

Discovery of first active breeding den of Chinese mountain cat (*Felis bieti*)

DEAR EDITOR,

In mid-September 2018, during a field survey in Chiat'ung, Sanjiangyuan (Three-River-Source) Region, Tibetan Plateau, China, we discovered the first active breeding den of the Chinese mountain cat (*Felis bieti*), inhabited by one adult female and two kittens. Based on fieldwork over the following months, five breeding dens were discovered, and 33 sightings were recorded. In addition, at least five individuals were confirmed to inhabit this overlooked region, and much previously unknown information concerning this cat species and its ecology was revealed for the first time.

The Chinese mountain cat is among the most elusive and endangered felid species in the world and is endemic to the eastern edge of the Tibetan Plateau, China (He et al., 2004; Nowell & Jackson, 1996). With a striped tail, hair-adorned ear-tips, and, unique among all wild cats, light blue pupils, the Chinese mountain cat is distinctive from the feral domestic cat (*F. catus*) and other congeneric species (Allen, 1938; Chen et al., 2005; Garcia-Perea, 2000; Grove, 1980; Kitchener et al., 2017; Liao, 1988; Sanderson et al., 2010). Since its discovery in 1892 (Milne-Edwards, 1892), very few field records or ecological studies have been carried out (Sanderson et al., 2010). To date, based on all known field information concerning the Chinese mountain cat, only four breeding dens and two temporary hiding burrows have been reported previously in northern Qinghai Province from 1975 to 1985 (Liao, 1988), all of which were deserted due to poaching. Therefore, our recent discovery of a breeding family provides crucial information that will help underpin future research and conservation of this poorly known felid.

In the current study, the dens and cats were discovered on the southern grassy hills of Chiat'ung, a typical alpine meadow in the southeast corner of the Sanjiangyuan Region (Figure 1A). The meadow now serves as pasture for eleven

villages of Tibetan herdsmen and is a perfect habitat for the plateau pika (*Ochotona curzoniae*), thereby attracting a great number of predators including the Tibetan fox (*Vulpes ferrilata*), red fox (*V. vulpes*), and Chinese mountain cat.

To monitor the nursery process, we set three camera traps beside the breeding dens (Figure 1A), with a programmed shooting sequence of two photos and one 30 s video with low trigger sensitivity. To better understand the habitat and to search for other possible dens, two transects totaling 26 km were surveyed (Figure 1A), with nine additional camera traps set beside potential cat burrows (Figure 1A). Moreover, we conducted household interviews in the nearby Tibetan communities to collect information concerning this population of Chinese mountain cat.

After five months of monitoring the breeding dens, 7 555 photos and 2 996 videos of the family, as well as 29 photos and 16 videos obtained from four additional camera sites, were collected in Chiat'ung (Figure 1A). Based on these data, important information regarding the nursery process of the family was acquired. During the family's time in the first discovered den (Den 2018-A; 16 September 2018–17 October 2018), they left twice for unknown reasons (Figure 1B), and on their last day in the den, the female was seen to nurse the kitten for the last time. After one week of field survey, the family were located in a second den (Den 2018-B) in the center of a wide valley only 670 m away, where they only stayed for four days after discovery (23 October 2018–26 October 2018; left probably due to disturbance by yaks). Subsequently, a third den (Den 2018-C) was discovered in mid-December on the other side of the hill at the sunlit top of the valley (13 December 2018–04 February 2019). The family remained here until the two kittens left the den on 24 December 2018, followed by the female in early February 2019 (Figure 1B). From the household interviews, we discovered that two more breeding dens from 2017 were located beneath Den 2018-C (2017-A, B; Figure 1A).

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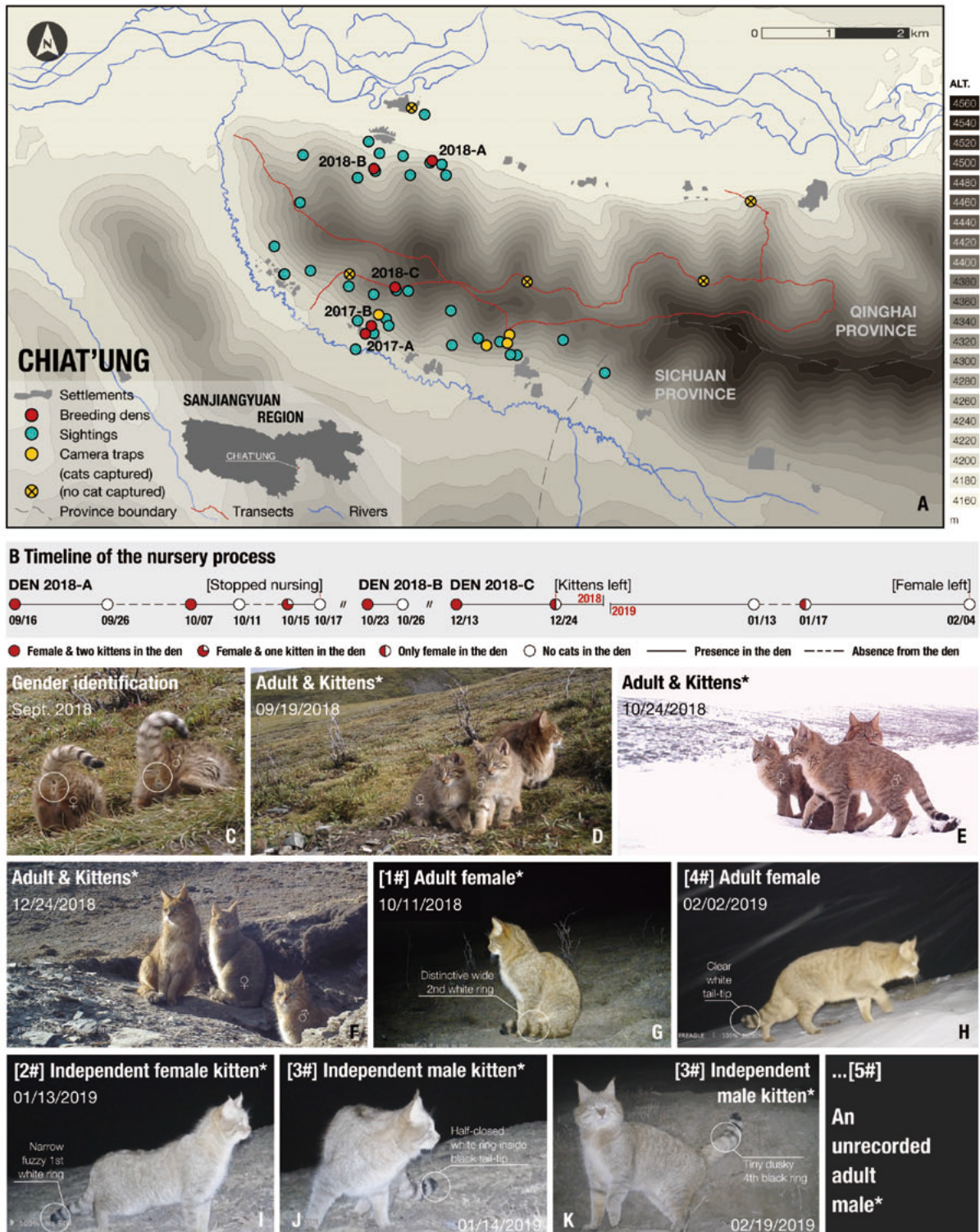


Figure 1 Study area, timeline of nursery process, and identified individuals of *Felis bieti*

A: Study area and fieldwork; B: Timeline of nursery process; C: Genders of kittens; D–F: Growth of kittens; G–K: Identified individuals of *F. bieti* in Chiat'ung. Symbol * represents family member discovered in 2018.

All three dens in 2018 were exposed on the ground without cover (Supplementary Figure S1A–C), whereas the 2017 dens were covered with grass (2017-A; Supplementary Figure S1D) or rocks (2017-B; Supplementary Figure S1E). Each den possessed only one entrance, in accordance with descriptions from Liao (1988). The diameters of the entrances varied from 29 cm to 41 cm, with an average width at 34.6 cm.

During monitoring, many Chinese mountain cat behaviors were observed for the first time (Figure 2). Generally, the adult female spent most of her time in vigilance, maintenance (e.g., stretching, licking, scratching, yawning), basking, nursing, feeding, and playing with the kittens. For the kittens, their time was mostly spent playing, basking, and observing.

From the captured images, we could clearly determine kitten gender – i.e., one female and one male (Figure 1C). Kitten growth was also recorded by the camera traps. When the kittens were about four months old (in September; according to Sanderson et al., 2010 and Zhu et al., 2007), their bodies were relatively pale and body patterns were clearer, with five to six black rings on the tail; one month later (in October), the color became more yellowish and the ear-tips became longer; in December, their fur was almost the same as that of the adult, with body patterns faded and only three to

four tail rings remaining clear (Figure 1D–F).

The congruity of the tail patterns throughout the kitten growth period makes it a perfect feature for individual identification of Chinese mountain cats – the patterns on their tails, especially the first three dark rings, remained constant from about four months of age. As a result, four individuals were identified in this area, including one adult female [1#] (Figure 1G), one female kitten [2#] (Figure 1I), and one male kitten [3#] (Figure 1J–K) from the above family, and one additional adult female [4#] (Figure 1H). Moreover, despite the lack of records, there should be at least one adult male [5#] who fathered the kittens, indicating the presence of at least five individuals in the area.

Habitat preference of the Chinese mountain cat has not been studied in depth, although several descriptions have been made based on previous field observations (Chen et al., 2005; Liao, 1988; Yin, 2007). For breeding dens, Sanderson et al. (2010) concluded that these cats prefer “abandoned dens excavated by marmots or badgers” on south-facing slopes of “grasslands or bush-covered mountains”, which was confirmed by our observations. Chen et al. (2005) and Yin (2007) stated that the Chinese mountain cat prefers to inhabit alpine meadows. This could be explained in Supplementary



Figure 2 Behaviors of adult female and kittens of *Felis bieti* (F: Female. K: Kitten)

Figure S2, i.e., when hiding in ungrazed winter pasture, the original and natural state of alpine meadows, the appearance of the cat would be perfect camouflage.

Through household interviews, the two dens from 2017 were discovered close to a Tibetan herdsman's house (Figure 1A). According to him, in July 2017, a female cat with four newborn kittens killed a Himalayan marmot (*Marmota himalayana*) and took over its den, which was only 120 m away from his house. Being devout Tibetan Buddhists, the family detested the cats for killing pikas in their yard, but pitying the kittens, they did not expel them until November. After being driven out, the cats moved to Den 2017-B, located only 110 m away from Den 2017-A (Supplementary Figure S2).

Moreover, 33 sightings of the cats were recorded between September 2018 and February 2019, including one individual spotted in Sichuan Province by a local field ranger (Figure 1A). Considering the similarity of the landscape, there should be more individuals inhabiting this geographic continuum on the southeast edge of the Tibetan Plateau.

As the only endemic felid in China, the Chinese mountain cat is assessed as Vulnerable by the IUCN Red List based on its "likely" small population, "high likelihood" of fragmentation, and "probably declining" trend (Riordan et al., 2015). This indicates an urgent need to fill the huge knowledge gap about this species and its status. Therefore, the discovery of this population may provide a great opportunity for future investigation and conservation and allow us to learn about and better protect this secretive felid species.

SCIENTIFIC FIELD SURVEY PERMISSION INFORMATION

Permission for field surveys in Chindu County, Qinghai Province was granted by the Chindu County Government, Chindu Environment Protection & Forestry Bureau, and Administration Bureau of Three-River-Source National Park.

SUPPLEMENTARY DATA

Supplementary data to this article can be found online.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

X.S.H., Z.L., L.Y.X., and X.Z. designed the research; X.S.H., Z.Y.D., and H.Q.C. conducted the fieldwork; X.S.H., Z.Y.D., and H.Q.C. analyzed the data; X.S.H. and H.Q.C. drafted the manuscript; X.S.H. and Z.Y.D. produced the figures. All authors read and approved the final version of the manuscript.

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