ARE BIRDS REALLY DINOSAURS?

By Stephen Czerkas

Do you think birds evolved from dinosaurs? It's intriguing to think of birds as living dinosaurs. And during the past three decades, more and more paleontologists have been willing to accept this once heretical concept. This is largely due to the now practically mandatory use of cladistics by paleontologists who have been searching for how different kinds of dinosaurs evolved and might be related to each other. Cladistics is a computer based method of comparative anatomy which can produce a hierarchy based on the progressive differences and similarities between related groups. By using this method, birds do appear to represent the descendents of bipedal carnivorous dinosaurs. But are they really?

Many ornithologists have been reluctant to accept dinosaurs as the ancestors of birds. This is because, for most of the past century, the classical interpretation was that birds evolved their ability to fly from some unknown arboreal reptile, where climbing allowed jumping to become gravity assisted gliding and eventually powered flight. The logic behind this concept is well supported by diverse examples of arboreal animals ranging from amphibians to reptiles to mammals which have the ability to glide only by using gravity to their advantage. Powered flight as seen in birds has only been matched by bats and the prehistoric flying reptiles called pterosaurs. The extraordinary long fingers of bats and pterosaurs are clear indications that climbing, rather than a terrestrial lifestyle, was crucial to their development of wings. No vertebrate animal has been known to develop gliding or actual flight without having an ancestor that could climb. Could birds be the greatest exception to the rule?

There are certainly problems with the popular belief that birds evolved from dinosaurs. For example, there has been no unequivocal explanation as to how the small arms of ground dwelling dinosaurs could inexplicably become larger and develop the unique anatomy and mobility of the avian flight stroke. Grasping for prey, or extending the arms for balance are, at best, insufficient explanations for how the avian wing could have developed. Yet paleontologists have maintained that for reasons unknown, only theropods--the bipedal carnivorous dinosaurs--could have developed their arms into the wings of birds. This has been a relatively safe assumption because there have been no other kinds of animals known which could be considered a viable alternative as a bird ancestor. As long as the climbing ancestor remained undiscovered and hypothetical, the ground dwelling dinosaurs would appear to be the only viable option.

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Without physical evidence to the contrary, the belief that birds evolved from dinosaurs has become widely established. The traditional arboreal theory of how birds evolved has for the most part fallen into disfavor and obscurity. Then, about a decade ago, in Liaoning, a northeastern Province of China, amazing fossils of prehistoric birds were being discovered in unprecedented numbers. These birds were from the age of dinosaurs, about 125 million years ago during the Lower Cretaceous which is more or less about 20 million years after *Archaeopteryx,* the most primitive bird, was known to have lived. These newly discovered birds from China are called *Confuciusornis*, and like *Archaeopteryx* they still had three clawed fingers on each wing. But while still primitive in some respects, *Confuciusornis* had become much more like modern birds in having lost the long tail and teeth as seen in *Archaeopteryx*, and instead had developed an avian pygostyle and toothless, beaked jaws. The Chinese fossils were extraordinary for representing new missing pieces to the evolutionary puzzle of how birds evolved. And even more amazing is the remarkable state of preservation in which details of the soft tissues-notably feathers-are often seen in remarkable clarity.

Below and left: A remarkably well preserved fossil from Liaoning of the bird, *Confuciusornis*.

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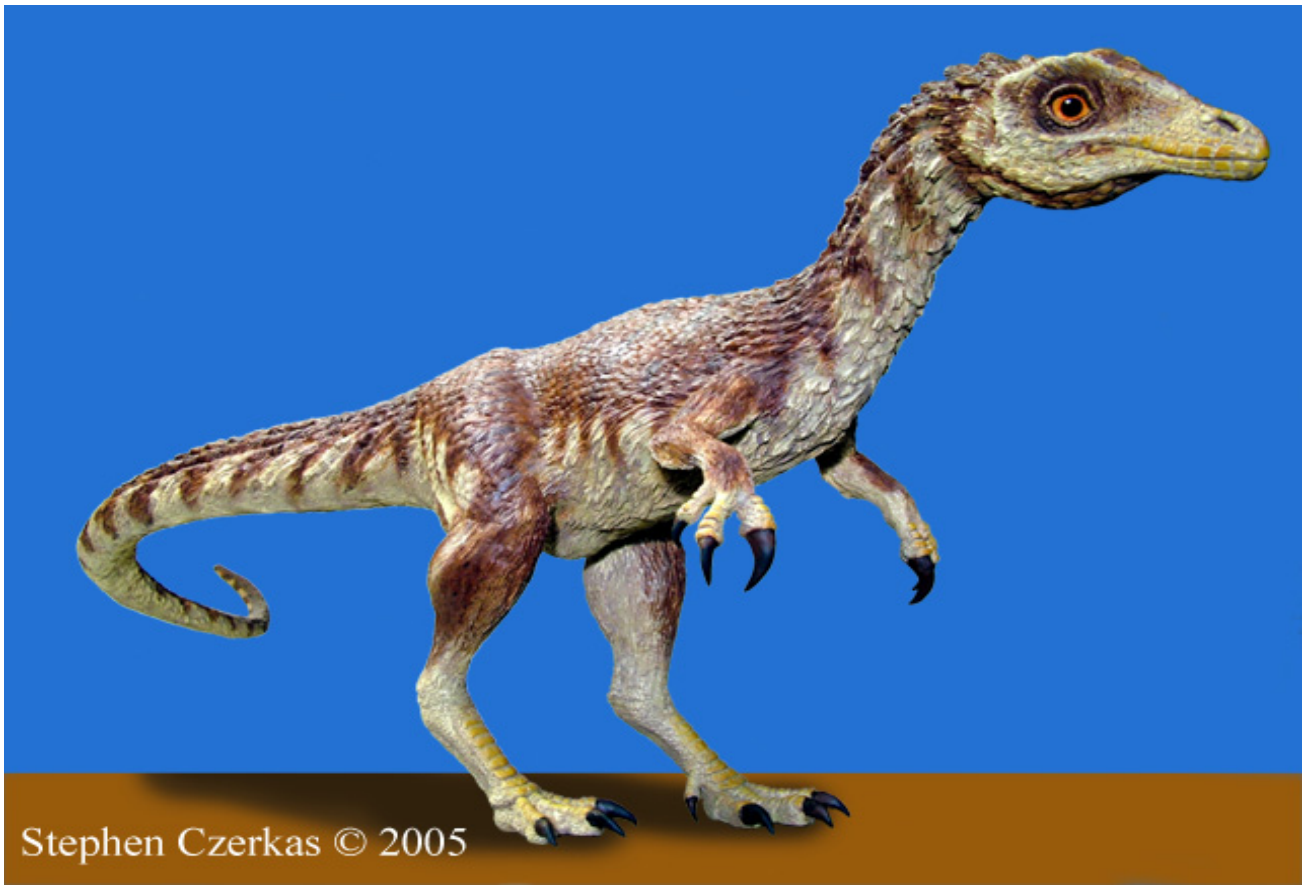


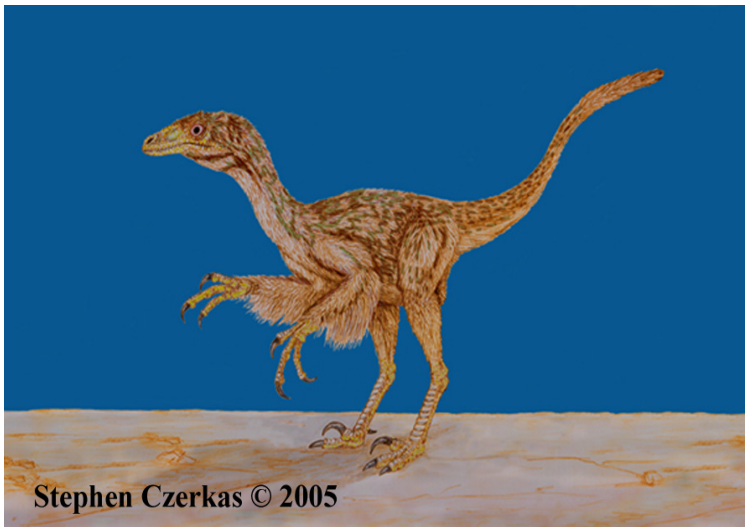
Above: A model of the feathered dinosaur, *Sinosauropteryx*.

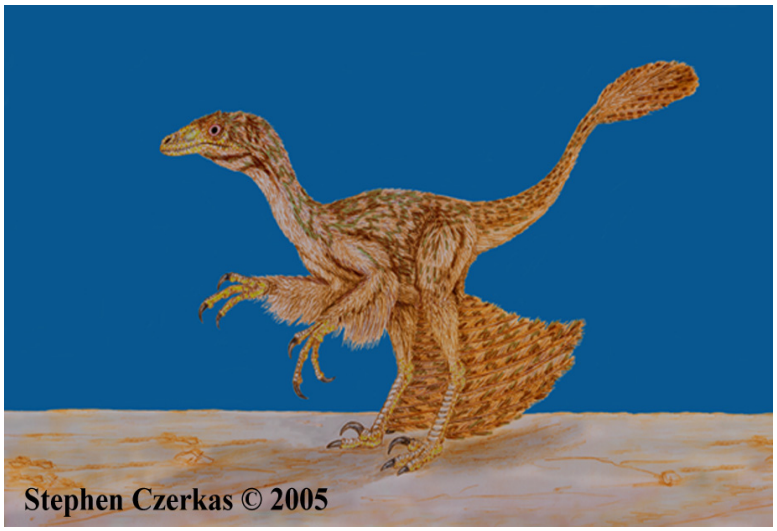
The Chinese continued to find more fossils of birds and small dinosaurs like the plant-eating onithischian, *Psittacosaurus*, a small ancestral form related to the more famous three-horned, *Triceratops*. As anticipation heightened with the realization of what might yet be found, the fossil of a new dinosaur, called *Sinosauropteryx*, was discovered. It was clearly not a bird because of its exceptionally long tail and short arms, but astoundingly there was a halo of what looked like fluffy down-like feathers preserved around its skeletal outline.

The evidence was compelling and it certainly looked as if paleontologists finally had the evidence they dreamed of to prove that birds were directly related to dinosaurs. But as if in a predictable fashion, not all scientists were convinced and some notable ornithologists were left very skeptical that the feathery covering was real. Even when a second specimen of *Sinosauropteryx* turned up again with the feathery covering, a dissenting few remained outspokenly critical.

Then more Chinese fossils of bird-like animals new to science were discovered with unmistakable feathers. They were much more bird-like than *Sinosauropteryx*, but because they apparently could not fly, they were championed by paleontologists as more feathered dinosaurs. *Protarchaeopteryx* and *Caudipteryx* were certainly feathered, but not everyone was convinced that they were dinosaurs. There was a very real possibility that they were flightless birds.

At about the same time, two other fossils were discovered with what was claimed to be feather impressions. They both had bony tails like on the dromaeosaur dinosaurs, *Deinonychus* and *Velociraptor*. But the preservation was far from perfect and critics claimed that the feathers were not real. As it turned out, there was a problem with the smaller of the two fossils. It was quickly announced by the scientists who were still studying the fossil called *Archaeoraptor* that it was actually a composite of two fossils which had been stuck together in order to enhance its monetary value. The mistake was made long





Above: Inaccurate interpretations of dromaeosaurs as non-avian feathered dinosaurs.

before the scientists had seen the fossil, but by the time they had realized that the fossil tail of a tiny dromaeosaur had been stuck onto the end of a new kind of toothed bird it was too late and advance publicity based on preliminary studies had already been made public. What *Archaeoraptor* initially represented was not welcome by either side of the argument from neither paleontologists nor ornithologists. A "flying dinosaur", as it was referred to, was simply too bird-like for anyone to accept as it would have proved both sides to have been irreconcilably incorrect.

It was not long before the fossil of another dromaeosaur was discovered with what looked like a halo of fluffy feathers around most of the body. This time it was a complete skeleton split in the rock like mirror images of itself on a main slab and counterslab. There was no obvious indication of flight feathers, but the arms were long for a dinosaur though shorter than those in *Archaeopteryx*. But all the more tantalizing was the fact that the arms were bent at the wrist indicating the same kind of unique mobility as in the wing of a bird. Paleontologists again thought they had the best evidence they could have to show that birds had evolved from these kinds of dinosaurs. Just as cladistic analyses had predicted, here was a feathered dinosaur that was definitely not a bird. At least that was what they thought.

Below: Detail of the flight feathers on the fossil of *Cryptovolans*.

Above: Model depicting what the 4-winged dromaeosaurs, *Cryptovolans* and *Microraptor* could have looked like in life.

Once again, critics remained unconvinced and challenged the validity of whether or not the feathers were real. And once again, yet another dromaeosaur fossil was discovered in China that was a complete skeleton split between two rock slabs. This time however, the preservation was just about the complete opposite of what was preserved on the previous dromaeosaur. Instead of having a body covered with feathers, the legs and end of the tail appeared to have long feathers, as long as what might be expected on the wing of a bird. While a notable ornithologist still claimed that he could not recognize the structure of these feathers, the paleontologist quite correctly pointed out that even his young child could identify the feathers in the rock. But feathers though they were, the dinosaur was not recognized as a bird and instead was specifically regarded as a pre-flight stage in the non-avian ancestry of dinosaurs that were basically experimenting with feathers for functions other than flight such as ornamentation and thermoregulation.

Then not long afterwards, the same dromaeosaur with the bizarre leg feathers was published on by another party who had been studying the same fossil on an independent basis. The publication was the first volume of The Dinosaur Museum in Blanding, Utah entitled "Feathered Dinosaurs and the Origin of Flight". Having much more time to examine the fossil than those who originally saw it in China, the second report came to the startling conclusion that the long feathers were actually asymmetrical and were identical to those of modern flying birds. But even more significant was that these flight feathers were stemming from the hands as on a real bird, making a clear indication that this animal, called *Cryptovolans*, had the ability to fly. What this meant was that Chinese dromaeosaurs had been misidentified as being feathered dinosaurs when they were actually birds all the time. This was a shocking revelation

Above: On the left is the original interpretation of the dromaeosaur, *Deinonychus*, as a scaly dinosaur. On the right is a feathered *Deinonychus* as a secondary flightless bird.

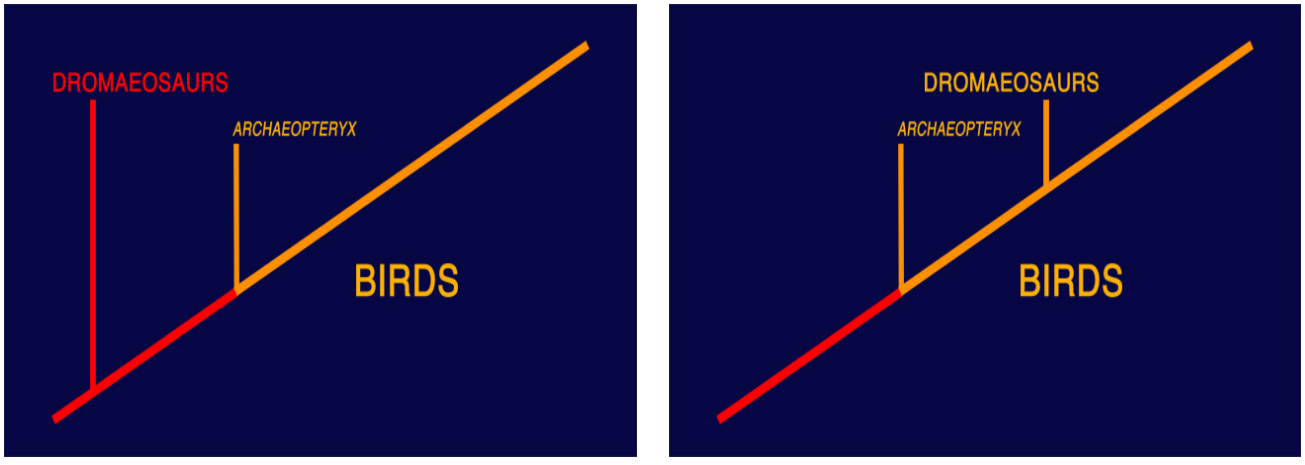
because dromaeosaurs were absolutely not supposed to have had the ability to fly, because if they did, it would mean that they were actual birds.

The irony here is that if there was one thing scientists agreed on, it was that dromaeosaurs were not birds and were only dinosaurs. Many, if not most, ornithologists thought that the bird-like characteristics found in dromaeosaurs were only convergent, perhaps brought about by similar behavior, but not due to having a direct ancestry. Opposing this view were paleontologists who believed dromaeosaurs were non-avian dinosaurs that were evolving towards becoming true birds. For either view to be maintained, dromaeosaurs could not be birds because that would essentially nullify the arguments from either side. Decades of scientific debates were based on the mistaken identity of regarding dromaeosaurs as dinosaurs instead of the birds that they really are. With the benefit of hindsight it is easy to see that if fossils of the small flying dromaeosaurs from China had only been discovered before the larger flightless dromaeosaurs like *Deinonychus* or *Velociraptor* were found, the interpretations of the past three decades on how birds are related to dinosaurs would have been significantly different. If it had already been established that dromaeosaurs were birds that could fly, then the most logical interpretation of larger flightless dromaeosaurs found afterwards would have to be that they represented birds, basically like the prehistoric equivalent of an Ostrich, which had lost their ability to fly.

It is remarkable that the initial discovery that dromaeosaurs were actually birds did not receive much public attention. The topic of feathered dinosaurs had previously received considerable fanfare and been treated as rather sensational evidence of how birds supposedly evolved from dinosaurs. But, when the evidence was first published that the Chinese dromaeosaurs were birds which could fly, reporters who had routinely covered interesting discoveries regarding dinosaurs simply ignored the issue altogether.

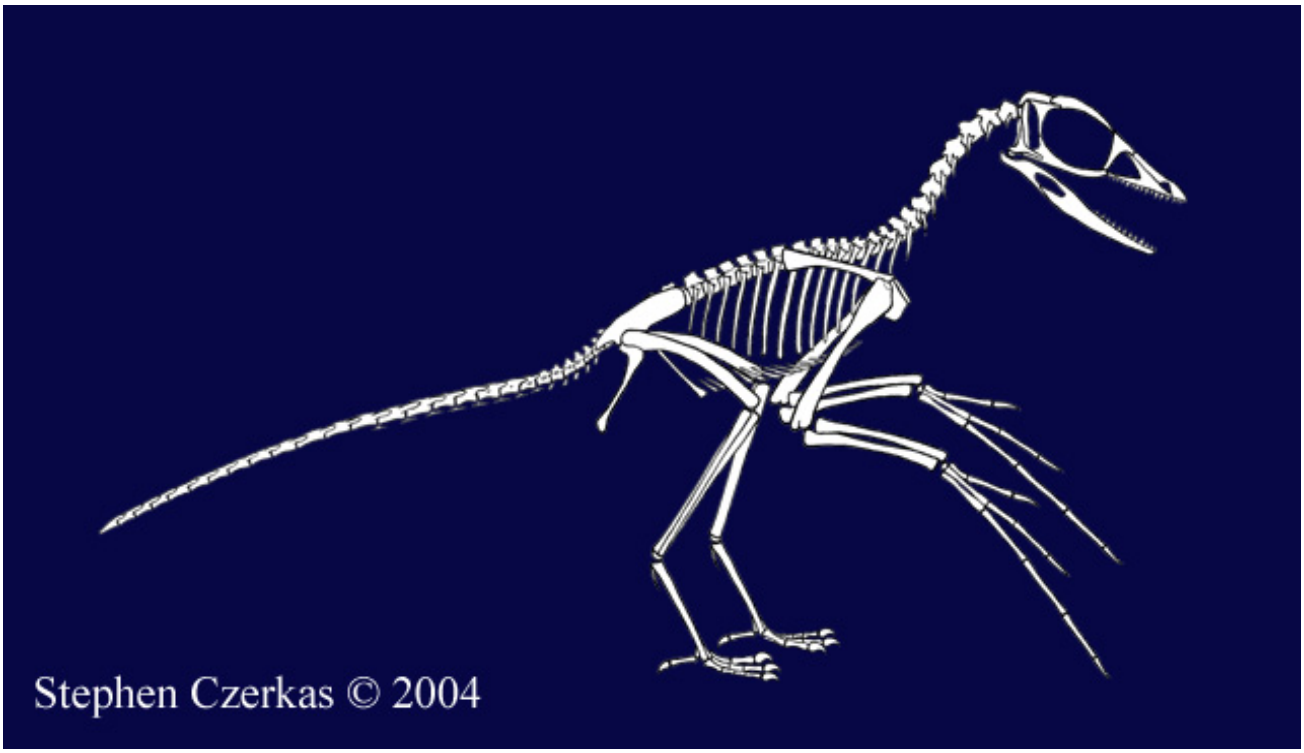
Only about a year later did reporters finally acknowledge that these dromaeosaurs could fly. The discovery had been verified by yet more fossils of similar dromaeosaurs, called *Microraptor*, from China. However, instead of acknowledging these dromaeosaurs as birds, scientists now called them "flying dinosaurs." This misguiding ploy of semantic double-talk was used to hide the fact that reputations based on the theory of birds evolving from ground dwelling dinosaurs were at stake. Even though dromaeosaurs had previously been vehemently denied as being birds or having flight feathers and the ability to fly, all this was swept aside as if there was no conflict in now regarding dromaeosaurs as flying dinosaurs. In part, this was made possible because not only did these flying dromaeosaurs have two wings like flying birds, but their hind legs were also equipped with long flight feathers giving the appearance of having four wings. With a complete disregard that these dromaeosaurs were not supposed to have any wings or ability to fly, the surprising hind wings were used to distract from the obvious implications that this still meant scientists were wrong in portraying dromaeosaurs as the ground dwelling non-avian ancestors of birds. Dromaeosaurs were birds, but in order to maintain the theory of how birds supposedly evolved from ground dwelling dinosaurs, no one could admit it.

In fairness, the methodology of cladistics is not completely responsible for the misidentification of dromaeosaurs as dinosaurs. Regardless of how non-objective cladistics supposedly is, the real problem stems from how the data is interpreted. In the case of how birds developed the ability to fly and were supposedly evolved from dinosaurs, the interpretation cladists created for themselves was unfortunately based on believing that any opposing views must be incorrect. Specifically, this meant that cladists had to automatically reject the traditional view of birds evolving from arboreal animals which could take advantage of gravity in their development of flight. No dinosaurs were known to have been capable of climbing so this made it unacceptable for cladists to think such a climbing ancestor of birds could have existed. In hindsight, this discrimination was unnecessary and very counterproductive, but the antagonistic rejection of opposing views spread throughout the science as some sort of Liliputian mind set of defending one's views at all costs.



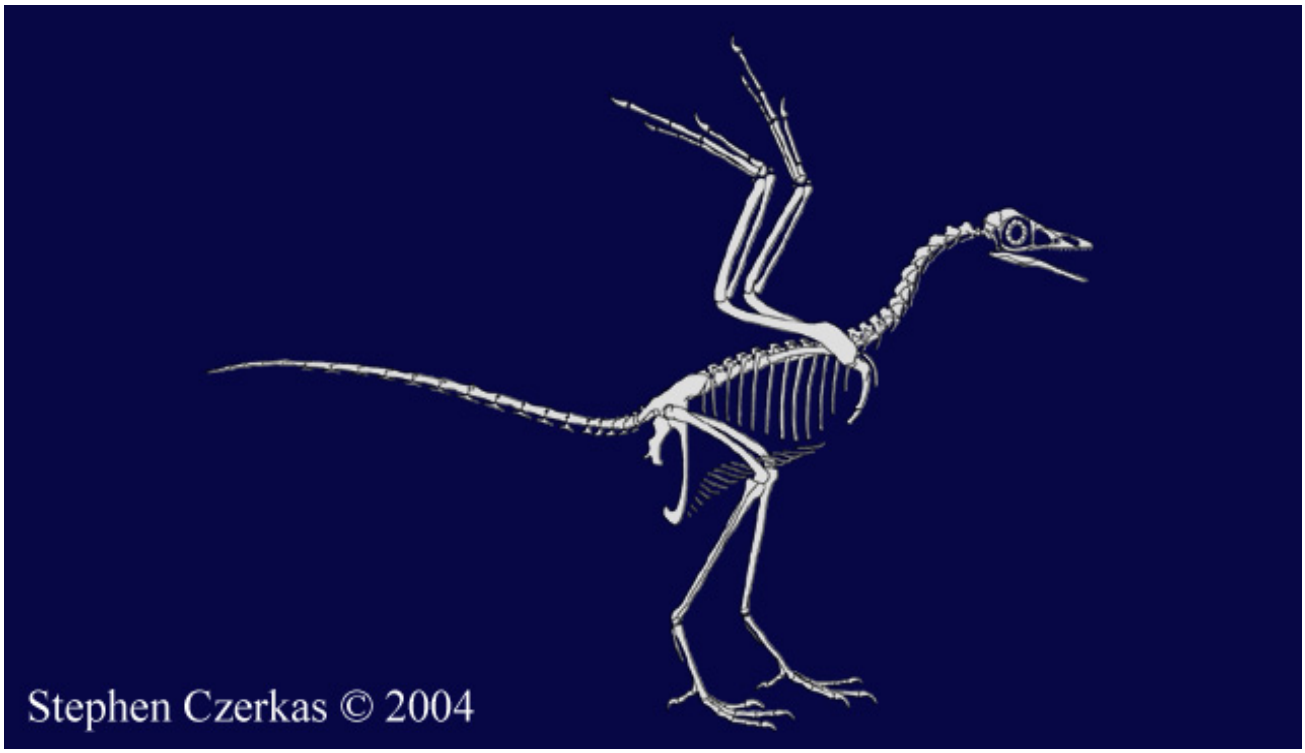
Above: On the left is the interpretation based on cladistics in which dromaeosaurs have been thought to represent non-avian dinosaurs and the concept that dinosaurs developed flight directly from the ground. The red lines indicate dinosaurs as being the ancestors of birds.

On the right, dromaeosaurs are acknowledged as being birds because they either had the ability to fly or had lost their ability to fly. The red line represents the ancestry of birds which may not represent actual dinosaurs, but instead could represent a separate avian lineage that was arboreal.



Above: The skeleton of *Scansoriopteryx* (about life-size) for comparison with *Archaeopteryx*. Note that unlike *Archaeopteryx*, the pelvis is still like that of a reptile; the shoulder and chest bones are more reptilian and less capable of flight. The long third finger of *Scansoriopteryx* indicates that it was not a true theropod dinosaur.

Below: Detail of the *Scansoriopteryx* fossil greatly enlarged to show the hand with the semi-lunate carpal in the wrist and the highly elongate third finger. Bones overlying the third finger belong to the lower leg and hind foot.



Above: The skeleton of *Archaeopteryx*, the most primitive bird known to have had the ability to fly (highly reduced in size).

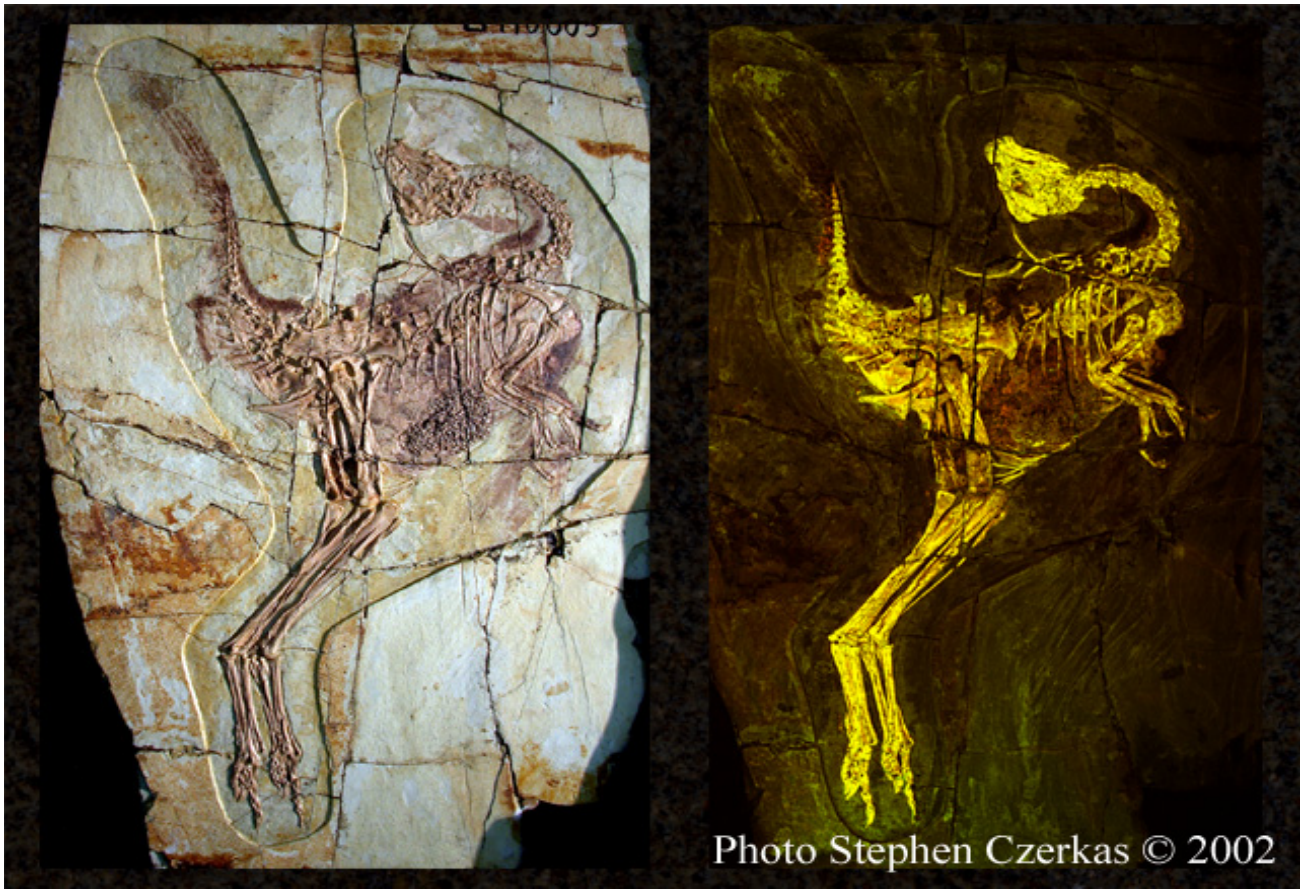
Even if cladistic interpretations were modified into placing dromaeosaurs into Aves and acknowledging that they really are birds, it is still possible for some to claim that other non-avian theropods, such as troodontids, continue to represent how ground dwelling dinosaurs were the ancestors of birds. While theoretically possible, this cladistic point of view still hinges upon the belief that arboreality did not play any role in the development of the flight related characteristics found in birds. In fact, the greatest problem confronting those who believe that cursorial dinosaurs could not have evolved into birds is that no one had ever found the fossilized evidence of their hypothetical climbing ancestor of birds. This all changed over three years ago when the fossil of a tiny hatchling was described in the same volume that initially reported on the flying dromaeosaur, *Cryptovolans*. Finally, evidence existed of a bird-like animal that most closely resembled *Archaeopteryx* but differed in ways that are unequivocally more primitive and had amazing adaptations clearly beneficial for climbing. The animal is called *Scansoriopteryx* and its discovery completely rejects and nullifies any reason to think that birds could only have evolved from ground dwelling dinosaurs.

Had *Scansoriopteryx* been discovered before the use of cladistics became so prevalent some two decades ago, the cursorial theory of how birds evolved from theropod dinosaurs could not have progressed as it has. *Scansoriopteryx* is known from strata believed to be from the Middle Jurassic, possibly 165 to 180 million years ago, and much older than when *Archaeopteryx* is known to have lived during the Late Jurassic. So there is no time paradox in its being ancestral to birds, as there is for dromaeosaurs of other bird-like dinosaurs. *Scansoriopteryx* simply does not represent a ground dwelling dinosaur, but it clearly does have a significant ability for climbing while at the same time is not as well developed for flight as was *Archaeopteryx*. The shoulder/chest complex of the scapula and coracoid are more primitive than that of *Archaeopteryx*. The furcula is not present, but is instead represented by separate clavicles. The arm is larger than any known theropod but more robust and primitive than the wing of *Archaeopteryx*. The hind legs are very primitive and yet the feet were very capable of perching and equipped with an avian hallux for grasping backward around branches. The tail was still long, basically like that of

Archaeopteryx. But unlike any known bird, the pelvis was still more like that of a reptile with its pubis directed forward instead of backward. In fact, when compared to any known dinosaurs, the pelvis has characteristics that would be expected as representing the ancestral stages very near the beginning of dinosaurs. All in all, *Scansoriopteryx* is clearly more primitive than *Archaeopteryx* and was less capable of flight. But the most astounding characteristic *Scansoriopteryx* had was its incredibly long third finger. Its first two fingers resembled those of other theropod dinosaurs, but the long third finger was the strongest of the three and had proportions consistent with being a primitive holdover. The offset placement of the three fingers created the possibility that they could have functioned like grappling hooks for catching onto branches while jumping, or even gliding, from branch to branch. The hand was so large that the wrist incorporated a semi-lunate bone, like birds, which allowed the hand to fold back like a wing. Here then, is the best example of what the ancestor of birds was like before powered flight was achieved at the stage represented by *Archaeopteryx*.

There are a few impressions of feathers on *Scansoriopteryx,* and it seems more likely than not that the fingers supported primary feathers of some sort. These feathers of the wings may have been less refined as those of flying birds and may have had a simpler morphology adequate for gliding or parachute jumping. Only an adult specimen might confirm such speculations. How and why feathers evolved may not have been initially for flight-related functions. As many paleontologists have speculated, feathers may have originated long before flight for reasons having more to do with thermoregulation and even display. Clearly, dinosaurs like *Sinosauropteryx* did not use their feathers for flight, and acting as a coat of insulation and species recognition would be inherently unavoidable. But having feathers does not

Below: The fossil of *Caudipteryx* in regular light on the left and ultraviolet light on the right. Feathers on the wings and tail are sufficiently preserved to avoid questions of authenticity. What is controversial is whether *Caudipteryx* should be considered as a feathered dinosaur or as a flightless bird.



automatically mean that *Sinosauropteryx* and other feathered dinosaurs were evolving towards becoming birds. Instead, even if they shared a common ancestor with the true lineage for birds, these feathered dinosaurs may in effect have been going away from flight in becoming more terrestrial. The common ancestor of all theropods may have been arboreal, initially stemming from the lineage that led to *Scansoriopteryx*, but before *Archaeopteryx* appeared. If they are descendents from at least the stage of *Archaeopteryx*, it would be incorrect to regard these animals as theropod dinosaurs. These would be birds. Dromaeosaurs are good examples of this misuse of being thought of as dinosaurs when they are actually birds. Other examples may eventually be reidentified as birds as well. Instead of being thought of as a non-avian feathered dinosaur, the bird-like characteristics in *Caudipteryx* may be much easier to explain as indications that it was actually a bird that lost its ability to fly. Some scientists have even gone so far as to suggest that *Oviraptors* have also been misidentified as dinosaurs and should actually be regarded as birds. Feathers, though, are not the distinguishing criteria in determining what is a bird. The ability to fly is the crucial factor in having an ancestor that was equal or greater than *Archaeopteryx*. The ancestry before *Archaeopteryx* consisted of arboreal reptiles which may share common ancestors to other dinosaurs, but the arboreal avian lineage may date back to the very beginning, or even before, actual dinosaurs appeared.

It is no longer correct to define a bird as any animal that has feathers. This is not only because some dinosaurs had feathers, but because other prehistoric reptiles are now known to have had feathers. The flying reptiles known as pterosaurs have been suspected as sharing a common ancestry with dinosaurs, but the fossil record is so incomplete that this has remained controversial and unable to be verified with intermediate forms. But unless feathers originated more than once in unrelated animals, the presence of feathers on pterosaurs suggests that the origin of feathers may predate the earliest known pterosaurs and dinosaurs and may have been inherited from an arboreal ancestor common to both groups before flight was achieved in either.

It has been over three years since the publication identified dromaeosaurs as having had the ability to fly and were in fact birds. At the same time, the discovery of a climbing ancestor of birds more primitive than *Archaeopteryx* was also identified. Primitive feathers were also described on pterosaurs which broadened the diversity of animals known to have been feathered. It is a historical fact that these discoveries dispute the claims by cladists regarding the widely popular view that birds evolved from ground dwelling dinosaurs. Nonetheless, both the popular press and many scientists continue to claim that birds are dinosaurs because they are descendents from ground dwelling theropods like dromaeosaurs.

The conceptual link between birds and dinosaurs was first made by Huxly back in the late 1860s. What has been controversial is not that there is a link, but the real debate has remained as to what the actual relationship was. The questions have centered on whether birds and theropods looked similar due to convergence or because of a direct ancestry. Perhaps the most significant question of all centers on how birds developed their ability to fly from either terrestrial theropods or from arboreal reptiles only distantly related to dinosaurs. The issues are complex and made even more so because of vested interests, making it difficult to accept evidence that contradicts their views. The intentional omission of the fact that dromaeoaurs, according to cladists, were never supposed to have had wings or the ability to fly is a fabricated misrepresentation of the facts. The ongoing one-sided portrayal that the origin of flight was brought about by ground dwelling theropods threatens the integrity of the science itself when evidence so strong as the arboreality of *Scansoriopteryx* is routinely dismissed and ignored by scientists who are clearly aware of its existence. What is at stake is far more than the embarrassment or reputations of scientists who have made honest mistakes in their interpretations. Paleontology is an interpretative science that thrives on correcting mistakes so it can find new answers to yet more questions. The origin of birds and how they achieved the ability to fly has been one of the greatest mysteries of evolution. The fossils from Liaoning have presented unprecedented amounts of information that has taken the fossil

record of birds from being one of the worst represented and made it among the best to show intermediate stages of the evolutionary processes at work.

Birds are not dinosaurs in the popular sense of supposedly being the descendents of theropod dinosaurs. Birds and dinosaurs are related, but only indirectly in having remote distant common ancestors that were arboreal. Because no dinosaurs have been regarded as being able to climb, birds may or may not be considered as true dinosaurs depending on the definition of the Dinosauria and whether or not it is a natural monophyletic group. If not, then birds should not be considered as actual dinosaurs, but instead as their own separate lineage. Exactly when the first true birds developed the ability to fly remains unknown, but structurally it occurred between the development of *Scansoriopteryx* and *Archaeopteryx*.