasonality on female reproduction in white-handed gibbons (*Hylobates lar*) at Khao Yai National Park, Thailand. *American Journal of Physical Anthropology* **135**: 1-12.

Schneider, C., Hodges, K., Fischer, J., and Hammerschmidt, K. (2008). Acoustic niches of Siberut primates *International Journal of Primatology* **29**: 601-613.

Silvery Gibbon Project (2008). *Silvery Gibbon Project Newsletter* **March 2008**: 1-6.

Silvery Gibbon Project (2008). *Silvery Gibbon Project Newsletter* **August 2008**: 1-4.

Staff, L. (2008). Endangered monkey species thriving in Cambodia. *FoxNews.com* **28 August 2008**: Internet: www.foxnews.com/story/0,2933, 412901,00.html.

Tran Thu Hang (2008). Stopping the trade of Vietnam's primates: Experiences and cases from ENV's Wildlife Crime Unit. In Nadler, T., and Rawson, B. (eds.), *Conservation of primates in Indochina. International Symposium, Cuc Phuong National Park, 27-30 November 2008*, Cuc Phuong National Park, Vietnam, p. 52 (Abstract only).

Van Ngoc Thinh, and Roos, C. (2008). Phylogeny, taxonomy and distribution of crested gibbons, genus *Nomascus*. In Nadler, T., and Rawson, B. (eds.), *Conservation of primates in Indochina. International Symposium, Cuc Phuong National Park, 27-30 November 2008*, Cuc Phuong National Park, Vietnam, p. 42 (Abstract only).

Walker, S., and Molur, S. (2008). Countdown 2010 - save hoolock gibbon - save biodiversity. *Zoos' Print Magazine* **23**(10): 13.

Waltert, M., Abegg, C., Ziegler, T., Hadi, S., Priata, D., and Hodges, K. (2008). Abundance and community structure of Mentawai primates in the Peleonan forest, north Siberut, Indonesia. *Oryx* **42**: 375-379.

Whittaker, D., and Dooley, H. (2008). Kloss's gibbon: Biology and conservation. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 38 (Abstract only).

Yang Martinez, C., and Nijman, V. (2008). Trade in Sumatran gibbons and Sumatran orang-utans. In *22 Congress of the International Primatological Society, August 3-8 2008, Edinburgh, UK, Abstracts. Primate Eye No. 96 (Special Issue, August 2008)*, p. 84 (Abstract only).

Zhang, X. Y., Zhou, W., Wu, J. P., Bai, B., Li, Z. B., and Li, J. H. (2008). [Food selection of hoolock gibbon (*Hoolock hoolock*) at Nankang, Mt. Gaoligong in spring]. *Dongwuxue Yanjiu/ Zoological Research* **29**: 174-180 (Mandarin text, English abstract).

Zhou, J., Wei, F., Li, M., Chan, B. P. L., and Wang, D. (2008). Reproductive characters and mating behaviour of wild *Nomascus hainanus*. *International Journal of Primatology* **29**: 1037-1046.

Congresses and workshops

5th Annual Meeting of the Gibbon Conservation Alliance

9 May 2009, Tierpark Dählhölzli, Bern, Switzerland.

E-mail: info@gibbonconservation.org

Website: www.gibbonconservation.org

32rd Annual Meeting of the American Society of Primatologists

18–21 Sep. 2009, San Diego, California, U.S.A.

Venue: Bahia Resort Hotel, 998 West Mission Bay Drive, San Diego, CA, U.S.A.

Website: www.asp.org/meetings/index.html

3rd Congress of the European Federation for Primatology

12–15 Aug. 2009, Zurich University, Switzerland

Venue: Anthropological Institute & Museum, Zurich University, Switzerland

Website: www.aim.uzh.ch/EFP.html

23th Congress of the International Primatological Society

12–18 Sep. 2010, Kyoto, Japan

Venue: Yoshida Campus, Kyoto University

Website: www.ips2010.jp

What is the Gibbon Conservation Alliance?

Gibbon Conservation Alliance

Goals

The **Gibbon Conservation Alliance** (GCA) supports the active conservation of gibbons, promotes research on their natural history, and raises awareness on gibbons and their plight. The **GCA** is a non-profit organisation. The **GCA** always welcomes help and funds to continue its important work.

Main Activities

- Publication of the Gibbon Journal and the Annual Report of the **Gibbon Conservation Alliance**
- Maintenance of a Website providing information on the **Gibbon Conservation Alliance** and its activities
- Raising funds to support gibbon conservation projects
- Promoting awareness of gibbons and the need to make efforts towards their conservation, as well as providing research results on gibbons. This can be carried out through lectures, publications, website, etc.

Organisation

The **Gibbon Conservation Alliance** is a non-governmental organisation based in Zurich/Switzerland. Established in 2004, the **Gibbon Conservation Alliance** comprises a small group of volunteers that raises funds for the conservation of gibbons.

How Can I Become a Member?

By becoming a member or by making a donation, you are helping us raise awareness and support for the conservation of the gibbons. An electronic application is possible via our Website (www.gibbonconservation.org). An application form can also be found on the last page of this publication. Additional application forms and information can be obtained from the following address: **Gibbon Conservation Alliance**, Anthropological Institute, University Zurich-Irchel, Winterthurerstrasse 190, CH–8057 Zurich, Switzerland; E-mail: www.info@gibbonconservation.org

Annual Membership Fees and Donations

Single member:	CHF 30.–
Students:	CHF 20.–
Bank address:	Raiffeisenbank Zürich, Limmatquai 68, CH–8001 Zürich, Switzerland
Payments from Switzerland:	
Post account:	87-71996-7
Account Nr.:	6929305
Bankclearing/Bankleitzahl:	81487
Payments from other countries:	
SWIFT-Code:	RAIFCH22
IBAN:	CH32 8148 7000 0069 2930 5

How can I help the gibbons?

Application

In order to apply to the **Gibbon Conservation Alliance** for membership, please fill out this form and send it to: **Gibbon Conservation Alliance**, Anthropological Institute, University Zurich-Irchel, Winterthurerstrasse 190, CH–8057 Zurich, Switzerland. Please note that entries marked with a * are mandatory.

Annual membership fees: Regular Member CHF 30.–, Students CHF 20.–

Title *		Mr		Ms
Family name *				
First name *				
Affiliation				
Street / Nr. *				
Zip code / City *				
Country				
Phone number				
E-mail				
Remarks				

Thank you for helping us save the gibbons!