DINOSAUR rEVOLUTION

SECRETS OF SURVIVAL

EXHIBITION BY

LUIS V. REY & GONDWANA STUDIOS

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HORNS, SPIKES, QUILLS AND FEATHERS. THE SECRET IS IN THE SKIN!

Not long ago, our knowledge of dinosaurs was based almost completely on the assumptions we made from their internal body structure. Bones and possible muscle and tendon attachments were what scientists used mostly for reconstructing their anatomy. The rest, including the colours, were left to the imagination… and needless to say the skins were lizard-like and the colours grey, green and brown prevailed.

We are breaking the mould with this Dinosaur Revolution!

Thanks to a vast web of new research, that this time emphasises also skin and ornaments, we are now able to get a glimpse of the true, bizarre and complex nature of the evolution of the Dinosauria.

We have always known that the Dinosauria was subdivided in two main groups, according mostly to their pelvic structure: Saurischia and Ornithischia. But they had many things in common, including structures made of a special family of fibrous proteins called keratin that covered their skin in the form of spikes, quills, protofeathers and feathers, that served as insulation, defensive-offensive items or simply ornamentation.

One group (ornithischians) would go extinct and the other (saurischians) would fly into another age! But not before some of their forms collided spectacularly. Porcupine-like runners, massive horned faces and tank-like monsters had to live with and defend themselves against the teeth and claws of the Feathery Menace… a menace that sometimes reached gigantic proportions in the shape of Tyrannosaurus… or in the shape of outlandish, massive ornithomimids with gigantic claws like the newly re-discovered Deinocheirus, reconstructed here for the first time in full.

All of them are well represented and spectacularly mounted in this exhibition. The exhibits are backed with close-to-life-sized murals of all the protagonist species, fully fleshed and feathered and restored in living and breathing colours.

This two tier exhibition is like no other: it will follow the two separate paths of dinosaur evolution that will meet at the end in a massive and dramatic battle, that, in evolutionary terms, could only be really won by flying away!

WHY A DINOSAUR rEVOLUTION?

Today we know that Dinosaurs are not all “big and extinct”. They reigned in widely different environments all over the world for 169 million years and vanished 65 million years ago when the Earth was struck by an asteroid.

But did all of them go extinct? For years many had suspected that birds were linked somehow to dinosaurs.

Bones, scales and armour sometimes fossilize well, but other soft tissues are more difficult to preserve if the conditions are not perfect.

Exceptionally well preserved fossils found in China have shown for the first time dinosaur skin and soft tissue, and even feathers and quills. This would change our image of dinosaurs forever:

Dinosaurs were diverse and strange, and birds were the last branch in the Dinosaur family tree, living with us today.

Scientists had to look again at all the evidence, and what they found was a true rEvolution. Revealing the secrets of the skin showed an evolutionary arms-race: one order of dinosaurs -Saurischia-, had feathers paired with scales, claws and sharp teeth; while the other -Ornithischia- had beaks, quills, scales, spikes, horns and massive body armour.

There was a clash of evolutionary strategies in which only the smallest dinosaurs would fly away and survive extinction!

SCALES, QUILLS AND SPIKES: ANCIENT ORNITHISCHIA

For many years very little was known about the external appearance of the earlier ornithischians, that were assumed to be simply scaly or armoured like many of their descendants.

However, the fossil findings in the Chinese Liaoning Province deposits have helped to get a first hand picture of the primitive ornithischians' external appearance, and they were as extraordinary and complicated as their Saurischian counterparts. Many of the primitive members were quilled like porcupines. So the very old heterodontosaurs and primitive ceratopsians like Psittacosaurus demonstrate that quilled or insulated dinosaurs were right at the base of the evolution of Dinosauria.

We can't call them precisely "protofeathery" like the Saurischians, but their peculiar range of outer coverings were also made of keratin and probably were as much used as defence, insulation and display as the Saurischians.

In fact, these quills probably evolved later into their massive armour and spikes, like the primitive armoured dinosaur Scelidosaurus shows.

Psittacosaurus showing "bristles" along the tail.

THE ARMOURED GIANTS

Ornithischians needed to defend themselves, and porcupine quills were not going to ever be enough when pitted against the speed, agility and powerful jaws of their Saurischian predators. Some of them like the Pachycephalosaurs evolved extraordinary spiked dome heads that acted as a battering ram against the belly of their rivals and predators.

Others became more and more armoured until they became slow moving fortresses that were practically impregnable.

But they were fortresses with a sting! Far from being merely passive, their tails show massive clubs that could act as leg-breaking weapons. The vertebrae of their tails were reinforced with rods that stiffened them and made them lethal weapons for any two legged theropod that tried their luck!

HORNED AND BEAKED: THE CERATOPSIANS

The peak of the 'Keratin Armour Race' was achieved by the Ceratopsians. A combination of heavy and light armour, long horns, powerful beaks and possible an aggressive temper were enough to set the score with any big theropod.

In North America a new distinctively horned and shielded species is found almost every month!

Long horns, short horns…no horns! Long shields or short shields! It is obvious that these ornaments were not simply for defence but for display and intra-species recognition. The shields might have been colourful and clad with intricate scaly patterns. Their heads' ball-and–socket attachment shows that they could wildly rotate their heads for better display effect, defence… or attack! Their heads were normally kept at an angle that will always fully display the shield.

And what about the beaks? They were probably used both as a weapon and to cut tough vegetation, to be processed by their powerful jaws.

And if the horns, beaks and shields were not enough, their skin was also heavily armoured with mosaics of scales and spikes, traces of which have often been found in North America.

The 'Keratin arms race' would continue until its fateful end 65 million years ago.

Coahuilaceratops skull.

THE DINOSAUR-BIRD CONNECTION

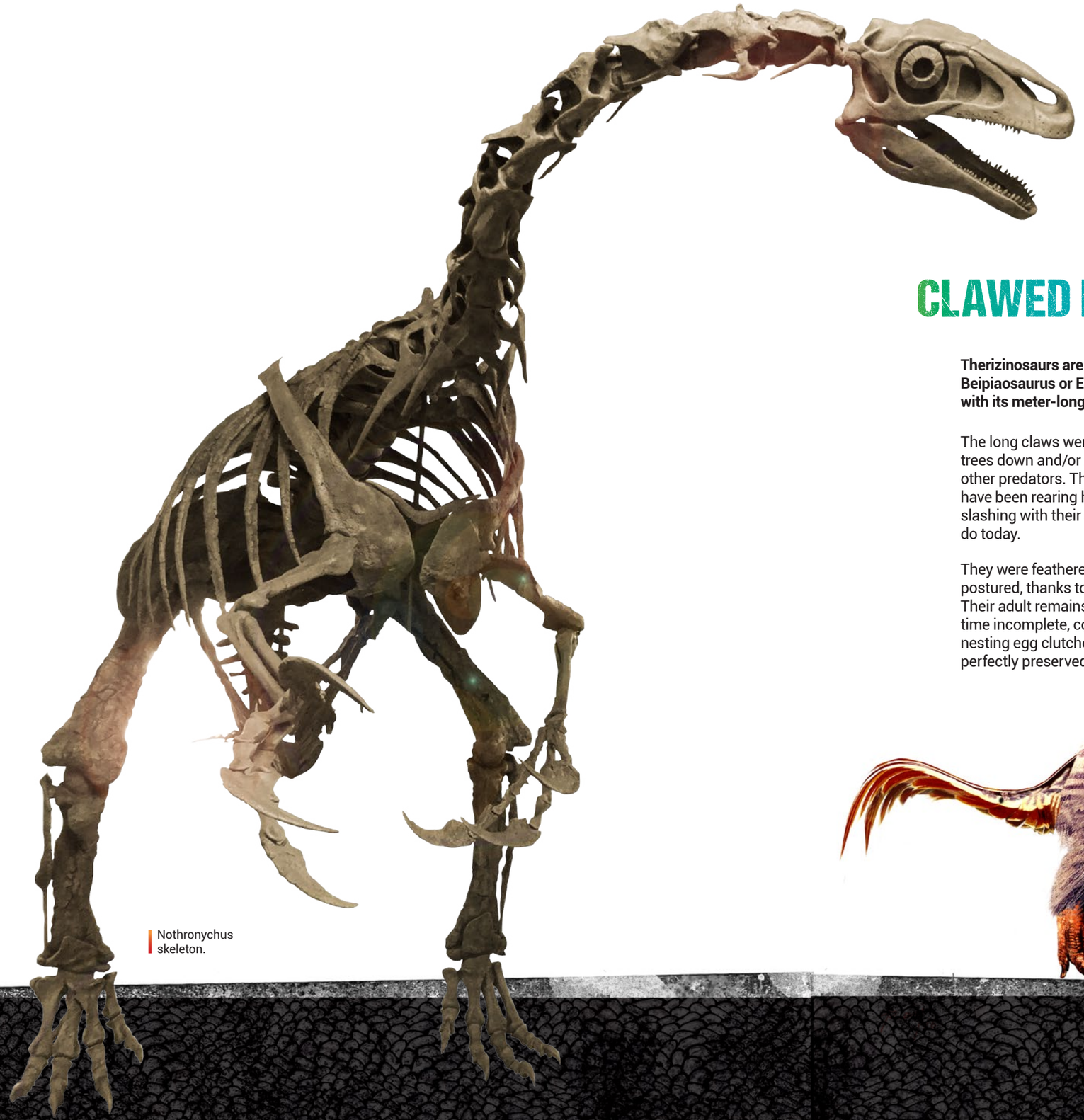
The Yi Xian deposits in China are revealing the link between Dinosaurs and birds. Never before have we had so many well preserved, complete specimens.

Feathers did not originally evolve for flight; they probably evolved for insulation, display and brooding behaviour. That became even more clear with the discovery of Sinosauropteryx, a theropod dinosaur not directly related to birds but covered with primitive filaments we call “proto-feathers”.

But some Saurischian dinosaurs, including non-flying ones, had modern-looking feathers. Some scientists believe they were also used as devices to assist juvenile or small dinosaurs running upwards to reach the protection of the top of the trees and parachuting back to the ground. The fact is that even famous dinosaurs like Velociraptor and Avimimus had traces of quills in their arm bones, just like any bird.

When we see feathers we also think “colours”, “display” and “communication”. Reptiles and birds are known for their colour vision. The world of the dinosaurs was probably also colourful, although we have very little evidence for it.

Our researchers today are little by little uncovering the enormous mosaic of feathery evolutionary trials of which modern birds are the only survivors, and possibly the only ones that could actually “fly”.



Nothronychus skeleton.

CLAWED ENIGMAS

Therizinosaurs are the most unusual group of theropods. They come in different sizes, from smaller Beipiaosaurus or Erlikosaurus to gigantic, pot bellied monsters like Nothronychus and Therizinosaurus, with its meter-long claws.

The long claws were probably used to strip trees down and/or as lethal weapons against other predators. Their defence method might have been rearing high on their back legs and slashing with their claws, very much like bears do today.

They were feathered, long necked and peculiarly postured, thanks to their very modified pelvis. Their adult remains are rare and most of the time incomplete, contrasting with the complete nesting egg clutches that have been found with perfectly preserved embryos inside.

From what we know by looking at their anatomy, these enigmas are the only theropod dinosaurs that might have been fully vegetarian!

Therizinosaurs, with a sideways rotation of their hands thanks to the crescent-shape bone in their wrists, were relatives of Velociraptor. However, they were much more cumbersome with flattened, scissor-like claws more than ten times longer than Velociraptor.

GIANT THEROPODS: WAS T. REX FEATHERED?

The giant dinosaurs, with their big bones, are better represented in the fossil record. But just as there are more mice than whales, we are finding now that most Dinosaurs were probably small. It is natural to think that protofeathers and feathers were restricted to the smallest Saurischian species.

This belief was shattered when a seven meter long ancestor of Tyrannosaurus rex was discovered clad with feathers. In fact most of the ancestors of T. rex have been found to have feathers! Tyrannosaurs are coelurosaurs, close relatives of the maniraptora, a clade of Theropod dinosaurs to which “Aves” also belongs. With few exceptions they were mostly carnivorous or omnivorous with sharp teeth, claws… and feathers!

Some scientists question that a dinosaur as big as T. rex could have been fully feathered, but it seems reasonable to think that if its ancestors were, T. rex probably would have been too.

We have found patches of skin of T.rex that were not feathered. Dinosaurs might also have been partially feathered, as ostriches are. A recent discovery has shown that a bird-mimic theropod was just that: naked legs and body covered in feathers.

THE GREAT SURVIVORS: AVES

For 169 million years the world was dominated by Dinosaurs. During that time mammals were mostly the size of a rat, with few exceptions reaching fox or cat-size. Mammals were relegated to opportunistically survive under the feet of the dinosaurs.

Dinosaurs occupied all the main natural habitats that mammals dominate today (except the waters).

65 million years ago a series of catastrophic events, including the strike of an asteroid, virtually destroyed Earth's climate. The sudden change was too much to bear for species larger than a small crocodile or a fox. The big Dinosaurs were all wiped out.

But well before the asteroid struck, Dinosaurs had already evolved a strategy to take over and populate a niche that was previously the exclusive domain of insects and pterosaurs (flying reptiles): the air!

Tens of thousands of species of Birds have flourished ever since and represent the last surviving dinosaurs. Their feathers have taken them far beyond the brink of extinction... Dinosaurs are the flying winners in the evolutionary race!

EXHIBITION AUDIENCES

'Dinosaur rEvolution' is designed to appeal directly to families, dinosaur enthusiasts and educational groups. Children's interests and school curricula have framed the exhibition approach. With these in mind, all exhibition text keeps scientific terms and jargon to a minimum.

The exhibition is rich in natural history specimens and has a large number of colourful artworks to illustrate scenes or 'windows' into Dinosaur life.

All fossilised objects on display are casts. The use of casts aids in the interactive nature of the show and allows people to touch and get close to the specimens.

BOOKING & CONTACT INFORMATION

GONDWANA STUDIOS

PO Box 148 Launceston,
Tasmania 7250 Australia

TEL: 0418 367 282 (International +61 418 367 282)

E-MAIL: info@gondwanastudios.com

WEBSITE: www.gondwanastudios.com

LUIS V. REY

E-MAIL: luisrey@ndirect.co.uk

WEBSITE: www.luisrey.ndtilda.co.uk

BLOG: luisvrey.wordpress.com


Gondwana Studios