Vocal Behaviour of White-Cheeked Crested Gibbons (*Nomascus leucogenys*): Vocal Production, Usage and Response.

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CERTIFICATION

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis and all sources used has been acknowledged in this thesis.

Signature

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PAPERS PUBLISHED DURING CANDIDATURE

Refereed papers

Chen, H.-C.; Kaplan, G. & Rogers L-J.2009, Contact calls of common marmosets (*Callithrix jacchus*): Influence of age of caller on antiphonal calling and other vocal responses. America Journal of Primatology 71 165-170

Chen, H.-C., Kamolnorranath, S & Kaplan, G., 2008. Female crested gibbons (genus *Nomascus*) sing male song. Vietnamese Journal of Primatology 2 47-53

Published Abstracts

Chen, H.-C. & Kaplan, G. 2008. Vocal individuality in white-cheeked crested gibbons (*Nomascus leucogenys*): Acoustic features and song organization. XXIInd congress of the International Primatological Society, 4th-9th August, 2008, Edinburgh, United Kindom, P 4

Kamolnorranath, S.; Chen, H-C. & Dumnui, S. 2007: Population assessment of crested gibbons (*Nomascus spp*.) in Zoological Park Organization of Thailand by using vocal identification – A non-invasive method. 16th Conference of South East Asian Zoos Association (SEAZA) 2nd – 4th September Zoo Negara, Kuala Lumpur, Malaysia.

Chen, H-C; Kaplan, G. & Rogers, L. J. (2006): Contact behaviour in the isolated marmoset (*Callithrix jacchus*) and its natal group. Abstract of 2006 Australian Society for the Study of Animal Behaviour (ASSB) Annual Conference, 20th-23rd April. 2006 pp. 29 Macquarie University, Sydney, Australia.

Chen, H-C; Kaplan, G. & Rogers, L. J. (2006): Vocal behaviour in isolated marmosets (*Callithrix jacchus*) on presentation of stimuli. Abstract of 2006 Australian Society for the Study of Animal Behaviour (ASSB) Annual Conference, 20th-23rd April. 2006 pp. 29 Macquarie University, Sydney, Australia.

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ABSTRACT

White-cheeked crested gibbons (*Nomascus leucogenys*), one of the most endangered primate species in South-East Asia, produce a series of loud calls to communicate. This special vocal behaviour is termed "song" and was previously thought to be a fixed stereotyped system of communication. However, recent research has raised questions as to whether or not white-cheeked crested gibbons express their vocal individuality under such a fixed and stereotyped call structure and song organisation. Whether or not any additional factors are involved with changes and process of song development is also unclear. Moreover, the adaptive functions of song remain inconclusive. It is unknown whether the primary function of white-cheeked crested gibbon songs is the same as that of other previously studied lar group gibbons (*Hylobates spp).* The aims of the present study were to investigate the vocal individuality of adult white-cheeked crested gibbons along with patterns and change of song in terms of their social status. In association with this, preliminary playback experiments were conducted to investigate the possible primary function of song.

This thesis investigated the vocalisations of nineteen white-cheeked crested gibbons housed at six different sites in Thailand and Vietnam between 13th August 2006 and 30th April 2008. A

total of 178 complete song bouts with visual identity were recorded. A total of 14,101 call phrases were identified and analysed. Twenty-nine song variables were selected and analysed through sound analysis software (Raven Pro 1.4). Results were analysed using the general statistical method of analysis of variance (ANOVA). One of a selection of non-parametric tests (Friedman test, Cochran's Q test, Wilcoxon signed rank test and McNemar test) was used in the analysis if the transformed data were still not normally distributed. One-way repeated-measures ANOVA was used in a number of instances to test for differences in relation to age groups or social context across different sampling periods, and to also determine whether or not acoustic features changed during development of an individual's song.

In Chapter 3, duet song of adult pairs of white-cheeked crested gibbons was examined. Results showed that within the pair in every measured song parameters, each pair produced relatively stable songs. There were significant differences among the pairs in terms of song context and call parameters. Individual white-cheeked crested gibbons performed songs differently in terms of vocal production and usage. Discriminant Function Analysis (DFA) was used to analyse the vocal individuality. It showed that both 95% of male calls and 76% of female calls could be correctly identified in relation to the responsible individuals. Results also indicated that

frequency-related parameters were the major factor that discriminated males, whereas temporal parameters mainly discriminated females.

In Chapter 4, measures at different sampling points showed that juveniles adjusted their call phrase usage in their song. The physical call structure, however, did not change over different sampling points. Similar results were also found among sub-adult individuals. Moreover, sub-adults that were of similar age, but keep under different social conditions, used the call phrases differently depending upon the changes of social context. Adults also expressed a certain level of vocal plasticity in both newly paired and long-term bonded individuals. The change of social context may also influence their call phrases usage.

In Chapter 5, behavioural observations were recorded before, during and after white-cheeked crested gibbons produced their song. Playback experiments were conducted at least three months after the purely behavioural observations. Results showed that although there was no particular behavioural change before gibbons initiated their song, all individuals tended to move to the canopy of the tree and stay in position during production of the song. It was found that hanging behaviour significantly increased after gibbons had finished their song. Although the results of playback experiments did not provide a conclusive answer to the precise function of

song, the results suggested that white-cheeked crested gibbon song is chiefly for intra-group communication rather than inter-group communication.

Overall, the result of the present study showed that white-cheeked crested gibbons performed their duet song with a high degree of coordination and maintained song stability in each pair. Moreover, vocal individuality of white-cheeked crested gibbons can be identified through different kinds of acoustic parameters such as frequency factors of call phrases in males and temporal factors of female great call phrases. This current study also provided new evidence to support the idea that vocal development of white-cheeked crested gibbons may not only be inherited, but also be influenced by social factors. This suggests that white-cheeked crested gibbons are capable of adjusting the production and usage of various call phrases. The ability for vocal flexibility and plasticity may allow song in white-cheeked crested gibbons to have multiple functions. This may result in inconclusive song function while conducting playback experiments. The findings of this study provide more understanding of white-cheeked crested gibbon in terms of vocal individuality and possible individual status. As vocalisations of gibbons have been used in population survey, this study may help managers assess and monitor population status of endangered white-cheeked crested gibbons in the wild.