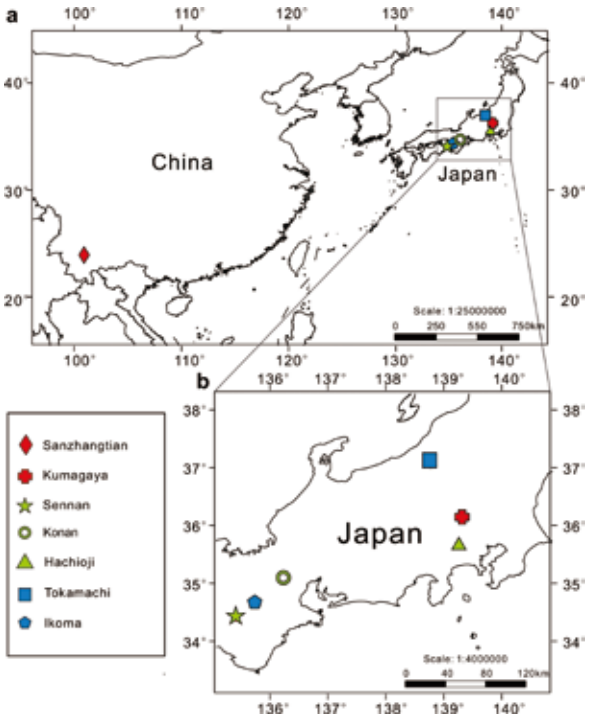
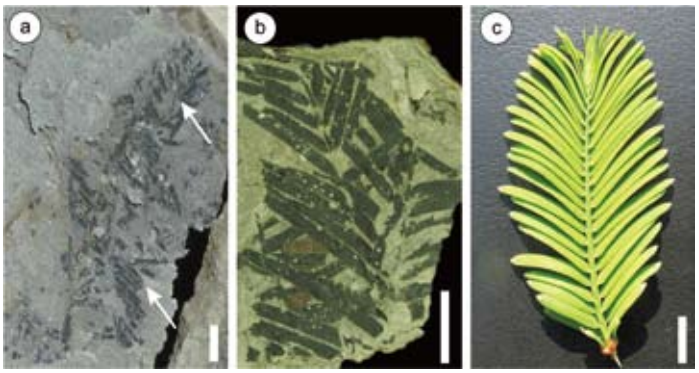
Fossilized Leaves Indicate Historical Atmospheric CO_2 Concentrations

The impact of high CO_2 concentration on global environmental system can be unraveled by a better understanding of the relationship between the paleo-atmospheric CO_2 concentration and ancient climate change. Stomatal parameters (stomatal index and stomatal density) are reliable proxies to estimate paleo-atmospheric CO_2 concentration. When *Metasequoia* has exhibited an evolutionary stasis since its appearance in the Late Cretaceous, fossilized *Metasequoia* can be considered to be conspecific with modern *Metasequoia* based on the morphology, biochemistry and inferred physiology. Therefore, the paleo-atmospheric CO_2 concentration changes over a long geological time can be determined from a correlation between the stomatal index of *Metasequoia* needles and the paleo-atmospheric CO_2 concentration.

Prof. ZHOU Zhekun and his team from CAS Xishuangbanna Tropical Botanical Garden (XTBG) used *Metasequoia* needles from seven localities in China and Japan to reconstruct continuous terrestrial paleo-atmospheric CO_2 concentration changes from the middle Miocene to Pleistocene. Based on the reconstructed paleo-atmospheric CO_2 concentration curve, they discussed the interaction between paleo-atmospheric CO_2 concentration evolution and global environment change since the middle Miocene.



Localities where fossilized Metasequoia were obtained. Locality map (a) showing the seven fossil sites in China and Japan. Enlarged map (b) illustrating the central area of Japan showing the position of the six localities in Japan: Kumagaya, Sennan, Konan, Hachioji, Tokamachi and Ikoma. Different colors identify the different ages of the localities (Red: Miocene; Green: Pliocene; Blue: Pleistocene).



Fossilized *Metasequoia* from Tokamachi and Kumagaya sites. Fossilized *Metasequoia* branchlet and needles from Tokamachi (a) and Kumagaya (b) as examples to show the megafossils of *Metasequoia* used in this research, compare with a modern *Metasequoia* branchlet (c). White arrows in (a) indicate the branchlet.

They found that from middle to late Miocene, the atmospheric CO_2 level stabilized around 350 ppmv which is slightly lower than today. The CO_2 level during the Pliocene to Pleistocene, as they revealed, was similar to the pre-industrial level and no fluctuation was detected in their study. They also discovered that the Pleistocene CO_2 level estimated by different proxies agreed well with each other. Last but not least, from middle Miocene to Pleistocene, when the global temperature decreased sharply, the global CO_2 level decreased by more than 50 ppmv, which may suggest that CO_2 decrease and temperature decrease are coupled.

Their study, entitled "Evolutionary History of Atmospheric CO_2 during the Late Cenozoic from Fossilized Metasequoia Needles", was published in *PLoS ONE*.