Manchester Geological Association
University Place, University of Manchester
Saturday 12th January 2013 at 10.00am

The Broadhurst Lectures
The Palaeontology of China

10.00 – 10.30 Welcome Tea/Coffee and Registration

10.30 – 11.15 Doushantuo Microfossils: the oldest animals in the fossil record?
Dr John Cunningham, University of Bristol

11.15 – 12.00 The Cambrian Fossils of Chengjiang, China: the flowering of early animal life
Professor David Siveter, University of Leicester

12.00 – 13.30 Lunch

13.30 – 14.15 Shaking the tree of life by the roots: a bottom-up perspective on the Palaeozoic and Mesozoic fossil plants of China
Dr Jason Hilton, University of Birmingham

14.15 – 15.00 Jurassic Spiders from China
Professor Paul Selden, University of Kansas

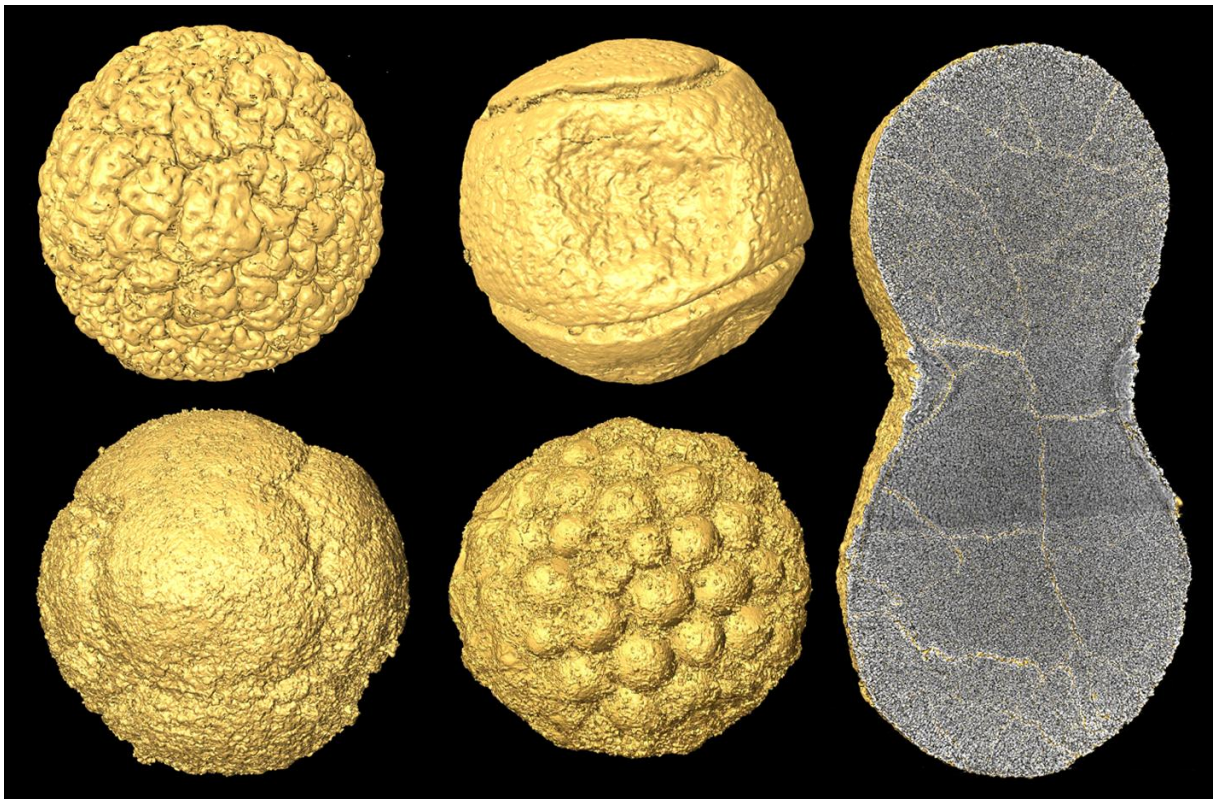
15.00 – 15.30 Coffee Break

15.30 – 16.15 Exceptional Preservation of Dinosaur Eggs and Embryos from the Upper Cretaceous of Henan Province, People's Republic of China
Dr John Nudds, University of Manchester

16.15 – 17.00 Pterosaurs from the People's Republic of China – another great leap forward?
Dr David Unwin, University of Leicester

Doushantuo Microfossils: the oldest animals in the fossil record?
Dr John A. Cunningham, Department of Earth Sciences, University of Bristol

The Ediacaran Doushantuo biota offers a rare window on multicellular life before the Cambrian. It has yielded a number of candidates for the oldest animals in the fossil record including embryo-like fossils and even advanced animals. However, all of these reports have proven to be controversial, and the fossils have been alternatively interpreted as either bacteria or protists. I will describe recent research designed to test between these competing hypotheses. Synchrotron tomography has played a vital role, by allowing the internal structure of the fossils to be visualized non-destructively at sub-micrometre resolution, providing new insights into internal and subcellular anatomy. However, much of the controversy results from the difficulty of distinguishing true biological structures from artefacts of decay and later mineralization - only when these processes are taken into account can the fossils be interpreted with confidence. Important insights into how decay has affected the fossils have been gained by allowing modern analogues to rot in controlled lab conditions. In addition, combining synchrotron tomography with Scanning Electron Microscopy and elemental mapping has allowed us to establish textural and chemical criteria capable of distinguishing between preserved biological structure and unrelated diagenetic mineral growth. Together these approaches have provided new insights into the affinities of the fossils. I will argue that there is currently no convincing evidence for advanced animals with bilateral symmetry in the Doushantuo biota. Furthermore, the embryo-like fossils are unlikely to be animals, but might provide information on the evolution of animal grade multi-cellularity.



Four embryo-like fossils (left) and a peanut-shaped fossil with many thousands of cells (right) from the Ediacaran Doushantuo biota of southern China

The Cambrian Fossils of Chengjiang, China: the flowering of early animal life
Professor David Siveter, University of Leicester

The discovery, in 1984, of the Chengjiang biota, in rocks of early Cambrian age in south China, was one of the most significant palaeontological finds of the 20th century. The fossils are abundant and exquisitely preserved, beautifully showing fine details of the hard parts and soft tissues of invertebrate and vertebrate species about 525 million years old. They are vital keys in helping to unravel the evolution of multicellular organisms during the so-called "Cambrian Explosion", when such life forms first become common in the fossil record.

The Chengjiang biota provides direct evidence for the roots of animal biodiversity. Over 200 species have been recorded, spread across most of the animal phyla, with arthropods being the most abundant group. The biota presents by far the most complete evidence of an early Cambrian marine community, and an unparalleled record of the early establishment of a complex marine ecosystem, with food webs capped by sophisticated predators. The majority of forms were bottom-dwellers, represented by both infauna and epifauna. The water column was colonized by a variety of floating and swimming animals. Trophic groups present include predators, scavengers, high and low level filterers and, possibly, deposit feeders. Not least, the fossils of Chengjiang bear upon fundamental questions regarding the design of animal body plans and the genetic generation of evolutionary novelty. The scientific importance and outstanding universal value of the Chengjiang fossil site is acknowledged with its recent inscription to the list of UNESCO World Heritage sites.

Lower Cambrian bivalved arthropod *Kunmingella douvillei*
from the Chengjiang lagerstatte, Yunnan Province

Shaking the tree of life by the roots: a bottom-up perspective on the Palaeozoic and Mesozoic fossil plants of China

Dr Jason Hilton, School of Geography, Earth and Environmental Sciences, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK; e-mail j.m.hilton@bham.ac.uk

Much of our present understanding of early evolution of plants is based around the legacy of knowledge built up in Europe and North America that spans more than 200 years of investigations. This talk will showcase recent research results from the Palaeozoic and Mesozoic floras of China that provide important insights into plant evolution and fundamentally challenge preconceptions developed from the plant fossil record in other geographical regions. Examples will include plants recognised from the Permian aged peat forming environments of North China that demonstrate a remarkable persistence of wetland plant communities from the Carboniferous of Europe and North America into the Permian of China, as well as the early evolution of tree ferns in the Permian floras of Southern China. The talk will conclude with an update on the stratigraphically oldest recognised angiosperms from the Cretaceous of North China, outlining what these do and don't tell us about the origin and early evolution of flowering plants.

Jurassic Spiders from China
Professor Paul Selden, University of Kansas

Spiders are rare in the fossil record, and especially so in Jurassic rocks; only a handful of Jurassic spiders were described before this century. Now, however, outcrops in the hamlet of Daohugou in Inner Mongolia have yielded several hundred specimens, including some quite spectacular and interesting finds. In this talk, I shall first give some basic information about spider biology, before describing a few of these discoveries and what they mean for understanding the fossil record of spiders, arachnid relationships, and palaeobiogeography.

Both specimens come from Middle Jurassic (ca. 165 Ma) strata of Daohugou, Inner Mongolia, China.

Above left - *Eoplectreurys gertschi*. This is referred to the modern family Plectreuridae. This small family is restricted to south-western USA, Mexico, and the adjacent Caribbean area today and hitherto has only a sparse Cenozoic fossil record. The morphology of *Eoplectreurys* is remarkably similar to modern forms and thus demonstrates great evolutionary conservatism. This discovery not only extended the fossil record of the family by at least 120 Ma to the Middle Jurassic but also supports the hypothesis of a different distribution of the family in the past than today and subsequent extinction over much of its former range.

Above right – *Nephila jurassica*. *Nephila* spiders are large, conspicuous weavers of orb webs composed of golden silk in tropical and subtropical regions. Nephilids have a sparse fossil record, the oldest described previously being from the Cretaceous of Spain. *Nephila jurassica* is the largest known fossil spider. The species extended the fossil record of the family by approximately 35 Ma and of the genus *Nephila* by approximately 130 Ma, making it the longest ranging spider genus known. The find suggested that the palaeoclimate was warm and humid at this time.

Exceptional Preservation of Dinosaur Eggs and Embryos from the Upper Cretaceous of Henan Province, People's Republic of China
Dr John Nudds, University of Manchester

Dinosaur embryos within their eggs are incredibly rare and are known from only a few localities across the globe. By far the best specimens are a collection of about 20 in-ovo embryos from the Upper Cretaceous of Henan Province in the People's Republic of China. These have been revealed in minute detail by a complex technique of acid dissolution of surrounding matrix. Conventional microscopy has now elucidated the morphology of these animals, and they have been identified with the therizinosaurid dinosaurs, an enigmatic group of uncertain affinities, but which might hold vital clues to the phylogeny of Dinosauria as a whole. Current, and on-going, examination of the embryos by the use of synchrotron radiation (using the European Synchrotron Radiation Facility [ESRF] in Grenoble) now enables virtual removal of all matrix so that the minute bones can be examined in 3D and from all angles. Some of the results are quite remarkable!

Therizinosaurid dinosaur embryo from the Upper Cretaceous of Henan, PRC.
Photo – C Howells

Pterosaurs from the People's Republic of China – another great leap forward?

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Pterosaurs, Mesozoic flying reptiles, are amongst the most fascinating and intriguing of all extinct creatures and have long attracted the interest and attention of both scientists and lay people. Until recently much of our knowledge of pterosaurs was founded on finds from Europe and the Americas. In the last decade, however, China has become the main focus of attention following the discovery of more than 100 well preserved pterosaur fossils in the mid Mesozoic of Liaoning and adjoining provinces. Lacustrine deposits of the mid Lower Cretaceous Yixian and Jiufotang Formations have yielded an extraordinarily rich biota containing a diverse flora, insects, fish, birds, dinosaurs and more than twenty species of short-tailed pterodactyloid pterosaurs. More recently the somewhat older Tiaojishan Formation, and contemporaneous horizons, has begun to yield an important early Upper Jurassic terrestrial biota containing several species of early, long-tailed pterosaurs. Together these finds have provided unique new insights into some important and much debated aspects of pterosaur palaeobiology.

The discovery of eggs, some with embryos, and in one case preserved with the mother (an example of *Darwinopterus* called 'Mrs T'), suggests that the reproductive biology of pterosaurs was much more like that of reptiles than birds. Pterosaur eggs were relatively small and had soft shells, implying that they must have been buried rather than brooded and likely developed at ambient temperatures. Hatchlings were well developed and seem to have been able to fly soon after hatching. Mrs T also provides the first clear evidence for sexual dimorphism in pterosaurs: *Darwinopterus* males had a relatively narrow pelvis and a crest on the skull, most likely used for display, while females had a relatively wide pelvis, but no cranial crest.

Chinese fossils also provide some of the clearest evidence for ecological partitioning in pterosaurs. Biotas from the Yixian and Jiufotang Formations are dominated by filter-feeding and piscivorous forms such as *Eosipterus* and *Boreopterus*. By contrast, roughly contemporaneous lacustrine deposits of north-west China have yielded biotas that appear to contain nothing other than highly specialised durophagous pterosaurs such as *Dsungaripterus*, that fed on shellfish.

Darwinopterus, already known from more than 20 individuals from the Tiaojishan Formation and one of the latest finds from China, has given some startling new insights into pterosaur evolutionary history. *Darwinopterus* has a highly unusual morphology: the skull is identical to that of advanced pterodactyloids, while the body and limbs are just like those of primitive long-tailed pterosaurs. This surprising combination of features bridges the large morphological gap between these two groups of pterosaurs and hints at a modular form of evolution by which large scale anatomical transformations could have taken place relatively rapidly.

A complete, fully articulated example of *Darwinopterus* from the early Upper Jurassic Tiaojishan Formation of Liaoning Province, China (HGM 41 HIII-0309A). Photo - D M Unwin.