A Middle Eocene lowland humid subtropical "Shangri-La" ecosystem in central Tibet

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Tibet's ancient topography and its role in climatic and biotic evolution remain speculative due to a paucity of quantitative surface-height measurements through time and space, and sparse fossil records. However, newly discovered fossils from a present elevation of ∼4,850 m in central Tibet improve substantially our knowledge of the ancient Tibetan environment. The 70 plant fossil taxa so far recovered include the first occurrences of several modern Asian lineages and represent a Middle Eocene (∼47 Mya) humid subtropical ecosystem. The fossils not only record the diverse composition of the ancient Tibetan biota, but also allow us to constrain the Middle Eocene land surface height in central Tibet to ∼1,500 ± 900 m, and quantify the prevailing thermal and hydrological regime. This "Shangri-La"–like ecosystem experienced monsoon seasonality with a mean annual temperature of ∼19 °C, and frosts were rare. It contained few Gondwanan taxa, yet was compositionally similar to contemporaneous floras in both North America and Europe. Our discovery quantifies a key part of Tibetan Paleogene topography and climate, and highlights the importance of Tibet in regard to the origin of modern Asian plant species and the evolution of global biodiversity.

biodiversity | fossil | monsoon | Tibetan Plateau | topography

The Tibetan Plateau, once thought of as entirely the product of the India–Eurasia collision, is known to have had significant complex relief before the arrival of India early in the Paleogene (1–3). This large region, spanning ∼2.5 million km^2, is an amalgam of tectonic terranes that impacted Asia long before India's arrival (4, 5), with each accretion contributing orographic heterogeneity that likely impacted climate in complex ways. During the Paleogene, the Tibetan landscape comprised a high (>4 km) Gangdese mountain range along the southern margin of the Lhasa terrane (2), against which the Himalaya would later rise (6), and a Tanghula upland on the more northerly Qiangtang terrane (7). Separating the Lhasa and Qiangtang blocks is the east–west trending Banggong-Nujiang Suture (BNS), which today hosts several sedimentary basins (e.g., Bangor, Nyima, and Lunpola) where >4 km of Cenozoic sediments have accumulated (8). Although these sediments record the climatic and biotic evolution of central Tibet, their remoteness means fossil collections have been hitherto limited. Recently, we discovered a highly diverse fossil assemblage in the Bangor Basin. These fossils characterize a luxuriant seasonally wet and warm Shangri-La forest that once occupied a deep central Tibetan valley along the BNS, and provide a unique opportunity for understanding the evolutionary history of Asian biodiversity, as well as for quantifying the paleoenvironment of central Tibet.*

Significance

The ancient topography of the Tibetan Plateau and its role in biotic evolution are still poorly understood, mostly due to a lack of fossil evidence. Our discovery of ∼47-Mya plant fossils from a present elevation of 4,850 m in central Tibet, diminishes, significantly, that lack of knowledge. The fossils represent a humid subtropical vegetation and some of the 70 different plant forms show affinity to Early-Middle Eocene floras in both North America and Europe. Using leaf architecture, we calculate that the forest grew at ∼1,500-m elevation within an east–west trending valley under a monsoonal climate. Our findings highlight the complexity of Tibet's ancient landscape and emphasize the importance of Tibet in the history of global biodiversity.

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*Shangri-La refers to the fictional hidden valley in Tibet hosting subtropical vegetation imagined in the novel "Lost Horizon" by James Hilton published in 1933.