

Female crested gibbons (genus *Nomascus*) sing male song

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Summary

Crested gibbons (genus *Nomascus*) belong to a group of gibbons that is still relatively unexplored. Their vocal behaviour, in particular, raises a number of important questions. One question is whether the loud calls, also known as “songs”, are species- and/or sex-specific. Past studies have suggested that the song repertoire of crested gibbons is sex-specific, particularly in adult individuals (Geissmann 2002). In this study (Geissmann 2002), only a few male individuals were reported to imitate the song phrase of a female. This report was presented as evidence that, on some occasions, female crested gibbons can sing male song phrases. In the present study, it was found that six of sixteen yellow-cheeked (*Nomascus gabriellae*) and white-cheeked crested gibbons (*Nomascus leucogenys*), housed in zoos of the Zoological Park Organization, Thailand and of the Endangered Primate Rescue Center, Vietnam, produced male song phrases. Six females were found to be able to produce at least the multi-modulated call phrases as thought to be exclusively belonging to the male song repertoire, and one female white-cheeked crested gibbon even produced several types of male song phrases. The structure of the first element of these multi-modulated call phrases was examined and found to be similar between males and females, but the females scored were found to have a larger frequency range than the males. Most females also produced first elements of longer duration than the males. These results lead us to believe that crested gibbons generally may have the ability to produce song phrases of either sex. However, it is unknown what exact factors may contribute to males or females producing elements of song by the opposite sex. Further study is needed. Resolving this question may have an impact on the current methods used in population surveys of crested gibbons.

Con cái các loài vượn (giống *Nomascus*) bắt chước kiểu hát của con đực

Tóm tắt

Các loài vượn thuộc giống *Nomascus* hiện còn ít được nghiên cứu. Những nghiên cứu về giọng hát của chúng đặt ra nhiều câu hỏi cần được làm sáng tỏ. Một trong số câu hỏi đó là, liệu tiếng kêu lớn tạo thành “bài hát” của chúng có phải là biểu hiện đặc trưng của loài hoặc của riêng một giới. Những nghiên cứu trước đây cho rằng các “bài hát” ở các loài vượn mang đặc trưng cho mỗi giới tính, đặc biệt là những cá thể trưởng thành (Geissmann, 2002). Trong nghiên cứu của mình (Geissmann, 2002), tác giả cũng ghi nhận những trường hợp một số cá thể đực bắt chước một phần trong “bài hát” của con cái.

Nghiên cứu của chúng tôi ghi nhận một vài trường hợp con vượn cái có thể hát những kiểu hát của con đực. Sáu trong số mười sáu cá thể nuôi nhốt tại Vườn thú Zoological Park Organisation, Thái Lan và Trung tâm Cứu hộ Linh trưởng Nguy cấp, Cúc Phương, Việt Nam, thuộc hai loài vượn đen má hung (*Nomascus gabriellae*) và vượn đen má trắng (*Nomascus leucogenys*) đã hát kiểu hát của con đực. Cả sáu cá thể trên đều hát được ít nhất một kiểu hát của con đực cùng loài, đặc biệt một cá thể còn hát được một vài kiểu hát khác nhau của con đực cùng loài với nó.

Cấu trúc của đoạn đầu trong nhiều kiểu hát của con đực đã được kiểm tra, kết quả cho thấy con đực và con cái hát giống nhau, tuy nhiên tần số tạo ra bởi con cái lớn hơn và các con cái hát đoạn này đều kéo dài hơn so với con đực. Kết quả trên cho phép suy luận rằng các loài vượn nói trên có thể tạo ra kiểu hát giống nhau ở cả hai giới. Tuy nhiên nhân tố dẫn đến hiện tượng này chưa được tìm thấy và cần có thêm những nghiên cứu sâu hơn. Việc tìm ra câu trả lời sẽ có ảnh hưởng rất quan trọng đến phương pháp đánh giá quần thể đang được sử dụng ngoài thực địa.

Introduction

Although studied for the last few decades, song behaviour remains one of the least researched aspects of gibbon behaviour. It has been suggested that gibbon songs of all species may be species and sex-specific (Marshall & Marshall, 1976). However, these studies largely have concerned species of the *Hylobates* genus, but relatively little is known about crested gibbons (*Nomascus* sp). Crested gibbons are the gibbons of Cambodia, China, Laos and Vietnam and this genus contains several endangered species and it is these species in which we are interested. Several studies on crested gibbons have focused on the physical features and organization of their song (Deputte & Goustard, 1978; Deputte, 1982; Goustard, 1984; Haimoff, 1984; Schilling, 1984). They have found that crested gibbons use different song elements in their songs. Geissmann (2002) argued that the song phrase used in adult crested gibbons represents the highest degree of specificity in their song repertoire. However, some studies have found that male adult crested gibbons occasionally produce some female-like great call notes, whereas none of the papers have reported similar issues in the song of female crested gibbons (Schilling 1984; Geissmann, 2002). Importantly, the song of crested gibbons has been used in various census surveys to estimate their population size (Jiang Xue Long et al., 2006; Park, 2007; Ruppell, 2007). If an individual, particularly a female, produces song phrases of the opposite sex this may result in miscalculations and incorrect sexing in population surveys of crested gibbons. We report here the singing behaviour of several adult female crested gibbons in which the question of sex specificity is raised and it is shown that females may produce male songs.

Materials

The study was conducted in the five Thai zoos under the auspices of the Zoological Park Organization of Thailand (ZPO) and the Endangered Primate Rescue Center (EPRC), Vietnam during several visits between August 2006 and January 2008. Sixteen female crested gibbons, including four yellow-cheeked crested (*Nomascus gabriellae*) and 12 white-cheeked crested gibbons (*Nomascus leucogenys*), in different housing conditions, were observed and their songs were recorded (Table 1). Only four individuals were paired with a male, the other 12 females were housed singly or with another female. None of the female adult individuals was born in captivity. Most of the individuals have been housed in their respective enclosures for over ten years, except two that arrived in the EPRC in 1998, and thus have spent slightly under ten years in their present housing.

Table 1. Location and Housing information of each observed female crested gibbons.

| Individual | Species | Location | Housing condition | Producing male song | Recording |
|------------|----------------------|-----------|-------------------|---------------------|-----------|
| 1 | <i>N. gabriellae</i> | Chiangmai | 1 | Yes | No |
| 2 | <i>N. leucogenys</i> | KKOZ | 1 | No | No |
| 3 | <i>N. gabriellae</i> | EPRC | 2 | No | No |
| 4 | <i>N. gabriellae</i> | Dusit | 2 | Yes | Yes |
| 5 | <i>N. leucogenys</i> | Dusit | 2 | No | No |
| 6 | <i>N. gabriellae</i> | Songkla | 3 | No | No |
| 7 | <i>N. leucogenys</i> | Songkla | 3 | No | No |
| 8 | <i>N. leucogenys</i> | Chiangmai | 3 | Yes | Yes |
| 9 | <i>N. leucogenys</i> | Chiangmai | 3 | No | No |
| 10 | <i>N. leucogenys</i> | EPRC | 3 | Yes | Yes |
| 11 | <i>N. leucogenys</i> | EPRC | 3 | Yes | Yes |
| 12 | <i>N. leucogenys</i> | EPRC | 3 | Yes | No |
| 13 | <i>N. leucogenys</i> | Dusit | 4 | No | No |
| 14 | <i>N. leucogenys</i> | KKOZ | 4 | No | No |
| 15 | <i>N. leucogenys</i> | Korat | 4 | No | No |
| 16 | <i>N. leucogenys</i> | EPRC | 4 | No | No |

1. The individual is singly housed, and no individuals of the opposite sex are housed in the same zoo.
2. The individual is singly housed, but conspecifics of the opposite sex are housed within auditory distance.
3. The individual is housed in the same or in an adjacent cage with another individual of the same sex.
4. The individual is housed as part of a pair or a family group.

Methods

The vocal recordings were taken between 05.00am and 11.00am on each day of observation because gibbons vocalise mostly at dawn or a few hours after dawn (Geissmann, 2002), and each individual was observed for five random days during the period of visit between August 2006 and January 2008. A directional microphone (Sennheiser ME-66) and a digital recorder (Marantz PMD-670) were used to record the songs. Some of the recordings are incomplete due to human factors (e.g.: one individual in Thailand and two individuals in Vietnam stopped producing male song phrases whenever the keeper or the observer appeared). All recorded songs were sampled digitally into the computer at a 16-bit quantization and 44.1 kHz sampling rate. Vocalizations were analysed by sound software (Raven 1.3, Connell University).

Sixty-four multi-modulated call phrases were collected from four adult females. As all individual recordings of females contained multi-modulated call phrases, the physical features of multi-modulated call phrases were analysed. Several studies (Deputte, 1982; Goustard, 1984; Schilling, 1984) have described the structure of multi-modulated call phrases, and these were shown to contain high variability in the number of elements and modulations. The first element of the multi-modulated call phrases was analysed, thus overcoming the variability problem of other elements in multi-modulated call phrases. In order to compare the differences in structure of multi-modulated call phrases in males and females, the first element of multi-modulated call phrases produced by an unpaired (M-1) and by a paired (M-2) adult male white-cheeked crested gibbon (*Nomascus leucogenys*) was also analysed. Four parameters (start frequency, lower most frequency, frequency range and duration) were measured (Fig 1).

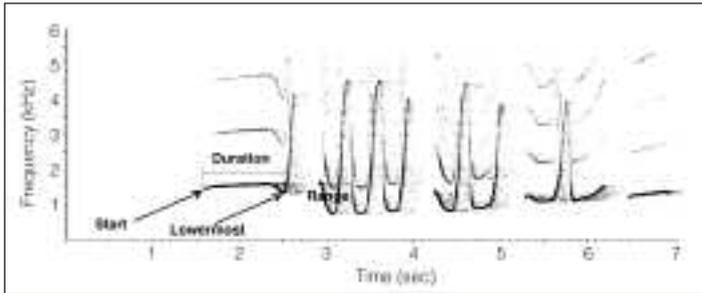


Fig. 1. The sonogram is an example of male multi-modulated call phrases. This graph shows the four parameters that were selected to measure the structure of the first element of multi-modulated call phrases.

Results

Six of the 16 females produced male song phrases and all individuals were visually identified by the observer. In the case of four of the six we were able to record them producing a male song phrase (Fig. 2). As the housing conditions in Table 1 show, none of the females were housed together with males. The six individuals that produced male song phrases were housed singly or with another female, and two of them were housed in zoos without any male crested gibbons in the same zoo.

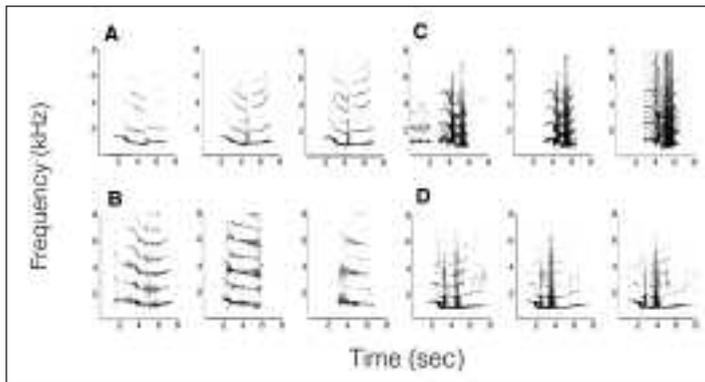


Fig. 2. The sonograms of multi-modulated call phrases produced by four adult females. The graph shows that the female produced fewer elements in each multi-modulated call phrase.

Three females produced male song consistently at least over one month's period. All females produced at least multi-modulated call phrases. One female individual even produced boom and staccato call phrases (Fig 3). Multi-modulated call phrases produced by females have less variety compared to males. The number of elements of each multi-modulated call phrase produced by females usually consisted of two elements, whereas the males' multi-modulated call phrases contained up to six elements.

Two individuals produced multi-modulated call phrases along with their own (female) great call sequence, whereas two other individuals were recorded when they only produced multi-modulated call phrases on their own.

The first element of multi-modulated call phrases was analysed (Table 2). Results showed that the multi-modulated call phrases produced by females have some structural similarity with adult male individuals. The duration of the first elements produced by females is generally longer than that produced by males. The frequency range in females is also larger than in males. Moreover, the

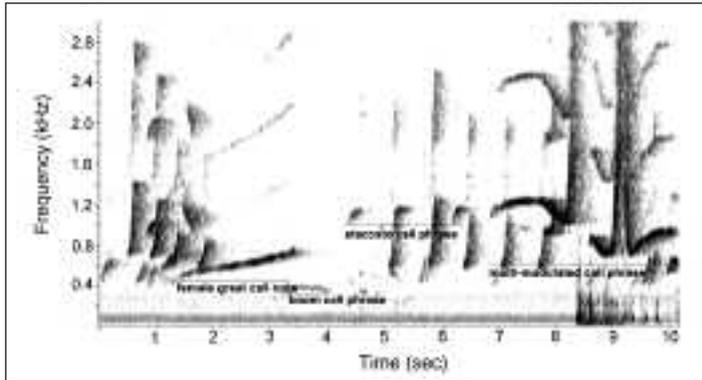


Fig. 3. Song element types produced by a female white-cheeked crested gibbon. During the recording, lar gibbons (*Hylobates lar*) also sang in the background. The female great call note was produced by another female crested gibbon housed in the adjunct cage. The two female white-cheeked crested gibbons produced great call phrases five seconds later in the same song sequences.

results showed that the call structure in the first element of multi-modulated call phrases may be individually different.

Table 2. Call parameters of the first element in multi-modulated call phrases. The first column shows the available number of notes collected from the individual. M-1 and M2 (bottom) are adult males (*Nomasucs leucogenys*).

| Individual (N) | Start Frequency (Hz) | Lowermost Frequency (Hz) | Frequency Range (Hz) | Duration (s) |
|----------------|----------------------|--------------------------|----------------------|--------------|
| 10 (27) | 1384.53 ± 10.69 | 881.93 ± 11.85 | 502.60 ± 18.51 | 3.28 ± 0.12 |
| 3 (27) | 1347.31 ± 7.37 | 803.78 ± 4.84 | 543.50 ± 10.61 | 1.88 ± 0.09 |
| 8 (7) | 1189.92 ± 10.79 | 961.76 ± 12.03 | 228.16 ± 15.92 | 1.36 ± 0.15 |
| 4 (3) | 1435.17 ± 34.26 | 1100.37 ± 8.37 | 334.70 ± 32.69 | 4.17 ± 0.55 |
| M-1 (32) | 1412.40 ± 7.98 | 1300.83 ± 5.53 | 111.57 ± 7.52 | 1.23 ± 0.06 |
| M-2 (33) | 1258.06 ± 11.20 | 1110.01 ± 15.24 | 148.05 ± 10.30 | 1.41 ± 0.03 |

Discussion

Crested gibbons are known to produce sex-specific song phrases in their duet song (Haimoff, 1984; Schilling, 1984) and it was considered unlikely that crested gibbons produce song phrases of the opposite sex. It has been noted in some studies that, in some rare cases, juvenile or adult males may produce female great call-like phrases synchronized with female great call phrases (Goustard, 1984; Schilling, 1984; Geissmann et al., 2000; Chen pers. observ.). The findings of this study provide some evidence of the ability of crested gibbons to use song elements of the opposite sex. Coupled with early findings in juvenile and adult male crested gibbons (Goustard, 1984; Schilling, 1984; Geissmann, 2002), it may now be argued that crested gibbons have the ability to produce the elements of song of either sex but they do so rather regularly in captivity, and in the absence of individuals of the opposite sex housed in the same zoo.

The ability to produce song elements of the song of the opposite sex may be partially inherent (a vocal template) and then refined and developed into sex specific song via social learning. Several studies conducted in hybrid individuals (*Hylobates* sp.) in captivity and in the wild have shown that the hybrid individuals produced intermediate song patterns between their parents

(Brockelman & Schilling, 1984; Geissmann, 1984). These studies suggest that genetic components may play a role in the development of gibbon song, and Geissmann (2002) has addressed this in his review of gibbon song. In this study, two female individuals produced male song phrases housed in a context where no male conspecifics were present in the same zoo. It could be argued that, as all gibbons studied here were wild-born and brought to the zoo from the wild as adolescents or adults, they would have heard and seen male female interactions of other adults in the wild, including, most notably, their song, giving them ample opportunity to learn song phrases of either sex. However, one of the female individuals was known to have been sent to the zoo while still an infant. This particular female would have had few or no opportunities to practise or learn male song phrases from other individuals. Therefore, social learning may not be the major influence affecting the ability of female crested gibbons to produce song elements of the opposite sex.

Such issues of singing song phrases of the opposite sex have also been found in other gibbon species (Geissmann, 1993). However, none of the studies have reported that female crested gibbons produce the male-like song phrases, except for one case that reported this to be so in a newly paired female pileated gibbon (*Hylobates pileatus*) that produced a male call sequence (Geissmann, 1983). In this study, all female crested gibbons that produced male song phrases were not housed with nor were they in the vicinity of male conspecifics. In contrast, those that were housed with male conspecifics were not once found to produce male song phrases. Further investigation still needs to be conducted to clarify how both genetic components and social learning affect the song behaviour in crested gibbons.

The finding of this singing behaviour may have some impact on current surveys of crested gibbons, as mentioned before. The duet song in crested gibbons was thought to present the highest degree of sex-specific behaviour among gibbon species (Geissmann, 2002). This study, however, showed that, in some cases, the duet song may be partly produced by a single female. It is not clear what exact circumstances, if any, make female gibbons produce the male song phrases. All these cases were found in captive environments. There is no direct evidence to show that such cases occur in the wild, yet one should not rule out this possibility. It may be very difficult to confirm the sex of an individual caller unless visual contact can be maintained at the time of vocalization. If this is the case in the wild, such behaviour may lead to biases in survey results as the current census population surveys mainly apply the method of spot listening (Brockelman & Ali, 1987; Brockelman & Srikosamatara, 1993). Therefore, one would need to be careful in deriving the sex of an individual from listening to its call.

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