So why did dinosaurs survive into the Jurassic period?

This is still a longstanding mystery which the DAWNDINOS team, led by Professor John Hutchinson, from the Royal Veterinary College are investigating in a five-year project funded by the European Research Council.

The study is looking at the locomotion of the earliest dinosaurs and is bringing together evolutionary and biomechanical research to address the unanswered questions about what made dinosaurs different from other archosaurs.

Did dinosaurs possess locomotor advantages relative to early crocodile-relatives during the late Triassic/early Jurassic period?
Could they run faster, jump farther, or walk more efficiently?

The **Locomotor Superiority Hypothesis** was proposed many years ago to explain what made dinosaurs distinct from other Triassic species of archosaurs, perhaps aiding their survival into the Jurassic. However this hypothesis has never actually been tested before. The DAWNDINOS team will be testing it for the very first time.

The DAWNDINOS logo depicts the struggle between the dinosaurs and the crocodile-line during the Triassic-Jurassic transition, with Pangaea in the background.

Archosaurian Dawn, by Robert Nicholls

Research Impact

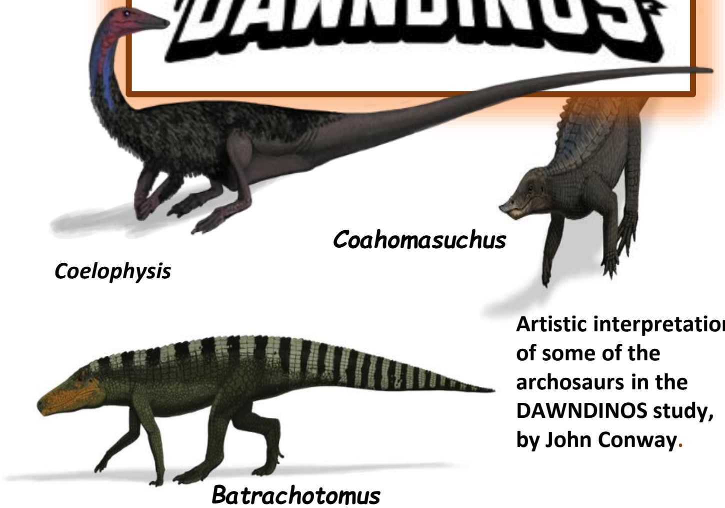
- Our research will advance the study of the evolution of the vertebrate musculoskeletal system during the Triassic-Jurassic transition, which had massive impact on future evolution on land.

- It will contribute to the field of evolutionary biomechanics as it pushes the frontiers of experimental and computational analysis of locomotor performance using modern digital tools, to predict how form and function are coordinated to produce movement.

- Cutting edge gait analysis techniques, including XROMM, electromyography and computer simulations will estimate parameters that otherwise might only be measurable invasively, if at all.

- The advancement in the use of computer simulation methods will ultimately enhance our understanding of how animals work, leading to improvements in clinical applications to animals and human studies in a wide array of fields including orthopaedics, prosthetics, medical and veterinary care and robotics.

European Research Council
Established by the European Commission
Royal Veterinary College
University of London



Artistic interpretation of some of the archosaurs in the DAWNDINOS study, by John Conway.

From about 245 to 66 million years ago, dinosaurs roamed the earth and were among the most successful group of vertebrate animals ever to walk on the planet.

Why were dinosaurs so successful?
Why did they survive and become so dominant across the Triassic-Jurassic boundary and their crocodile-like competitors the pseudosuchians did not?

Find out more about our research at:

www.dawndinos.com

How do we test hypotheses about organisms that lived over 200 million years ago?

Biomechanics brings dinosaurs back to life!!

Pushing the frontiers of experimental data collection and computational analysis

Using state-of-the-art techniques and biomechanical tools the DAWNDINOS team is investigating the evolution of locomotion in the surviving descendants of archosaurs; **Tinamou birds** (from the bird lineage - Ornithodira) and young **Nile crocodiles** (from the crocodile lineage - Pseudosuchia).
These living relatives of extinct archosaurs allow us to experimentally measure key factors about how their limbs support and move their body and collect data that is important in our study, including:

- **3D skeletal motions**, using XROMM (X-ray Reconstruction of Moving Morphology) – "X-ray video"
- **Limb forces**, using force plates
- **Muscle activations** using EMG (electromyograms)

The measurements from living animal subjects can then be applied to 3D CT scans we have of fossil dinosaurs and pseudosuchians.
By comparing the fossil and live animal skeletons we can predict how Triassic archosaurs (dinosaurs and their cousins) may have moved and learn more about their locomotor behaviours including standing, walking, running, turning and jumping.

Fossils and Bones

All that typically remains of extinct animals are the fossilised bones and skeletons.

To make skeletons move again, we need to add muscles to them. Muscles often leave characteristic bumps and scars where they attach to the bones. From careful examination of the limb anatomy of living relatives (birds and crocodiles, in our case), we can determine which muscles are associated with which bumps and scars on the bones. This allows us to reconstruct the muscular anatomy of extinct pseudosuchians and ornithodirans with reasonable confidence.

The key to creating accurate 3D skeletal models is being able to generate high-quality digitised bones. For our project we are using two methods: computed tomography (CT) scanning and photogrammetry - which works by capturing photographs of an object from a series of orientations and software assembles the photographs to create a 3D view.

Although the geometry of a bone can inform about how it was used in life, it nevertheless only gives part of the picture. Modelling and simulation of extinct species, using the laws of physics and mathematical optimization theory, allows us to reconstruct walking, running and other movements.

Musculoskeletal modelling and Simulation of Movement

Musculoskeletal modelling is an approach to understanding how movement is produced in animals and involves building computer models that represent the jointed skeleton, muscles and tendons of a living animal.
Using these models, we can execute **simulations** (goal-directed activities solved by computers) in which the model can recreate the forces and movements associated with measured activities like jumping and running.

Models and simulations have been used in clinical applications to analyse and treat problems with limbs in humans and other species, but we can also use them to study movement in extinct animals.

The aim of our study is to build musculoskeletal models of living birds and crocodiles that can, as accurately as possible, simulate the movements and forces they use when running, jumping, standing, walking and turning. This will allow us to understand the function that each muscle does during these activities.
Combining this knowledge of muscle function with our reconstructions of muscle anatomy allows us to build moving musculoskeletal simulations of extinct pseudosuchians and ornithodirans.

Musculoskeletal model of the hindlimb of a tinamou bird (*Eudromia elegans)*, a living archosaur from the DAWNDINOS research.