Paleontology and Paleoanthropology Research

The Chinese Academy of Sciences (CAS) takes pride in its time-honored academic research covering an extensive and refined disciplinary spectrum of paleontology and paleoanthropology, spanning from invertebrate paleontology, vertebrate paleontology, biostratigraphy and chronostratigraphy, to paleoanthropology. Over the past four decades, a lot of heart-stopping discoveries have emerged from these fields, thanks to the long-term efforts made by generations of CAS scholars and their cooperators.

Chengjiang Fauna and Cambrian Explosion

The origin and early evolution of life on the Earth has been an important and captivating issue in earth sciences. Nevertheless, remnants of early organisms from the very first episodes of this spectacular adventure, probably occurring up to hundreds of million years ago, can hardly survive the complicated and drastic geological processes afterwards, to be preserved and found by human beings as fossils in the strata.

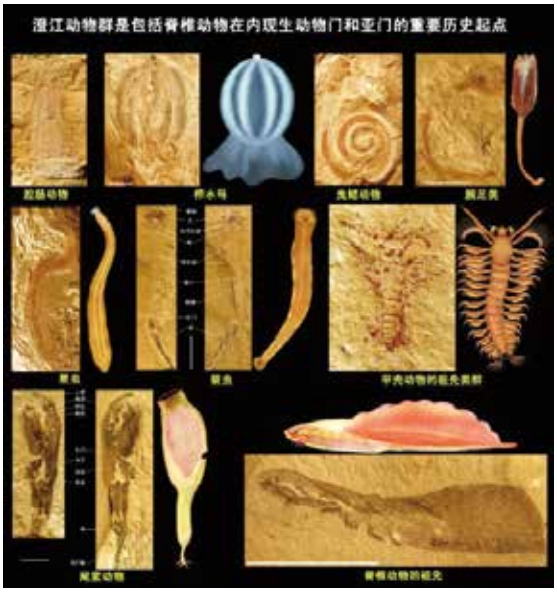
Therefore, it takes some serendipity to find and identify fossil materials from such agelong periods. Scarcity of fossil evidence has thrown some grand events in the early stage of life evolution in clouds – for example the Cambrian explosion, the "sudden" appearance and radiation of most major animal phyla during a relatively short time, roughly 20 million years beginning about 542 million years ago.

Building on their long-term work, scientists at the

Paleontologists at NIGPAS probe into the early evolution of life on earth and have unveiled the mysterious world of Cambrian marine life 530 million years ago, with their discovery and research into Chengjiang Biota. (Credit: NIGPAS)

Nanjing Institute of Geology and Paleontology, CAS (NIGPAS), first discovered abundant fossil materials in 1984 from the Cambrian strata of Chengjiang, Yunnan Province of southwestern China, and established the Chengjiang Fauna with subsequent excavations and comprehensive research. Their 17-year work on over 30,000 pieces of fossil has since led to a series of ground-breaking discoveries, and a vivid reconstruction of the marine ecosystems of 530 million years ago, unveiling the scope, effects and influence of the "Cambrian explosion" and displaying the biodiversity and complicated ecosystems stemming from this evolutionary event.

This work, acclaimed as "one of the most amazing scientific discoveries of the 20th century", earned NIGPAS a First Prize from the National S&T Awards for Natural Science in 2003.



Part of the fossil materials from the Chengjiang Fauna. (Credit: NIGPAS)

Global Boundary Stratotype Sections and Points (GSSPs)

Widely described as "golden spikes" nailed down into geological strata, Global Boundary Stratotype Sections and Points (GSSPs) is a globally-recognized system consisting of internationally agreed reference points, each on a stratigraphic section defining the lower boundary of a stage on the geologic time scale. The delimitation is often based on paleontological transitions. Just like a coordinate based on which one can draw the curve of a function, subdivisions are derived from this framework. Therefore, ratification of a GSSP demands great accuracy and reliability, and hence entails very careful work based on strong evidence.

As of July 2018, among the 60-odd GSSPs established over the world, a total of 11 had been established by Chinese scientists, the biggest share taken by a single country. Among them, seven have been forged by NIGPAS scientists.

In recognition of their excellent work in the study on Cambrian and Ordovician Global Boundary Stratotype Sections and Points (GSSPs) and chronostratigraphic subdivisions, the NIGPAS team was granted a 2nd Prize from the National S&T Awards for Natural Science in 2008.

Landmarks of different styles are seen set up at the seven representative stratigraphic profiles of GSSPs established by NIGPAS. (Credit: NIGPAS)

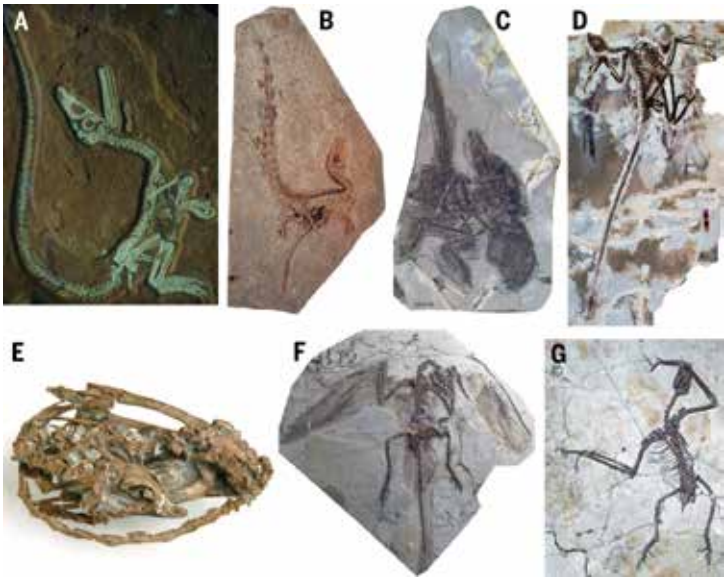
Jehol Biota

Based on large-scale field work and excavations for decades, paleontologists with the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP), CAS have been focusing on research in the fossil fishes, dinosaurs, birds, mammals and other species unearthed from the Jurassic and Cretaceous strata of an area in northeastern China known as "Jehol" in ancient time. Materials accumulated and a fossil biota was established and labeled with the ancient name of this area. Research in this fauna has led to breakthroughs in a series of critical evolutionary issues.

Prominently, new species of bird-like dinosaurs from this fauna, particularly those exotic, feathered ones, have subverted many once well-rooted believes, including the definitions of dinosaurs and early birds, and the origin of feather and flight. The continuous, exhaustive work in this fauna has presented abundant evidence to demonstrate how one dinosaurian lineage, i.e., theropods, developed small and lightweight body structures and evolve into birds, making it one of the best documented evolutionary transitions in paleontology research.

To celebrate their contributions, *Science* listed "dinosaur-bird transition" in its picks for the 2014 annual top 10 ground-breaking discoveries and achievements.

Research in this fauna has also led many major discoveries concerning the origin and phylogeny of many taxonomies, improving the understanding of the terrestrial ecosystems of this geological period.



Research by IVPP scientists into the transitional forms of theropods and early birds has made the transition from dinosaurs to birds one of the best documented episode of evolution. Shown are part of the transitional forms of theropods and early birds discovered and described by IVPP scientists: (A) *Sciurumimus*, (B) *Sinosauropteryx*, (C) *Anchiornis*, (D) *Microraptor*, (E) *Mei*, (F) *Jeholornis*, and (G) *Sapeornis*. (Credit: IVPP)

Completed in the early 2000s, this ecological reconstruction of the Jehol Biota illustrates new species discovered and described by CAS scientists, including fishes, amphibians, dinosaurs, birds, mammals, and others. Now the landscapes of the Jehol Biota have been and are still being updated with more new species and their behavior details, resulting from the ongoing work by CAS scientists and their cooperators. (Image by ZENG Xiaolian, IVPP)

New Insights into Early Migration of Modern Humans

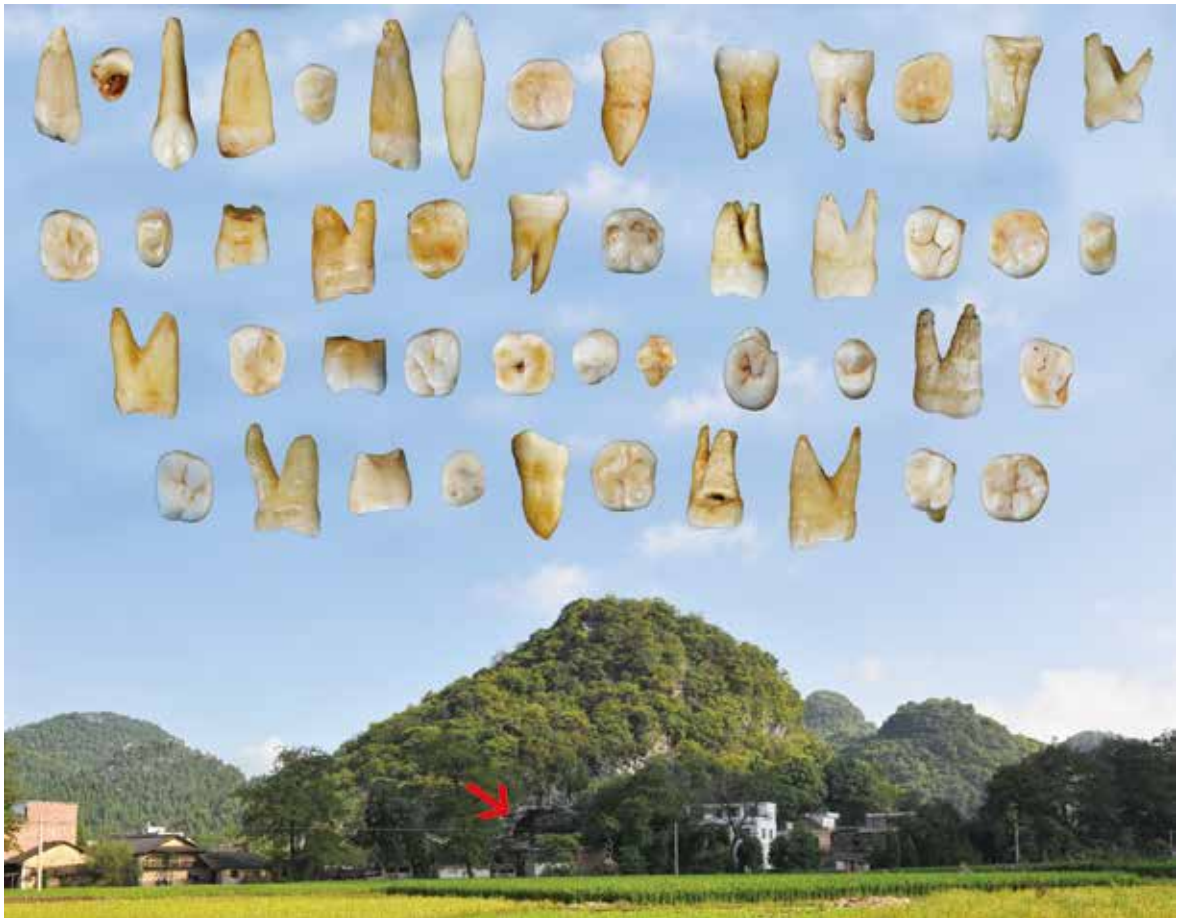
The origin and early migration of modern humans has been an issue intensively disputed among paleoanthropologists. It is widely believed that all modern Eurasians are offspring from the first population of *Homo sapiens* to step out of Africa, the cradle of humanity; however, due to the scarcity of hominin record from southern Asia for the early Late Pleistocene epoch, how our common ancestors have migrated from Africa has been elusive.

Filling this long-existing gap, an international team of paleoanthropologists led by IVPP experts reported in *Nature* October 2015 their discovery of a total of 47 human teeth from Fuyan Cave in Daoxian, southern China. Dated to be from early *Homo sapiens* living 80,000 to 120,000 years ago, these materials represent the earliest evidence of fully modern humans outside Africa. The research suggests that *Homo sapiens* might have trekked into Asia far earlier than previously known and, much earlier than migrating into Europe.

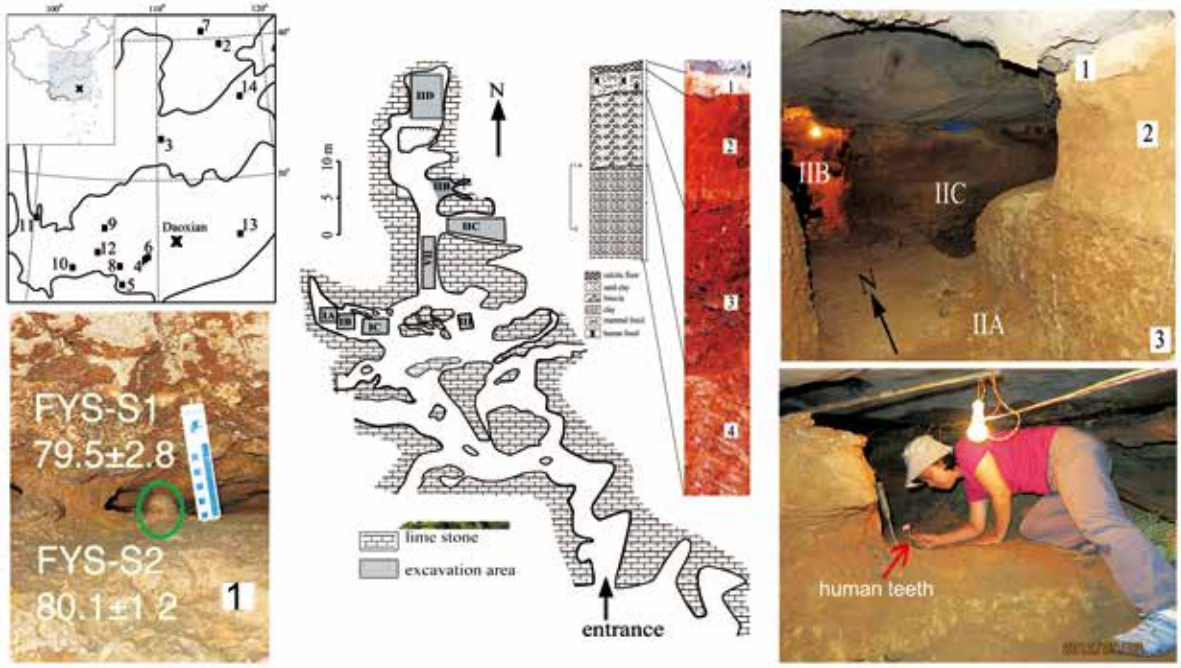
This discovery offers new insights into the early dispersal routes of modern humans, indicating a potentially different story of "Out-of-Africa".

Before this, a discovery jointly made by scientists from IVPP and the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany had shed some new light on this issue.

A mysterious leg bone from Siberia, named Ust'-Ishim after the area where it was found, turned out to be remains of a male hunter-gatherer of about 45,000 years old. The information of its original environment has been unfortunately lost; yet the well-preserved



The 47 fully modern human teeth and the Fuyan Cave in Daoxian, southern China. (Image by LIU Wu, IVPP)



The geographical location and stratigraphy of Daoxian site. (Image by LIU Wu, IVPP)

DNA harvested from it has offered some clues about this population and their ancestors.

Analysis revealed that this ancient DNA, the oldest genome sequence known for *Homo sapiens* on record, probably represents an extinct population that may once have spanned northern Asia. Interestingly, 2% genes of this genome sequence could have come from Neanderthals, about the same percentage as modern non-Africans. Analysis in mutation rate in this genome indicated that this interbreeding could have occurred 7,000 to 13,000 years earlier. This genetic inflow from Neanderthals, a species of human that could be traced back to around 300,000 years ago roaming across Europe, hints on a possible episode of the "Out-of-Africa" story that the ancestors of this mysterious population might have encountered with Neanderthals when they travelled from Africa to Middle East, the corridor connecting Europe and Asia.

This discovery was listed in the *Nature* version of 2014 top 10 scientific events.