By their foes and by their kins — endemic Chinese mountain cats are threatened by domestic dogs and cats

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Abstract

The Chinese mountain cat (Felis bieti) is among the most elusive and endangered felid species worldwide and is endemic to the eastern edge of the Tibetan Plateau, China. Currently, the cat is assessed as Vulnerable by the IUCN Red List based on its 'likely small population', 'high likelihood of fragmentation', and "probably declining" trend. Specifically, two human activities were identified by the previous studies as the major threats that this unique lineage is faced with, as the large-scale pika poisoning program and illegal hunting prevailing in the area. However, during our monitoring of a breeding family discovered in the Sanjiangyuan Region, two cats of the family were found dead and were most likely killed by free-ranging dogs. Moreover, following genetic analysis indicated that both cats were genetically contaminated by local domestic cats. Consequently, based on the examination of the carcasses, associate genetic analysis, and survey on free-ranging dogs, in this study we identified two so far overlooked threats for the Chinese mountain cats, as the killing by free-ranging dogs and genetic contamination from domestic cats. These threats mark the tricky balance among humans, domestic animals and wildlife in both historical and recently burgeoning human activities, which requires further investigation, research and conservation efforts.

Introduction

As the only endemic felid in China, the Chinese mountain cat (*Felis bieti*), exclusively inhabits in the monotonous steppe and shrubland along the eastern edge of the Tibetan Plateau (Liao , 1988; He *et al.* , 2004). Unique by its looks, as the orangish fur, dark-striped tail, clear-tufted ears and light blue pupils, the cat is distinctive from its congeneric relatives (Yin, 2008). However, because of its secret nature and rugged habitats, only a handful of reliable records of the cat were made and even less scientific studies were conducted (Han*et al.* , 2020). Despite the limited information and knowledge available on this unique species, it was already enough for us to tell that the Chinese mountain cats are embracing for the impact from burgeoning human activities (Sanderson, Yin, & Drubgyal, 2010).

Currently, the IUCN Red List classifies the cat as Vulnerable due to its "likely" small (fewer than 10,000 mature individuals) and "probably" declining population (Luo *et al.* , 2022). Specifically, Sanderson*et al.* (2010) concluded two major threats as illegal hunting and extensive pika poisoning programs launched. On the one hand, although the species was enlisted in the Chinese Wildlife Protection Law in 1988, general hunting for pelt trade still prevailed in the 1990s and early 2000s, as their pelts were found for open sell in street-side stalls (Jackson & Nowell, 1996; He *et al.* , 2004; Chen *et al.* , 2005). On the other hand, since 1958, widespread poisoning campaigns (both large-scale and small-scale) have been launched across the Qinghai-Tibetan Plateau to eradicate 'assumed pests' such as pikas and other rodents (Zheng & Cai, 2007; Wu & Wang, 2017), which are among the major prey of cats (Liao, 1988). Therefore, illegal hunting, decreased density of pikas, as well as potential secondary poisoning constitute our previous understanding of the threats that the Chinese mountain cats are faced with (He *et al.* , 2004; Chen *et al.* , 2005).

The monitoring of a breeding group of Chinese mountain cats has made us realize that the aforementioned threats are not the only threats the cats are faced with. In Sept 2018, one adult female cat together with its two kittens (one male and one female) was discovered in the Gyatong Grassland of the Sanjiangyuan Region (also known as " Chiat'ung Grassland"; Han *et al.* , 2020; Fig. 1a). Shortly after the kittens left their den, the adult female and the female kitten were found killed by free-ranging dogs. Based on the morphology examination and genetic analysis of the two corpses, and survey on free-ranging dogs, in this article we suggest two previously overlooked but crucial threats to the survival of the Chinese mountain cats.

2. Materials and Methods

2.1 Study area

The cats were discovered in the Gyatong Grassland (Chindu County, Yushu Prefecture, Qinghai Province of China). Geographically, the grassland is located in a central plain surrounded by gentle steppe mountains at elevations of 4200-4700 m, which also serve as the boundaries between Qinghai and Sichuan provinces (Fig. 1b). The central plain is typical alpine meadow with the Ya-lung River flowing eastwards, covered with herbs, while shrubs are scarcely distributed in the shady sides of surrounding mountains (Fig. 1c). Vegetation as such make the place a perfect habitat for the plateau pika (*Ochotona curzoniae*), thus providing abundant food resources for meso-carnivores such as the Tibetan fox (*Vulpes ferrilata*), red fox (*Vulpes vulpes*), Pallas's cat (*Otocolobus manul*), leopard cat (*Prionailurus bengalensis*) and the Chinese mountain cat.

Other than wildlife, the meadow also hosts eleven villages of Tibetan herdsmen. Their settlements and winter pastures are generally located in the central plains, as well as in the bottom of surrounding mountains, while summer pastures are located in surrounding mountain valleys and steppe slopes. The dens of the Chinese mountain cats were all found in a valley and were only several hundred meters away from human settlements (Fig. 1b).

2.2 Collection and identification of carcasses

The discovery and monitoring of the breeding family of Chinese mountain cats were described in Han *et al.* (2020). The family was closely monitored by camera-traps until both kittens left the mother on 24 Dec 2018. Shortly after their independence, the female kitten (CMC-1) was first found dead on 30 Jan 2019. About one week later, on 7 Feb, the dead body of the adult female (CMC-2) was also found by a local field ranger (Fig. 2). The identification of both dead cats was based on the distinctive black stripes on their tails (compared with the information provided in Han *et al.* , 2020).

Both bodies were carefully recovered and stored under -20 °C for following examination and genetic analysis. Moreover, we also interviewed the locals who live close to where the bodies were found, to acquire more information on the cats' demise.

2.3 Free-ranging dogs survey

Tibetan dogs, typically Tibetan mastiff (*Canis familiaris*), are usually raised to protect herds and family property, with large body size, aggressive nature, and a strong territorial defense *(Wang et al.* , 2004). In our study area, dogs are commonly free-roaming (i.e., not permanently chained or under human control) and thus there is no clear boundary between domestic dogs (loose after sunset and during summer when herdsmen moved away from their village to summer pasture), stray dogs and feral dogs (Messerschmidt, 1983). Hereinafter, we used 'free-ranging dogs' as a general designation for dogs in our study area, while specifically we used 'domestic dogs' to refer to dogs belonging to certain households and 'stray dogs' to those that are not. These numerous free-ranging dogs pose great threats to local wildlife (Hughes & Macdonald, 2013), including the Chinese mountain cat. Consequently, in spring 2019, we investigated the population of domestic and stray dogs in the area where the cats occur. Later on, in May 2019, we interviewed a total of 15 herdsmen about their dogs (e.g., number, rearing patterns, abandonment), stray dogs around their village (e.g., number, population trend, potential origin, interactions with their dogs, livestock, and wildlife), and their attitudes to stray dogs (e.g., feeding behaviors, management measures) (see Table S1 for full interview questions). The participation of herdsmen in the interview was voluntary and anonymous.

2.4 Genetic analysis of carcasses

For the genetic analysis, tissue samples (CMC1, 2) were collected from the carcasses of the two Chinese mountain cats and stored in 95% alcohol at -20 °C. DNA was extracted with Dneasy Blood & Tissue Kit (QIAGEN, Hilden, Germany). At first, partial mitochondrial gene *CytB* and 9 nuclear loci were amplified (see Table S2-S4 for PCR recipe, protocol, and primers) and sanger sequenced. Then, their whole genome DNA were sequenced with DNBSEQ-T7 platform in 150 bp pair-end runs by BGI company (Shenzhen, China). Results of the two methods were consistent. Additionally, we sampled two cubs (CAT1, 2) reportedly hybrids of male Chinese mountain cat and female domestic cat in Labu Town, Chindu County, approximately 40 km away from the Gyatong Grassland. Blood samples were collected from ears, stored in vials and preserved in ice bags, to be delivered to Berry Genomics (Biotechnical Company, Beijing, China) for DNA extraction and next-generation sequencing by Illumina NovaSeq 6000 system in 150 bp pair-end runs.

High-throughput sequencing generated 60.4G raw data for each of the two Chinese mountain cats and 53.9G, 41.5G for the two hybrid cats respectively. After filtering poor quality reads, adapter trimming and duplicates removal, clean reads were mapped to public sequences of nuclear loci on autosome and X chromosome in Johnson *et al.*(2006) and Y chromosome in Yu *et al.* (2021) for genotyping, and a complete mitochondrial genome (GenBank Accession Number MT499915) of *Felis catus* in Geneious Prime® 2020.0.3. Consensus sequences were generated and annotated for bases covered by at least 2 reads with Highest Quality. Our mitochondrial genome sequences were aligned with mitochondrial fragments sequenced by Yu *et al.* (2021) and the phylogeny was reconstructed by MrBayes 3.2.6 (Huelsenbeck & Ronquist, 2001; Ronquist & Huelsenbeck, 2003), with GTR+I+G model and 1,100,000 iterations with beginning 100,000 burn-in. Species-diagnostic nuclear genes of 8 autosomal genes, 3 X chromosome genes, and 2 Y chromosome genes inferred from published data (Accession Numbers DQ081730-DQ082545; Johnson *et al.* , 2006; Yu *et al.* , 2021) was referred to identify genetic composition to the four cats examined in our study.

3. Results

3.1 Carcass features and information collected on site

The adult female weighed 3.62 kg, with a body length of 68.2 cm, tail length of 29.4 cm; the female kitten weighed 2.62 kg, with a body length of 60.3 cm and tail length of 27.2 cm. Compared with the kitten, the adult clearly showed worn palm pads, claws and a greater tooth wear (especially canine teeth) (Fig. 3a, b). Both the carcasses showed a severed cervical spine caused by a carnivore bite, with fracture in C3-C5 of CMC-1 (Fig. 3c, d), while the occipital bone was dislocated from C1 for CMC-2 (Fig. 3e, f). Other than these fatal injuries, no other health issue was detected. This suggested that the spinal injury was the cause of death.

The body of the female kitten (CMC-1) was found right beside the farm of a local herdswoman on 30 Jan 2019. She reported that in the night of 29 Jan, when she was driving the yak herd back, she saw her dog chase the cat into its hiding burrow and bark in front of it. In the next morning, she found the dead body of the cat beside its den and, later, her dog dragged the dead cat approximately 50 m away from its burrow (Fig.

1b). On 7 Feb, the body of the adult female was also found beside its hiding burrow and similar description was also collected for it (Fig. 1b). One local herdsman reported that, two days before, stray dogs chased the adult female not far from where the body was found on 7 Feb. Based on our camera trap monitoring since Sept. 2018, no wild predators in Gyatong capable of killing the cats (e.g., lynxes, wolves, bears) have been recorded in the area. Therefore, all the evidence suggested that free-ranging dogs were responsible for the death of both cats.

3.2 Free-ranging dogs survey

Overall, 15 valid questionnaires were collected in Gyatong. The survey and interview suggested that there were two kinds of free-ranging dogs in the area: unchained domestic dogs and homeless stray dogs. In total, 166 domestic dogs were recorded in the Gyatong Grassland. Among them, 27 domestic dogs and seven stray dogs were found roaming in the range of the Chinese mountain cats (Fig. 4).

With respect to the rearing methods for the domestic dogs, all the interviewees suggested that they would chain their dogs in the daytime when there was someone home. However, domestic dogs would be set free at night or when the owners left home. No dogs are vaccinated. No dog abandonment was reported. There were also no cases of hybridization between domestic dogs and stray dogs according to the herdsmen. All the interviewees suggested that the number of stray dogs were increasing in recent years. When being asked about the potential origin of stray dogs, the locals suspected that they wandered here from Sichuan province.

In terms of attitudes towards stray dogs, most local herdsmen claimed that they were unaware of stray dogs' predation on wildlife, yet showed high tolerance of such behaviors when informed. They were not averse to the capture of stray dogs so long as the dogs were not killed on-site and the control measures had no effect on domestic dogs.

3.3 Genetic analysis of carcasses

Taxonomic status of the Chinese mountain cat is controversial and a recent genomic study suggested an alternatively classification as a subspecies (*F. silvestris bieti*) in wildcat conspecifics (Yu*et al.* , 2021), which we followed in the genetic analysis.*F. s. bieti* , *F. s. ornate* and *F. s. silvestris* were separated into three distinct lineages, and *F. catus* and its wild ancestry *F. s. lybica* formed one more lineage in the mitochondrial phylogeny. Both our Chinese mountain cats and hybrid kitten samples were clustered in the lineage of *F. catus* +*F. s. lybica* (Fig. 5a). Genotyping of nuclear loci showed that seven of the eight autosomal loci and all the three X-chromosomal loci for CMC1 and CMC2 were homozygous *F. s. bieti* genotype, while only one locus was homozygous *F. catus* genotype (Table 1). Those results indicated that the vast majority of the genome in this cat family originates from the Chinese mountain cat. However, domestic cats are identified as at least one of their maternal predecessors. The genotype of CAT1 and CAT2 was 4 homozygous *F. catus* loci, 1 homozygous *F. s. bieti* locus and 3 heterozygous loci on autosome, and 2 homozygous *F. catus* loci and 1 homozygous *F. s. bieti* locus on X chromosome (Table 1). The Y loci of male CAT2 was*F. catus* genotype. The genetic compositions of the two ancestral species are both considerable, as ~70% from the domestic cat and ~30% from the Chinese mountain cat. However, the fact that they have homozygous genotype from both ancestral species suggested that the hybridization in this pedigree had happened for multiple generations.

4. Discussion

In our study, two previously overlooked yet critical threats to cat survival were identified in the Gyatong Grassland: killing by free-ranging dogs and genetic contamination from domestic cats, which supplements our previous understanding of the major threats of pika poisoning programmes and illegal hunting (Sanderson *et al.* , 2010).

4.1 Killing by free-ranging dogs

We understand that solely based on the results from interviews and camera trap monitoring, we cannot prove that free-ranging dogs killed both cats – after all, the scene of killing was neither recorded nor seen by anyone. However, combined with other evidence from previous research as well as our observations of dogs' predation on other sympatric wildlife in the region, we do believe that free-ranging dogs have been the killers.

Liu's study (2020) in the Sanjiangyuan Region revealed that stray dogs showed fairly large home ranges (10 km^2 on average), large body weight (over 20 kg), and a high hunting success rate brought by group-hunting strategies, which indicated that they might be in a dominant position in their relationships with sympatric meso-carnivores. Meanwhile, stray dogs are notoriously known to harass sympatric wildlife and finally resulting in an reduction of survival rate via direct killing or increased stress level, altered activity pattern and habitat use (Lenth, Knight, & Brennan, 2008; Gingold *et al.* , 2009; Young*et al.* , 2011; Hughes & Macdonald 2013). For example, in New Zealand just one stray dog killed about 500 kiwis (*Apteryx australis*) in six weeks, accounting for more than half of local kiwi population (Taborsky, 1988). This is particularly worrying in the context of the recent surge in stray dog population in the Tibetan region. The collapse of the Tibetan mastiff market along with the implementation of nomadic settlement projects has resulted in a dramatic decrease in the economic and productive value of domestic dogs, leading to widespread dog abandonment in the region (Jenny, 2012). Official statistics from 2016 show that there were more than fifty thousand dogs in Golog Prefecture alone, Qinghai province, of which fourteen thousand were stray dogs (Yin *et al.* , 2017). The spots of these dogs' predation on wildlife have been frequently made (Fig. 4a, b; Yang*et al.* , 2019). Besides the fairly high population density (4.6 individual / km^2 near villages), the growth rate of them (10.3% on average) also indicates that this issue requires more attention and efforts (Liu, 2020).

In the case of Gyatong, our interviews revealed a fact that the current rearing methods of locals blurred the boundary between domestic dogs and stray dogs. At night or during the absence of owners, these domestic dogs would be unchained and allowed to hunt for themselves (Messerschmidt, 1983; Cui, 2006). As a natural result, such potential overlap in both time and space between free-ranging dogs and nocturnal Chinese mountain cats (Liao, 1988) has facilitated interactions detrimental to the cat. Moreover, cats are not the only victims in the region, with other meso-carnivores (e.g., Asian badgers *Meles leucurus* , Tibetan foxes) all threatened by these dogs. In June 2019, during the absence of the owner of a house 150 m away from the den of the Chinese mountain cat family, his two dogs were found to kill at least two Tibetan foxes, one steppe polecat (*Mustela eversmanii*), four Asian badgers, and one Himalayan marmot (*Marmota himalayana*) (Fig. 4b, Fig. 6; all these carcasses were found near the house and probably there were more undiscovered). Badgers and marmots were all consumed by dogs, but carnivores such as foxes and polecats were only killed and left intact, in accordance with previous diet analyses (Liu, 2020). Consequently, this leads to an increased exposure of the cats to free ranging dogs, because when dogs are attracted to the dens of badgers and marmots, the cats might be using them as hiding burrows (Sanderson *et al.* , 2010; Han *et al.* , 2020; Fig. 4c).

4.2 Genetic contamination by domestic cats

Compared with threats from free-ranging dogs, genetic contamination from domestic cats revealed by our genetic analysis is a much more imperceptible threat, but with a long-lasting impact on the survival of the cat as a unique lineage.

Despite the maintenance of typical morphological (Fig. 1a) and ecological features, our two Chinese mountain cat specimens carried both mitochondrial and nuclear genotype of domestic cats. This is the first time that wild individuals of the Chinese mountain cat were proven to contain the DNA of their domestic relatives. On the flip side, genetic introgression from the Chinese mountain cat to sympatric domestic cats has been proven with genetic evidence and supported by local observations. Yu *et al.* (2021) found that domestic cats sampled from the core range of the Chinese mountain cat's distribution (i.e., eastern Qinghai and northwestern Sichuan) carried 5-10% genetic admixture from Chinese mountain cats, which dated back to around 7.4 generations ago (approximately 20 years). Comparatively, our case samples from two hybrid cubs showed approximately 30% genetic source from Chinese mountain cat, suggesting a more recent admixture event or higher local introgression background. The hybrids also displayed intermediate morphological characters, e.g., light brown fur, little ear tufts, light brown pupils (Fig. 5b). Our finding supported that long-term bidirectional gene introgression between Chinese mountain cats and local domestic cats existed in the Gyatong Grassland and adjacent regions.

Moreover, local herdsmen claimed that the cats were rather common around their village about ten years ago, the time when many domestic cats were kept as pets. During mating seasons in spring, they could hear the cat screaming for the whole night, and a few locals have even seen male Chinese mountain cats wandering into their village to fight male domestic cats and mate with females (the opposite was not learned during this survey). Such potential asymmetric hybridization is probably related to the larger body size of the Chinese mountain cats compared to domestic cats, which gives them a mating advantage in accessing females (Similar phenomena of male Chinese mountain cats mating with the smaller female Asiatic wildcats *F. s. ornate* have also been reported; Yu*et al.* , 2021). Furthermore, from camera trap monitoring, we know that the male kitten has survived. On March 2019, he was found urine marking a boulder located below the third den of the breeding family, right after a white domestic cat did so, which suggested the opportunity for their mating competition.

The bidirectional gene flow between the Chinese mountain cat and local domestic cats in the Sanjiangyuan Region, if confirmed by future genetic analysis on larger scale, could be quite detrimental to the vulnerable Chinese mountain cat species, jeopardizing its distinctiveness, genetic integrity, and even its survival in the alpine environment. Extensive studies have demonstrated a similar genetic contamination crisis faced by the European wildcat (*F. s. silvestris*), which commonly interbreeds with the ubiquitous feral cats, raising widespread conservation attention (Allendorf *et al.* , 2001; Oliveira *et al.* , 2008). For Chinese mountain cats, more research efforts are in urgent need to investigate the extent of the problem.

4.3 Tricky balance among humans, dogs, cats and beyond

Both cats were genetically contaminated by domestic cats and very likely, killed by free-ranging dogs, which are almost inevitable results from their proximity to human settlements (Webb *et al.* , 2016). Among all the three dens of the family, the last one was located less than 100 meters away from a herdsman's house who owns one cat and three dogs. Such proximity facilitates frequent contact of the Chinese mountain cats with free-ranging dogs and domestic cats. Apparently, there requires no further words to explain the legitimacy of all of their existences. However, this fact indeed constitutes the very bedrock when we are trying to find a way out of this dilemma.

The complexity of the issue is rooted in both the material as well as the spiritual life of the Tibetans. On the one hand, domestic dogs and associate rearing methods are of utter importance to the safety of property and life of local herdsmen. Currently, in the Sanjiangyuan Region and most areas on the Tibetan Plateau, wolves and bears are two carnivores that have caused most human-wildlife conflicts (Dai *et al.* , 2020). As the major 'weapon' against them, unchained dogs, particularly Tibetan mastiffs, are of unparalleled importance to local herdsmen (Messerschmidt, 1983). On the other hand, the locals seem to acquiesce in the killing behaviors of their dogs. Our interview suggested that many of the locals were unaware of the dog's negative impact on wildlife. Despite so, from the fact that most local herdsmen would set their dogs free when they are leaving, it is clear that they are allowing dogs to prey on wildlife. In this case, the real causes of such avoidable incidents were selectively attributed to the poor and inevitable fates of the victim animals, instead of the indifference (or 'bad karma' if more precisely) of the dog owners (note that by no means we are criticizing Tibetan Buddhism here because it was the exact reason that has kept the Tibetan Plateau one of the most pristine habitats to wildlife in the world, as shown in Ma & Chen, 2005; Shen *et al.* , 2012; Li *et al.* , 2014).

Therefore, it was not realistic to simply ask nomads to chain their domestic dogs all the time. Leaving dogs to neighbors seems worth trying if the causal connections could be established between 'setting dog free' and 'deaths of innocent wild animals', yet which might be most effectively done by someone with same religion. Comparatively, for stray dogs, potential management measures seem less tricky and more feasible. According to the interview conducted in Gyatong, most local herdsmen did not mind the treatments of stray dogs (e.g., neutering, killing) as long as they are not treated on-site ("you can put them in a truck and take them away, but do not tell me what you will do to them"). The only difficult part of this solution is that surrounding Tibetan monasteries must be well informed and educated, since during our survey they were found feeding and harboring stray dogs to a great extent (for example, a Nunnery in the study area have been keeping over one hundred stray dogs and none of them was chained).

Consequently, it now seems to us the most feasible solutions to mitigate the situation in Gyatong are, (1) carefully monitoring and regularly catching stray dogs in the region, (2) persuading dog owners send their dogs to a host family instead of setting them free when they are away, (3) establishing the causal link between 'dead wild animals' and 'dogs owners' misdeeds' in the mindsets of the locals. For dog-release at night, it seems to us there is no feasible alternative for now, unless the current conflicts between humans, bears and wolves are alleviated. However, as stated above, suggestions as such might also be applicable to the region alone, considering the very high yet often overlooked cultural biodiversity within the Tibetan Plateau (e.g., studies conducted in the Golog Prefecture suggested that the locals show no tolerance to any dog-hurting behavior; Liu, 2020).

To summarize, through the examination and analysis on two carcasses from a consistently monitored Chinese mountain cat family and two hybrids, as well as the survey on free-ranging dogs in this area, we suggest that two so-far overlooked threats to the cat are elicited from domestic dogs and cats, their foes and their kins, in addition to the previously-identified threats of pika poisoning programs and illegal hunting. With the synthesis on available knowledge and observations, the complexity of the issue was illustrated and accordingly, potential solutions were proposed. With the species up-listed to the National First-Class Protected Wild Animal, more attention should be paid to the Chinese mountain cat. Along with it, we hope more research and conservation resources and efforts will be directed to this endemic carnivore.

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.

Conflict of interest

The authors declare that there are no conflict of interest.

Data availability

The raw data of whole genome sequencing reported in this paper have been deposited in the Genome Sequence Archive (Chen *et al* ., 2021) in National Genomics Data Center, China National Center for Bioinformation / Beijing Institute of Genomics, Chinese Academy of Sciences (GSA: CRA011608) that are publicly accessible at https://ngdc.cncb.ac.cn/gsa.

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Author contributions

X.S.H, H.Q.C., X.Z. and Z.L. designed the research; X.S.H., H.Q.C., Z.Y.D. conducted the fieldwork; H.Q.C. carried genetic analysis and analyzed the data; C.Y.W., X.S.H. and H.Q.C drafted the manuscript; X.Y.S. reviewed and improved the manuscript; X.S.H. and H.Q.C. produced the figures. All authors contributed critically to the drafts and gave final approval for publication.

Tables and figures

Table 1. Genotyping of species-diagnostic nuclear genes of the four cats in our study. Homozygous loci with *F. s. bieti* genotype are highlighted in blue and homozygous loci with *F. catus* genotype are highlighted in green. Heterozygous loci are highlighted in yellow.

Chromosome	Autosome	Autosome	Autosome	Autosome	Autosome	Autosome	Autosome	Autosome	Autoso
Gene	*CMA1*		*CLU*	*CLU*	*CLU*	*CLU*	*CLU*	*CLU*	
Site	479		20	666	735	1069	1261	1298	
F. s. bieti	G		T	G	A	C	C	C	
F. catus	A		C	G	A	G	C	A	
CMC1	G		T	G	A	C	C	C	
CMC2	G		T	G	A	C	C	C	
CAT1	A		T/C	A/G	A/G	C/G	C/G	C/A	
CAT2	A		T/C	A/G	A/G	C/G	C/G	C/A	

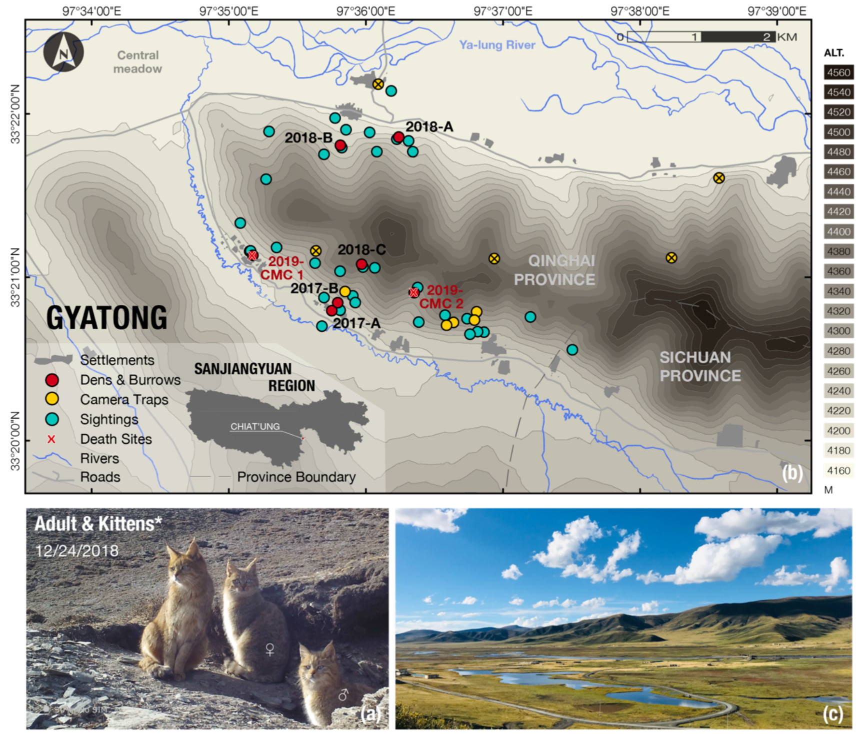

Figure 1. Gyatong and the breeding family of the Chinese mountain cats. (a) The first breeding family of Chinese mountain cat discovered on Sept 2018 (Han *et al.* , 2020); (b) Study area; (c) Landscape of the Gyatong Grassland.

Figure 2. Carcasses picture on sites. (a) The carcass of the female kitten (CMC-1); (b) The carcass of the adult female (CMC-2).

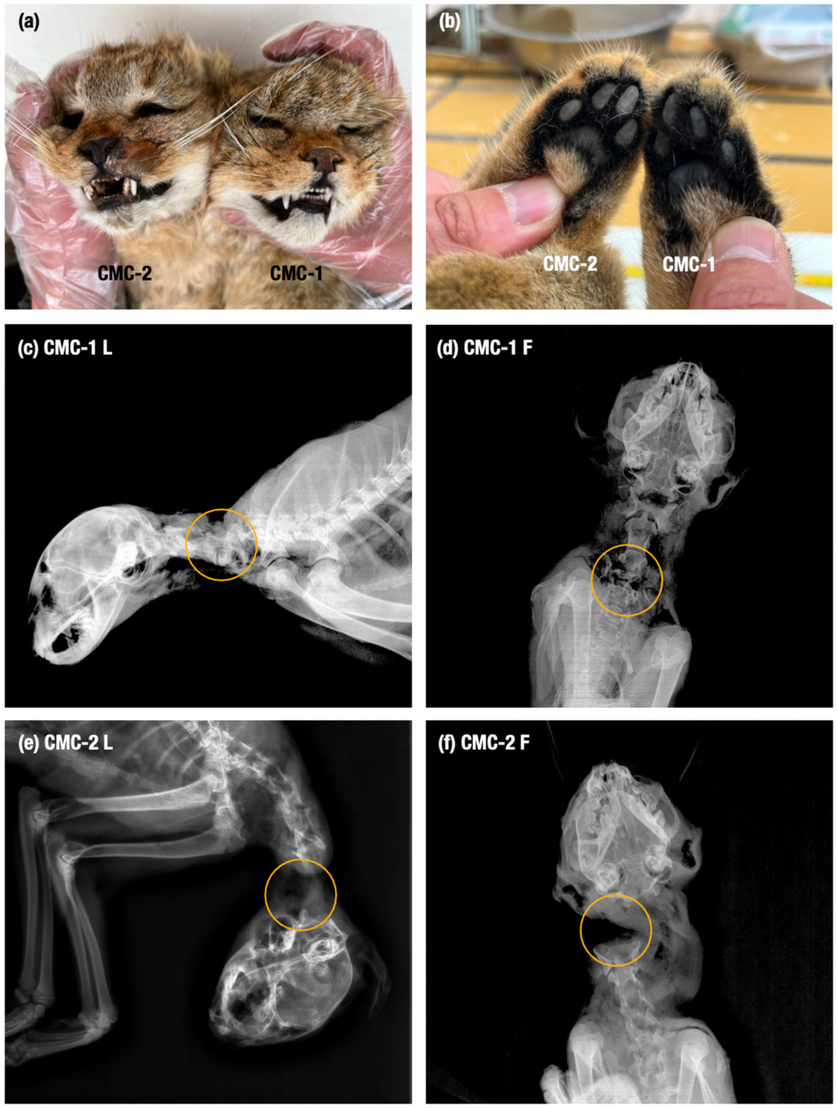

Figure 3. Examination of two carcasses. (a) Comparison of the canine teeth; (b) Comparison of the paw pads; (c) X-ray image of the female kitten (CMC-1; lateral view); (d) X-ray image of the female kitten (CMC-1; front view); (e) X-ray image of the female kitten (CMC-2; lateral view); (f) X-ray image of the female kitten (CMC-2; front view).

Figure 4. Free-ranging dogs near the range of the Chinese mountain cats. (a) One domestic mastiff unchained at night, phototrapped close to a hiding burrow of the Chinese mountain cat; (b) A free-ranging dog with a juvenile marmot in its mouth; (c) Two domestic dogs unchained by their owner during his short absence.

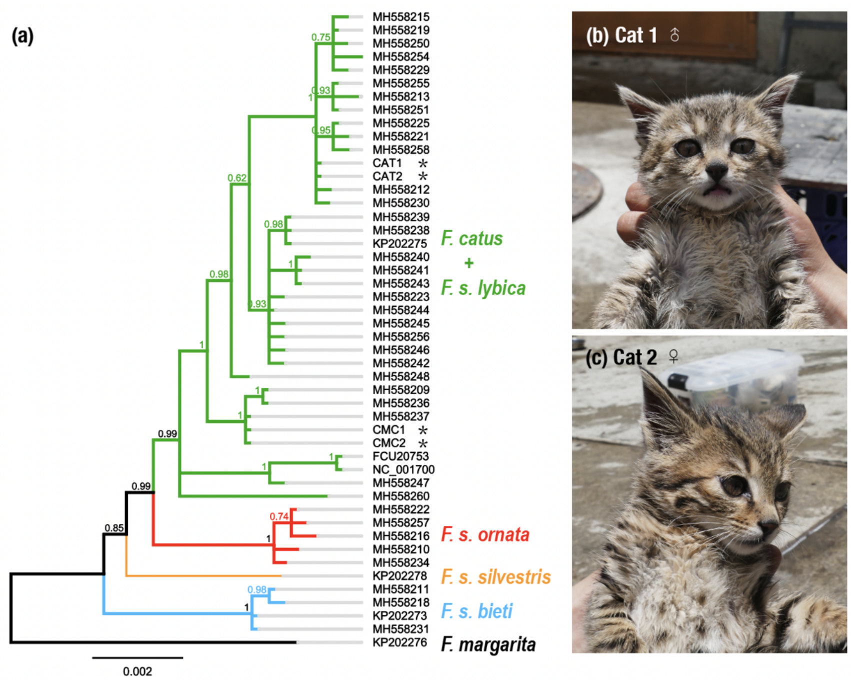

Figure 5. Mitochondrial genetic analysis of two Chinese mountain cats and two hybrid kittens. (a) Bayesian phylogeny of four mitochondrial lineages in *F. silvestris* based on 351 bp partial *CytB* , with *F. margarita* as outgroup. , Posterior probabilities are noted above each branch and accession numbers of referred sequences or our sample IDs were listed at the end nodes.(b, c) Morphological characters of two hybrid cats CAT1 and CAT2.

Figure 6. Carcasses of kills made by two free-ranging domestic dogs (from left to right: one skull of Himalayan marmot, four skulls of Asian badgers, one carcass of steppe polecat, and two carcass of Tibetan foxes)

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