Secrets of dinosaur footprints revealed, thanks to Goldilocks

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(PhysOrg.com) -- Terrain thought to be ruled by only the largest dinosaurs to inhabit the earth could have in fact been home to dozens of other creatures, ground-breaking research from The University of Manchester has found.

Writing in the journal of the *Royal Society Interface*, Dr Peter Falkingham has discovered that dinosaurs only created lasting footprints if the soil conditions were perfect to do so – and entirely depending on the animal's weight.

Dubbed the 'Goldilocks Effect' – as all conditions have to be 'just right' for a print to be created – this work could help to bring ancient environments to life, by showing how a great number of animals can

walk over an area, but only a few leave behind tracks.

The findings mean that hugely-significant prehistoric dinosaur track sites, such as Paluxy River in Texas, USA, or Fumanya, Spain could have been host to a much larger number of dinosaurs and other animals than the tracks themselves show.

Dr Falkingham, from the University's School of Earth, Atmospheric and Environmental Sciences, led a team using detailed computer modelling to recreate the process of large dinosaurs making footprints in different types of mud.

The team incorporated scientists from a range of disciplines, including vertebrate palaeontologist Dr Phil Manning and Geotechnical engineer Dr Lee Margetts, both from The University of Manchester, and biomechanicist Dr Karl Bates (University of Liverpool).

By using computer modelling to simulate dinosaurs making tracks, the scientists were able for the first time to run dozens of simulations in order to systematically change the conditions of the mud.

As dinosaurs ranged vastly in weight, from Brachiosaurus, weighing around 30 tonnes, to Compsognathus, which was the size and weight of a chicken, Dr Falkingham worked out that only the heaviest creatures would leave prints in certain mud conditions.

Equally, in other areas where the mud was deep and soft, only lighter, nimbler dinosaurs would be able to walk over it and therefore leave prints; larger animals would become stuck and die.

These insights give palaeontologists the chance to re-evaluate the ecosystems which existed more than 100 million years ago.

Dr Falkingham said: “By using computer modelling, we were able to recreate the conditions involved when a 30-tonne animal makes a track.

“That’s very hard to do with physical modelling, more so when you need to do it 20 times in 20 different types of mud.

“But the real advantage of computer modelling is that everything is controllable. We were able to ensure that in every simulation we could look at the effects of each variable (for instance, the shape of the foot, or the weight of the animal) independently.

“As with most scientific papers, this isn’t the end of research, this is the beginning.

“Now we can use this “Goldilocks” effect as a baseline for exploring more complicated factors such as the way dinosaurs moved their legs, or what happens to tracks when a mud is drying out.”

In Paluxy River, site of one of the most famous sets of dinosaur footprints which seem to show a sauropod being chased by a carnivorous theropod, there are only footprints recording large dinosaurs.

But Dr Falkingham’s findings suggest that many more species probably lived there, walking over the same mud, but their footprints either made no impression or have disappeared over time.

The computer method was based on a technique common in engineering, known as finite element analysis.

This method lets scientists simulate the deformation of a material under load. Whilst in engineering this may be an aeroplane wing supporting the aircraft, Dr Falkingham and his co-authors applied the method to mud supporting a dinosaur.

More information: Paper: ‘The 'Goldilocks' effect: preservation bias in vertebrate track assemblages’, by P. L. Falkingham, K. T. Bates, L. Margetts and P. L. Manning

Provided by University of Manchester