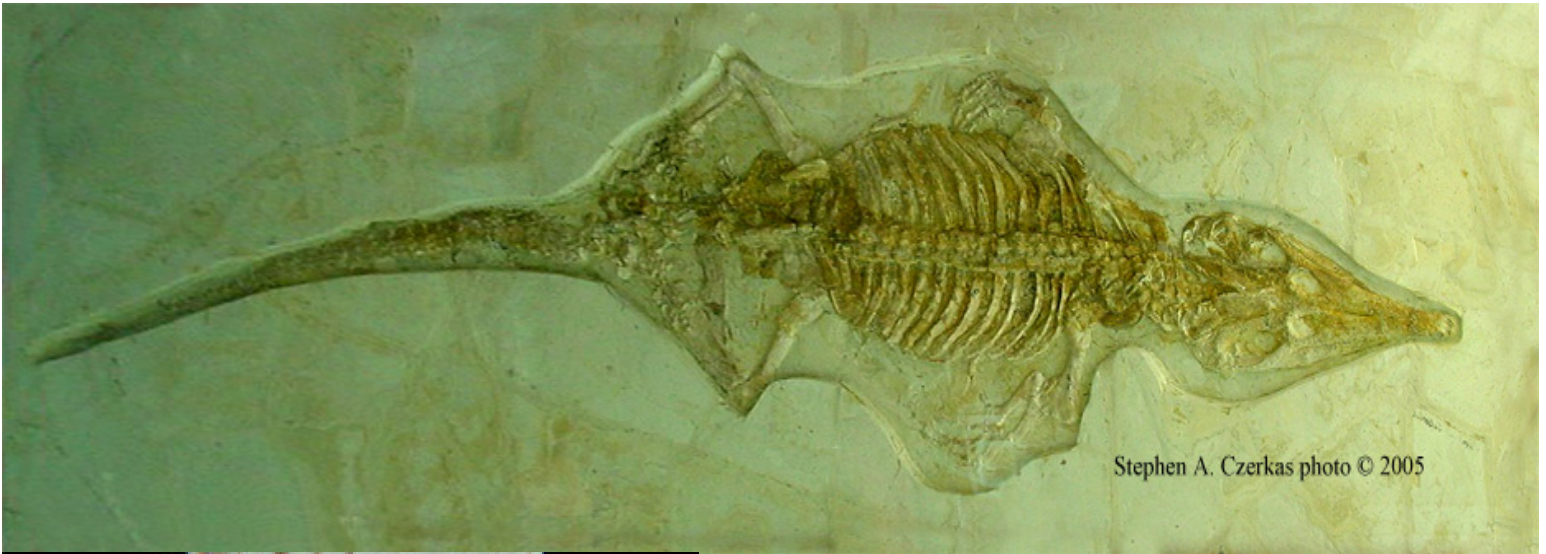


Feathered Dinosaurs and the Origin of Flight

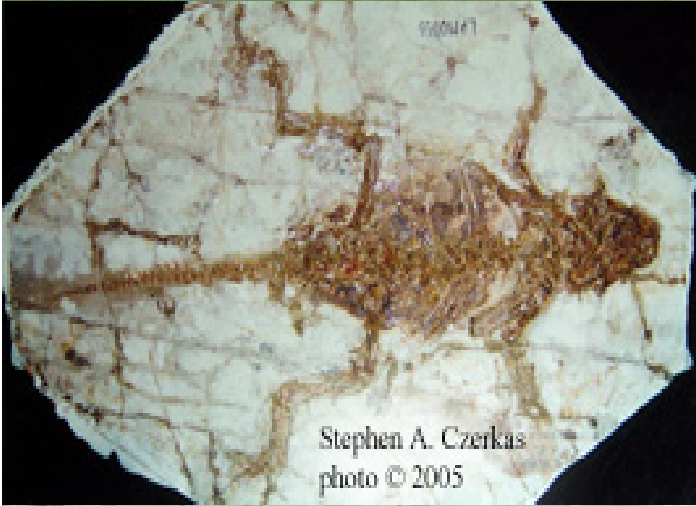
**Exhibition Organized and Circulated by:
The Dinosaur Museum, Utah
The Fossil Administration Office, Liaoning, China
Beipiao City Paleontological Research Center, Liaoning, China**



Stephen A. Czerkas
model © 2000 photo © 2002



Stephen A. Czerkas photo © 2005



Stephen A. Czerkas photo © 2005

THE PREHISTORIC WORLD OF LIAONING

The fossils of Liaoning represent a complex ecosystem creating a more complete picture of this particular age of dinosaurs than ever before. Life of the Early Cretaceous, 120 million years ago, was far more than a world of dinosaurs. The fossils include a remarkable variety of plants, crustaceans, insects, fish, amphibians, lizards, crocodiles, aquatic reptiles, flying reptiles, as well as birds that could fly and others which were flightless.



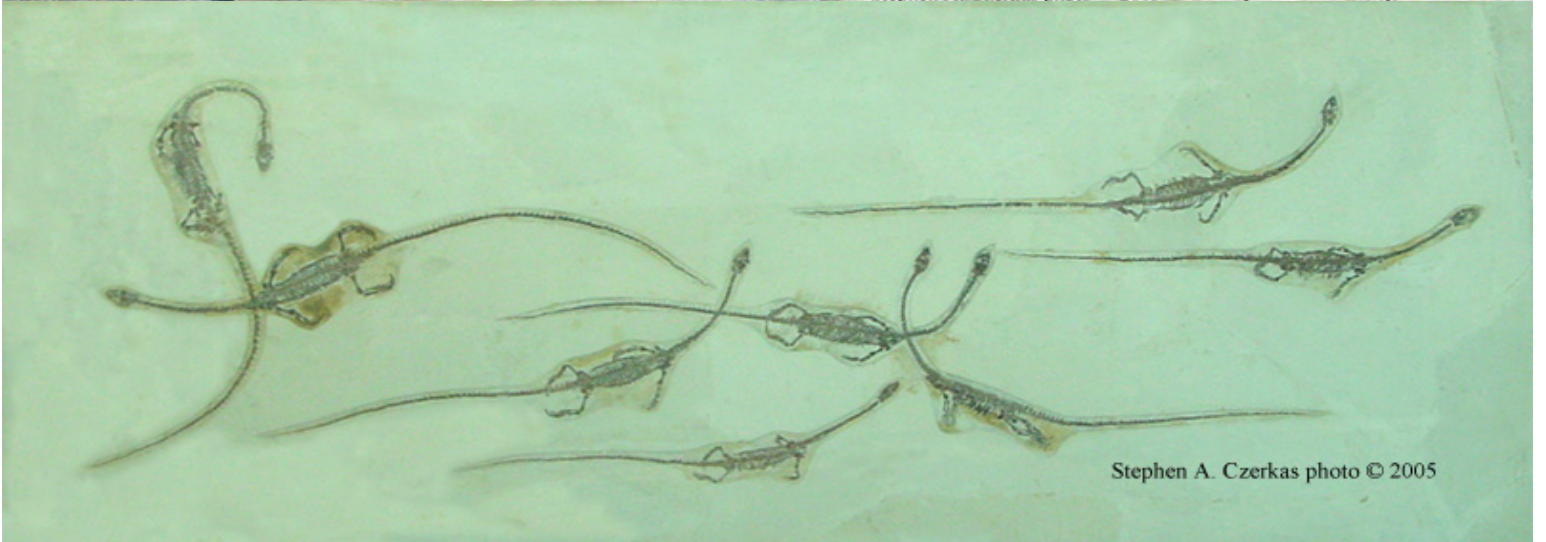
Stephen A. Czerkas photo © 2005



Stephen A. Czerkas photo © 2005



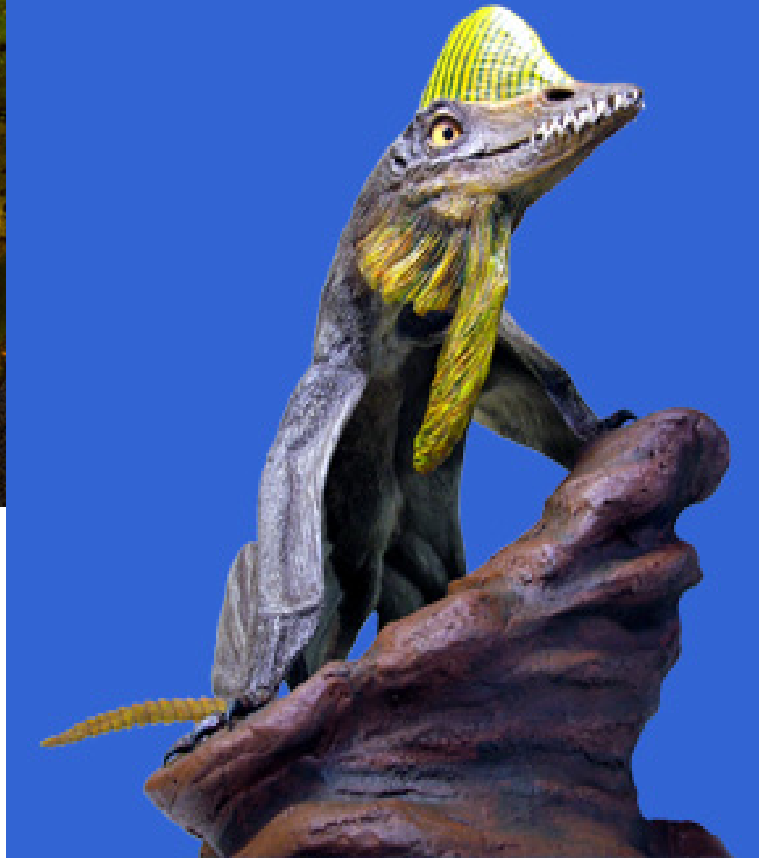
Stephen A. Czerkas photo © 2005



Stephen A. Czerkas photo © 2005



Stephen A. Czerkas © 2005



FEATHERS BEFORE BIRDS

Included are graphics and photos which show developmental stages of feathers. The fossil of the flying reptile, *Pterorhynchus* is preserved with details of what pterosaurs looked like which have never been seen before. The body is covered with down-like feathers which resemble those also found on the dinosaur, *Sinosauropteryx*. Because feathers are now known to exist on animals other than birds, this discovery changes the definition of what a bird is.

Pterorhynchus



Sinosauropteryx

FLYING DROMAEOSAURS AND THE MISTAKEN IDENTITY

Dromaeosaurs have been thought to be ground-dwelling dinosaurs that represented ancestral stages of how birds evolved. Fossils in this exhibit show that they have been misinterpreted as dinosaurs when they are actually birds. Feather impressions reveal that they had flight feathers on the wings and a second set on the hind legs. Even without the feathers preserved, the avian characteristics of the skeleton demonstrate that these dromaeosaurs are birds. This discovery means that the larger dromaeosaurs, like *Deinonychus* and *Velociraptor* of “Jurassic Park” fame, were really feathered and are secondarily flightless birds.



Stephen A. Czerkas photo © 2005

Stephen A. Czerkas © 1989

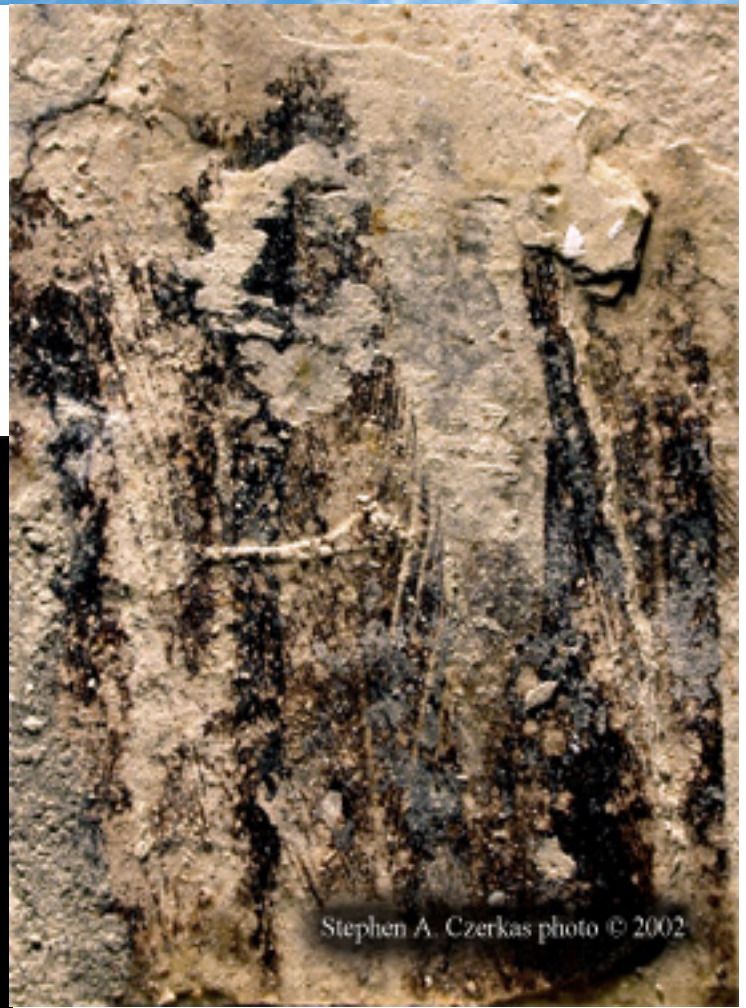
Stephen A. Czerkas © 2000





THE HIDDEN FLYER

The discovery that dromaeosaurs such as *Cryptovolans* had flight feathers and were capable of flight means that they had been misidentified as dinosaurs and not properly recognized as the birds that they were. Even without the feathers preserved, the skeletal anatomy is comparable to that of *Archaeopteryx* which confirms that dromaeosaurs are birds.

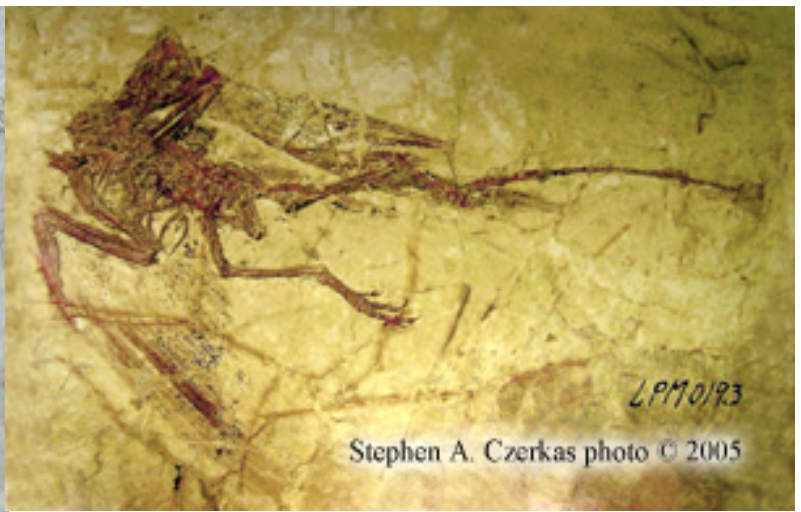
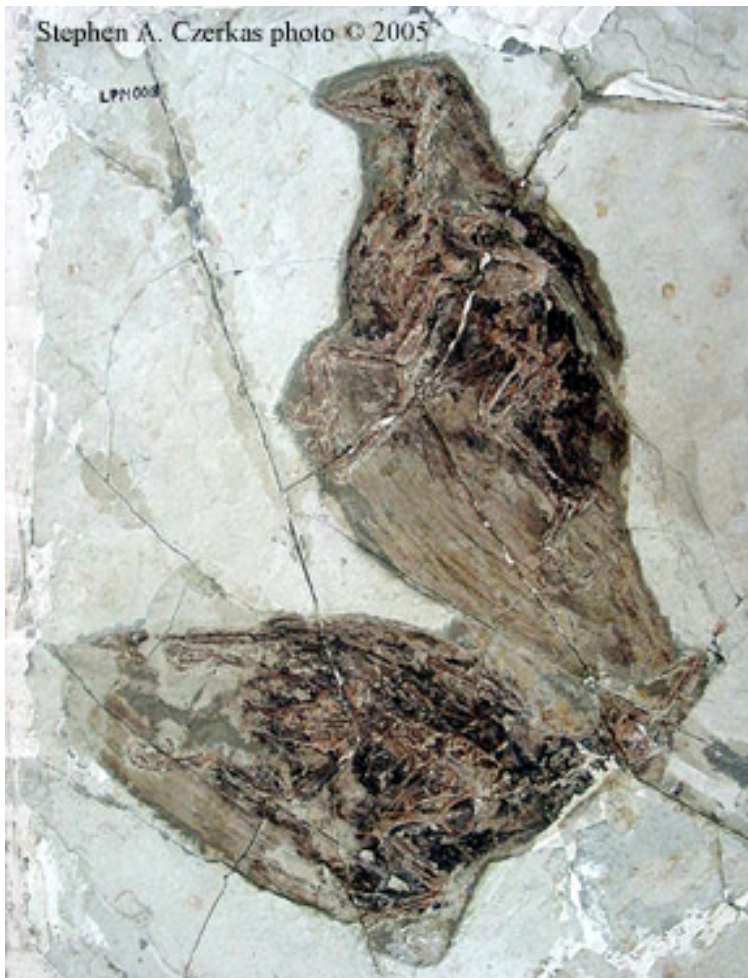




THE FEATHER REVOLUTION

Flying dromaeosaurs revealed that flightless dromaeosaurs were also birds and should not be portrayed as the scaly dinosaurs as once thought. This suggests that other “dinosaurs” may actually be birds as well.





Stephen A. Czerkas photo © 2005

THE DIVERSITY OF BIRDS

Flying and flightless birds, some with long tails or short, with teeth or beaked jaws, all represent a far greater world of birds than had been known before. This diversity allows for a better understanding of the relationship between birds and dinosaurs.



Stephen A. Czerkas photo © 2002



Stephen A. Czerkas photo © 2002



Stephen A. Czerkas © 2005

Caudipteryx, a flightless bird, or feathered dinosaur?

Entrance area showing where the fossils are from.



Introduction panel.

Lifesize bronze sculpture of *Compsognathus* and some of the historical lithographs.





Historical area with fossil footprints, and the earliest interpretations of dinosaurs as quadrupedal and bipedal animals.



The second area represents the diversity of flying creatures other than birds and shows a wide selection of fossils from Liaoning.

Fossils, models and graphics are used to show how feathers may have evolved.





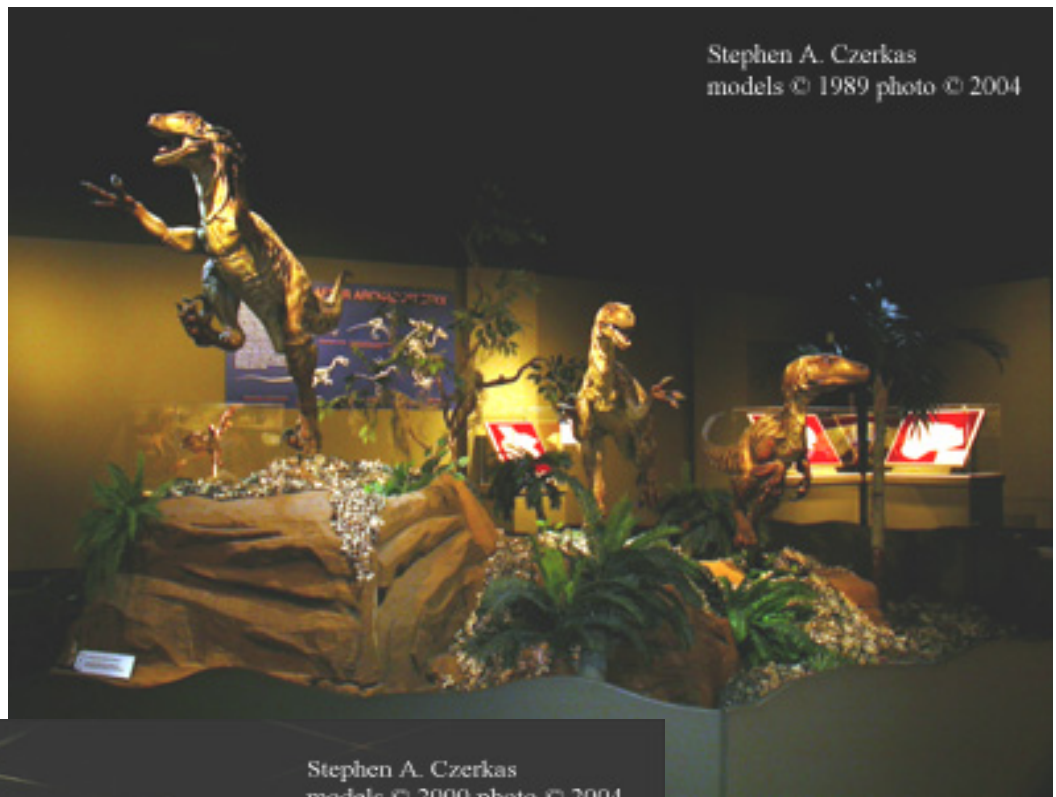
This third section explains the differences between dinosaurs and birds.

Fossil skeleton preserved with feathers that changed the interpretation of how dinosaurs are related to birds.

Interpretative charts and anatomical comparisons reveal that some dinosaurs were actually birds which could fly.

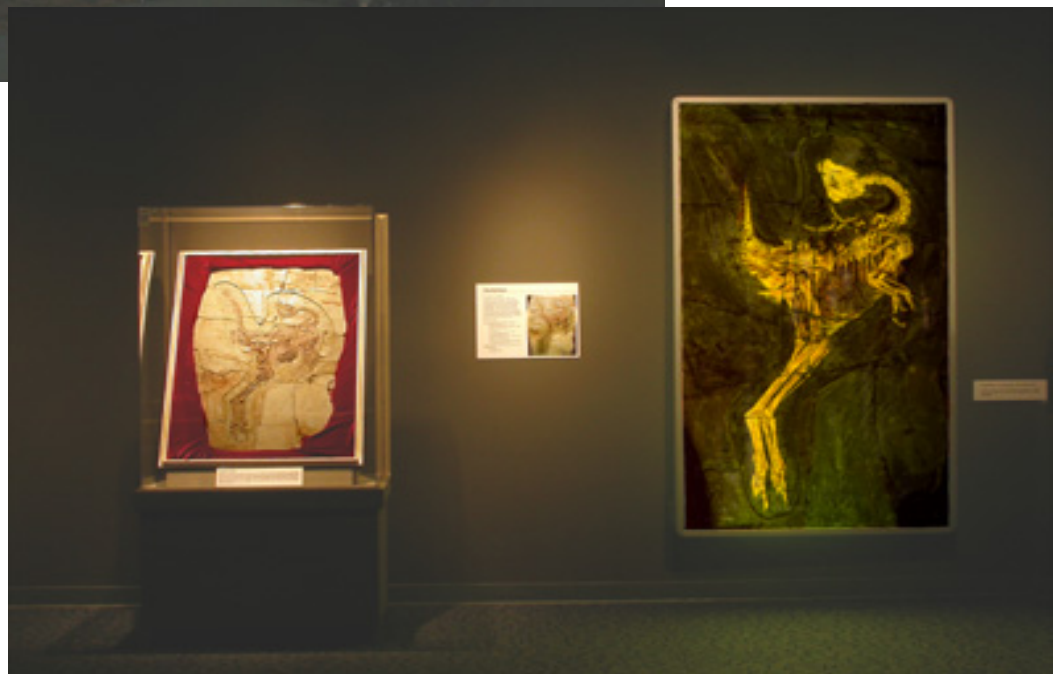


The popular, but incorrect, interpretation of *Deinonychus* as a scaly dinosaur.



The new version of *Deinonychus* as a feathered flightless bird.

Caudipteryx, a flightless bird, or feathered dinosaur?





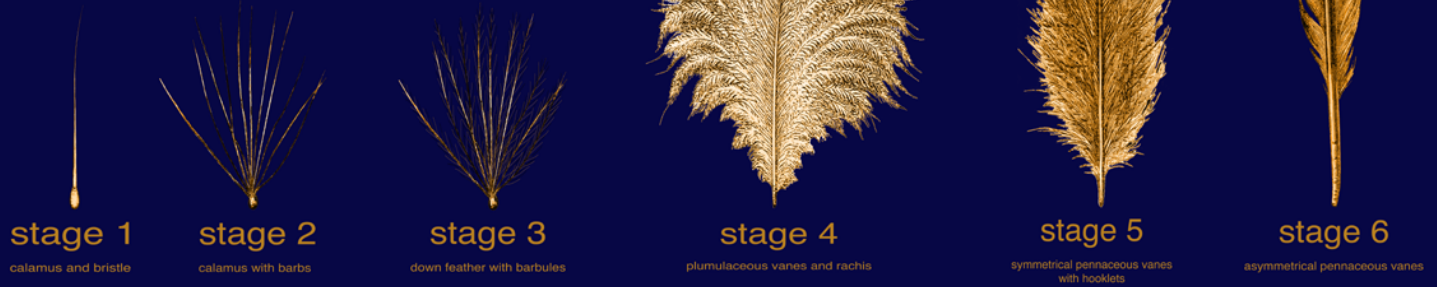
One of 54 billboards used to publicize the exhibit while at San Diego, California.



Organizers of the exhibit in front of the Royal Ontario Museum.
Left to right: Yinxian Li, Stephen Czerkas, Sylvia Czerkas, Jinglu Li

DEVELOPMENTAL STAGES OF FEATHERS

A hypothetical reconstruction of the different stages of development in the evolution of a feather can be made by continually simplifying the structure of a modern feather. The most advanced feather is a flight feather that has a hollow root, called the calamus, which extends into a long rachis, or shaft, complete with asymmetrical vanes made up of barbs, barbules, and hooklets. Stage 2 is what we now know existed on pterosaurs. The simple structure of their proto-feathers consisted of only branched barbs extending from a calamus. This means that feathers either evolved independently in different lineages, or birds and pterosaurs share a distant common ancestor.



BEFORE AND AFTER ARCHAEOPTERYX

Feathers are no longer the key diagnostic characteristic that defines what a bird is, because they are also found in pterosaurs and theropods. Having the ability to fly at least as well as *Archaeopteryx*, or having lost this ability in becoming secondarily flightless is crucial in determining what a bird is. While *Archaeopteryx* has only a few physical characteristics related to its ability to fly, various levels of development towards the modern avian anatomy are readily obvious in the prehistoric birds that came later. However, determining what kind of ancestral forms led up towards *Archaeopteryx* and birds is much more difficult. The ground dwelling theropod dinosaurs appear to have an ancestral relationship which may have led towards birds, but the discovery of *Scansoriopteryx* reveals that birds did have arboreal ancestors which, perhaps independently of theropods, led towards the development of avian flight by first being able to climb.

