BIBLIOGRAPHIC INFORMATION SYSTEM

Journal Full Title: Journal of Biomedical Research & Environmental Sciences

Journal NLM Abbreviation: J Biomed Res Environ Sci

Journal Website Link: https://www.jelsciences.com

Journal ISSN: 2766-2276

Category: Multidisciplinary

Subject Areas: Medicine Group, Biology Group, General, Environmental Sciences

Topics Summation: 128

Issue Regularity: Monthly

Review Process type: Double Blind

Time to Publication: 7-14 Days

Indexing catalog: Visit here

Publication fee catalog: Visit here

DOI: 10.37871 (CrossRef)

Plagiarism detection software: iThenticate

Managing entity: USA

Language: English

Research work collecting capability: Worldwide

Organized by: SciRes Literature LLC

Manuscript should be submitted in Word Document (.doc or .docx) through

Online Submission

form or can be mailed to support@jelsciences.com

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JOURNAL OF BIOMEDICAL RESEARCH & ENVIRONMENTAL SCIENCES
issn: 2766-2276
SUBJECT AREA(S): PRIMATOLOGY
DOI: 10.37871

REVIEW ARTICLE

Hainan Gibbons (*Nomascus hainanus*), the Most Threatened and Rarest Primate in the World

Ren Baoping[1]*, Zhou Jiang[2] and Deng Huaiqing[2]

[1]Ministry of Education Key Laboratory for Ecology of Tropical Islands, Key Laboratory of Tropical Animal and Plant Ecology of Hainan Province, College of Life Sciences, Hainan Normal University, Haikou 571158, China
[2]School of Karst Sciences, Guizhou Normal University, Guiyang 550001, China

Summary

Gibbons (*Hylobatidae*) are exclusively arboreal small apes only inhabiting in tropical rainforests of Southeast Asia [1]. Gibbons in *Nomascus* have 52 chromosomes and adult males and females are almost the same body size. There are six species in the genus *Nomascus* including Eastern black gibbons (*N. nasutus*), Western black gibbons (*N. concolor*), Hainan Gibbons (*N. hainanus*), Northern White-Cheeked Gibbons (*N. leucogenys*), Southern White-Cheeked Gibbons (*N. siki*), and Buff-Cheeked Gibbons (*N. gabriellae*) [2]. Among them, Hainan gibbons are the most endangered one and restricted to the Bawangling National Nature Reserve (BNNR, 18˚57′~19˚11′N,109˚03~′109˚17′E) on Hainan Island in China [3]. Hainan gibbons elevated to species level from a subspecies of Eastern black gibbons after 1996 based on molecular data, morphological features and pelage color and territorial vocalizations [2,4].

Hainan gibbons had suffered dramatic declines in their population form more than 2000 individuals before 1950s to 21 individuals by 1989 [4]. Habitat correspondingly had shrank from ever 886,000 ha across almost half size of Hainan Island to extant 1,600 ha restricted in The BNNR (area 29,980 ha.) [3]. The latest demographic investigation of the tiny remnant population of Hainan gibbon was 35 individuals in 2022 [5]. Individuals are related at the level of half- to full-siblings between social groups, and full-siblings or parent–offspring within a family group [6]. The genetic diversity of Hainan gibbons was exceptionally low [7,8]. Although inbreeding might increase in the future [6] avoidance of inbreeding makes it more difficult for solitary adults find a mate. Furthermore, it cannot ignore that gibbon dispersal and social group formation might constrain population recovery in this species [9].

Gibbons generally establish long-term pair bonds [10], but Hainan gibbon mainly keeps one-male-two-female mating system in *Hylobatidae* [4,11]. Two adult females in the same family group were observed both carrying their infant. Sizes of those family groups usually vary from 2 to 10 animals [11]. And multi-male-multi female family group has been founded in this gibbon recently [5]. Hainan gibbon takes more diverse mating strategies for its living conditions than ever. Those 35 gibbons belong to five family groups (Group A, 6 individuals; Group B, 8 ind.; Group C, 8 ind., Group D, 5 ind., and Group E, 3 ind.) including five lone members [5]. The adult male-to-female sex ratio in those five family groups was 1:1.2 [5]. Two to three family group survived in the wild when the BNNR was founded in 1980 [11].

***Corresponding author(s)**

Ren Baoping, Ministry of Education Key Laboratory for Ecology of Tropical Islands, Key Laboratory of Tropical Animal and Plant Ecology of Hainan Province, College of Life Sciences, Hainan Normal University, Haikou 571158, China

E-mail: renbp@163.com

DOI: 10.37871/jbres1570

Submitted: 14 September 2022

Accepted: 10 October 2022

Published: 12 October 2022

BIOLOGY GROUP

PRIMATOLOGY

VOLUME: 3 ISSUE: 10 - OCTOBER, 2022

How to cite this article: Baoping R, Jiang Z, Huaiqing D. Hainan Gibbons (*Nomascus hainanus*), the Most Threatened and Rarest Primate in the World. 2022 Oct 12; 3(10): 1152-1154. doi: 10.37871/jbres1570, Article ID: JBRES1570, Available at: https://www.jelsciences.com/articles/jbres1570.pdf

The small population sizes of Hainan gibbons had fluctuated between 10-25 individuals for over the following 30 years [7,11]. Group A and Group B occurred in 1970 [12]. Group C formed in 2011, Group D in 2015 and Group E, in 2019 [13] almost every four years. Especially, the newly formed Group E lives in the north of known gibbon range away from 8 km, suggests that 4-5 family groups might reach the maximum habitat capacity in the region of BNNR.

Hainan gibbons are slender and acaudate. The average head-to-body length in males is about 49.1 cm; average head-to-body length in females is about 48.3 cm [4]. The arm length is between 54.1-71.3 cm and leg length, between 42.5-47.2 cm [11]. Sexual dichromatism of adult Hainan gibbons is glaringly visible. The adult males are entirely black with a medium-length crest (hair length: 3 cm) while the females brownish-yellow with a species-specific black-haired crown streak or crest [3]. Especially in rainy season (May-October), adult females look more orangey due to ambient humidity. They have a thin white face ring that is wider below the orbital ridges and above the mouth [2]. Neonates are light yellowish-brown and then take 5-7 months to change into entirely black while growing up. When those young black females start to mature sexually, they slowly become brownish-yellow as those adults show [11]. Sexual maturity is estimated around 5-8 years of age [6] with 7-8 years old for males, and females, 5-6 years old. Gestation period of Hainan gibbons is about 136-173 days and the interbirth interval is about two years [4,14] ranging between 2.5-3.0 years. Longevity of this gibbons might be up to 50-60 years. Only six reproductive females and at least three of them have had more than 5 children [7], loss of fertility of those elder females is inevitable in the future.

Hainan gibbons mainly branchiate in the middle dense tree canopy (i.e. swinging by the arms) and sometimes take bipedalism (i.e. walking upright on two legs) in their habitat at the elevation of 800-1200 m [9]. The gibbon ever only live in the tropical forest below 760 m above sea level (asl.) [15]. Most primary forests < 600 m asl. were cleared and replaced by monoculture plantations [16]. Hainan gibbon had lost their original habitat forever. Brachiation facilitate them to get food that hang beneath the branches. Body weight of Hainan gibbons are 7-10 kg that allow them to reach thin outer branches.

All gibbon species generate loud and long vocalizations typically in the early morning [9] and last about 15-30 min [17]. Male gibbons defend their territories by producing different forms or types of their species-typical songs. Such songs can be audible within 2-3 km, a distance that can avoid encountering one another nearby. Such a distance also can be used to estimate how many groups inhabit within a given region. Duet songs can enhance male-female bonding cohesion [13]. Gibbons often communicate with one another this way. Researchers can identify different individuals by recording their calls on different days at some stable listening sites programmed in the habitat population size and number of family groups both, therefore, can be estimated. Gibbon groups live in stable territories of about 20-40 ha which include their feeding trees and preferred arboreal pathways [18]. Home range of Hainan gibbons is extremely large (548-987 ha) [19] due to their poor habitat. The gibbons are frugivorous for they mainly feed on ripe fruits (84.4%) from about 132 food source plants. They eat a small quantity of young leaves and flowers (8.9%). Occasionally, Hainan gibbons are observed foraging on birdie and eggs, spiders, lepidoptera pupa and termites [20]. Those gibbons particularly prefer fruits from *Polyalthia laui*, *Ficus altissima*, *Ficus tinctoria*, *Ficus virgata*, *Ficus glaberrima*, *Spondias lakonensis*, *Microcos paniculate*, *Psychotria rubra*, *Ficus variegate*, *Pouteria hainanenseis*, and *Nephelium topengii*. Groups mainly move about the elevation of 700-1000 m due to availability of food resource plants [19]. Hainan gibbons travel 1590 ± 106 m daily in dry season with two activity peaks (7:00-8:00 and 16:00-18:00). They migrate 842 ± 171 m in the day time in rainy season and have two different activity peaks (6:00-7:00 and 17:00-18:00) due to extended daytime hours.

External environmental factors caused near extinction of Hainan gibbons are mainly attributed to vegetation reduction, ecological deterioration and human slaughter and animal trading. Since Dramatic shrinkage of distribution and habitat of Hainan gibbons happened between 1950 and 1989 due to developing rubber industries by clear-cut primary tropic rain forest. Demand of local economic development prevailed against survival of wildlife including Hainan gibbons on this island that time. Roads, factories, and villages encroached and fragmented the limited habitat of Hainan gibbons meanwhile. The critical situation of gibbons make both public and government, inducing the provincial government enact laws and regulations to protect them from further harm since 1995. All types of forestry in or around the BNNR have been rigidly prohibited over the past 40 years.

For conservation action, poor understanding of habitat fragmentation and territory of Hainan gibbon still is the problem and leads to inability to figure out effective conservation action. Now, it is time to consider problems happened and happens on the primate itself. Too small population size might constrain formation of new breeding group. Solitary adults either male or female cannot find their mate might have been become the most important limitation for population rejuvenation in this rare gibbon. Those fertile females are growing older (Figure 1).

Acknowledgment

This work was granted by The Biodiversity Survey and Assessment Project of the Ministry of Ecology and Environment, China (grant numbers 2019HJ2096001006).

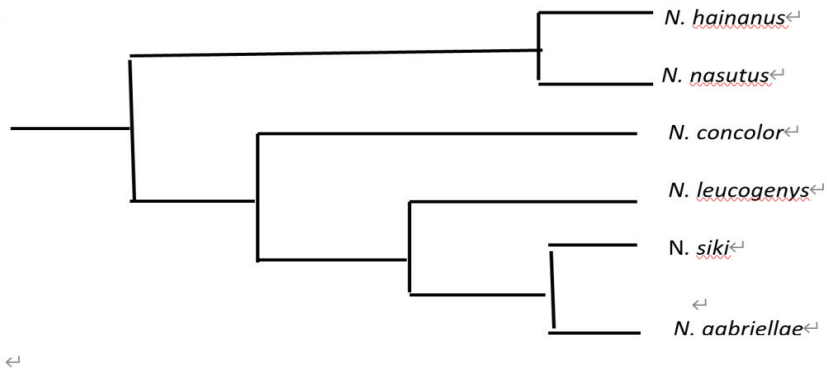

Figure 1 Phylogenetic tree of crested gibbons (*genus Nomascus*) [21].

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How to cite this article: Baoping R, Jiang Z, Huaiqing D. Hainan Gibbons (*Nomascus hainanus*), the Most Threatened and Rarest Primate in the World. 2022 Oct 12; 3(10): 1152-1154. doi: 10.37871/jbres1570, Article ID: JBRES1570, Available at: https://www.jelsciences.com/articles/jbres1570.pdf