Genomic study discovers evidence of giant panda's population history and local adaptation

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A research team, led by Institute of Zoology of Chinese Academy of Sciences and BGI, has successfully reconstructed a continuous population history of the giant panda from its origin to the present. The findings suggested whereas global changes in climate were the primary drivers in panda population fluctuation for millions of years, human activities were likely to underlie recent population divergence and serious decline. This work reveals a good example for assessing and establishing the best conservation method for other endangered species. The latest study was published online in *Nature Genetics*.

The giant panda is the rarest member of the bear family. Looked upon as

the ambassador for all endangered species, it is a well-recognized symbol of international wildlife conservation. The giant panda is currently threatened by continued habitat loss, human persecution, among others. Its dietary specialization, habitat isolation, and reproductive constraints have led to a perception that this is a species at an "evolutionary dead end", destined for deterministic extinction in the modern world.

In this study, researchers carried out whole genome resequencing of 34 wild giant pandas and found the current six geographic populations of giant panda could be divided into three genetic populations, including Qinling (QIN), Minshan (MIN) and Qionglai-Daxiangling-Xiaoxiangling-Liangshan (QXL). Through reconstructing giant panda's population history, they found several important evolutionary events such as two population expansions, two bottlenecks and two population divergences.

The giant panda has a very special bamboo diet, while its ancestor was omnivorous or carnivores. As early as about 3 Myr ago, they probably had already completed their dietary swift and pygmy panda emerged with bamboo as its primary diet. The warm and wet weather at that time provided ideal conditions for the spread of bamboo forests that further led to the first population expansion of giant panda. However, about 0.7 Myr ago, the panda population began to decline due to the two largest Pleistocene glaciations happened in China, and its first population bottleneck occurred at about 0.3 Myr ago. During that period, pygmy panda was gradually replaced by another subspecies - baconi panda that has larger body size.

After the retreat of the Penultimate Glaciations, giant panda's second population expansion happened and it reached its population peak between 30~50 thousand years (kyr) ago. The warm weather in the Greatest Lake Period (30~40 kyr ago) and alpine conifer forest may play an important role in the flourishing of the panda population. However, during the period of last glacial maximum (LGM), the climate was cold,

dry, and inhospitable with frequent storms and a dust-laden atmosphere. Under such harsh environment, extensive panda habitats were loss and its second population bottleneck occurred.

The more recent panda population history showed that the panda population separated into Qinling (QIN) and non-QIN populations at about 0.3Myr ago, and then the non-QIN cluster diverged into two populations, the Minshan (MIN) and Qionglai-Daxiangling-Xiaoxiangling-Liangshan (QXL) at about 2.8 KYA ago. Subsequently, the three populations were different in the ways of fluctuation. For example, there was a drastic decline in the QIN, a slight increase in the MIN and a more remarkable growth in the QXL populations.

Researchers identified the signals of panda's local adaptation. They found the largest group of selected genes in these populations was related to sensory system. However, the two genes, Tas2r49 and Tas2r3, were associated with bitter taste and were under directional selection between the QIN and non-QIN populations, showing no signal of directional selection between MIN and QXL populations.

As a form of olfactory communication, odor perception is crucial for reproduction and survival of giant pandas in the dense forest. Researchers found the MIN and QXL populations had fewer directionally selected genes than QIN and non-QIN, suggesting less variation happens in the selection processes between MIN and QXL. They also found the evidence that population fluctuations were driven by global climate shifts, but recent human activities have likely caused population divergence and the serious recent decline.

Shancen Zhao, Project Manager from BGI, said, "We have identified three genetic populations of giant panda for the current six geographic populations lived in western of China. The varied local adaptations found in our study provide invaluable resource for researchers to better

select effective conservation methods to rescue the giant panda even other endangered species. The translocation of wild-caught individuals or releasing the captive-bred ones may be a feasible approach. "

Provided by BGI Shenzhen