ABSTRACT BOOK

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greater potential for representing specimen-specific biomechanical capabilities than scaling an MM. As a next step, we plan to explore the use of this workflow for transforming MMs between species, with the ultimate goal of applying this approach to the study of fossils.

A14.22 TAPIRS PRESENT THE KEY TO HORSES PAST? INVESTINGATING TAPIR MANUS LOADING, WITH IMPLICATIONS FOR LOCOMOTION IN ANCESTRAL HORSES.

Friday 7 July 2023 **11:00**

Jamie A MacLaren (Universiteit Antwerpen, Belgium), João P Oliveira de Almeida (Universiteit Antwerpen, Belgium), Kwinten Vangeel (Universiteit Antwerpen, Belgium), Sandra Nauwelaerts (Universiteit Antwerpen, Belgium)

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The tapir forelimb condition (tetradactyly) is also exhibited in the earliest ancestors of all other perissodactyl groups (including equids, rhinoceroses, brontotheres etc.), and is a stark contrast to the limbs of living families of perissodactyls (monodactyl equids and tridactyl rhinoceroses). The application and distribution of loading forces across the four digits of the manus remains integral to understanding how force application varied within the tetradactyl manus of basal perissodactyls, and how that may have influenced digit reduction in the ancestors of modern species. In this study, we examined under-foot pressure distribution in all modern tetradactyl perissodactyl species (Tapirus spp.), investigating load distributions and centre-of-pressure, and testing them against stress patterns (using FEA of metapodials modelled at mid-stance) and linear morphometric measurements in an effort to correlate pressure beneath each toe with mechanical / morphological characteristics of the manus. Our results suggest that mean pressure distributions per species are strongly correlated with metapodial length and midshaft depth, in addition to mean equivalent stress from FEA; however, this pattern does not hold true for all species. Interestingly, the centre-of-pressure for the modern Malayan tapir does not support biomechanical mesaxonic symmetry in this species (when walking). Extrapolating to the fossil record, equivalent stress of metapodials, digit lengths, and midshaft depths would all represent viable predictors for under-foot pressure in the earliest ancestors of modern horses, although care must be taken if inferring centre-of-pressure.

A14.23 FROM DISCOVERY TO SIMULATION: THE CHALLENGES OF MUSCULOSKELETAL MODELLING IN FOSSIL SPECIMENS

Friday 7 July 2023 **11:30**

Ashleigh L A Wiseman (University of Cambridge, United Kingdom), Julia Van Beesel (Department of Development and Regeneration KU Leuven Campus Kulak Kortrijk Belgium., Belgium), Marta Mirazon Lahr (Department of Archaeology University of Cambridge Cambridge UK., United Kingdom), James Charles (Institute of Life Course and Medical Sciences University of Liverpool Liverpool UK., United Kingdom), John R Hutchinson (Structure and Motion Laboratory Department of Comparative Biomedical Sciences The Royal Veterinar, United Kingdom)

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In recent years, progresses in imaging and musculoskeletal modelling have greatly advanced how we can study the movement capacities of an extinct species. This talk will provide an overview of the challenges we face in evolutionary biomechanics, from discovery to simulation. To develop a musculoskeletal model, a scientist must first create a representation of the specimen's skeleton, which might be heavily distorted and fragmentary. This can require extensive reconstruction and retrodeformation, and also rearticulation of disarticulated remains. After reassembling the skeleton, muscles must be added to the model. Soft tissues do not preserve in the fossil record, and thus assumptions must be made using a phylogenetic bracket of living, comparative species. However, the muscles' shapes, sizes and configurations are not sufficient to drive the model forward. Rather, the muscles require estimation of their architectural data, such as fibre lengths and physiological cross-sectional areas, which do not preserve in the fossil record. The finalised model can be used to investigate movement through simulations of performance. The kinematics and kinetics of a specimen can be computed and biomechanical information such as moment arms, moments and muscle activations can be extracted so that we can model how an extinct species might have moved. Here, we present pelvic and lower limb musculoskeletal models of extinct hominin species, ranging from Australopithecus afarensis to Homo erectus, in which soft tissues were reconstructed, muscular parameters were estimated and preliminary simulations have begun to unravel changes in the movement capability within the human evolutionary lineage.

A14.24 MUSCULOSKELETAL MODELLING UNTANGLES THE ORIGINS OF MAMMAL FORELIMB FUNCTION AND POSTURE

Friday 7 July 2023 **11:45**

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The 'sprawling-parasagittal' transition was a major postural shift in the ancestors of mammals, resulting in musculoskeletal reorganization of the forelimbs that underpins modern mammal locomotor diversity. However, 'when' and 'how' this important postural shift occurred is unknown. While the anatomical changes characterizing this transition can be traced through the fossil record, how these relate to functional changes, and the acquisition of parasagittal posture, remains poorly understood. We produced three-dimensional musculoskeletal models of the forelimbs of extant (n=3) and fossil (n=8) taxa that phylogenetically and functionally span the sprawling–parasagittal transition. We calculated joint range of motion (ROM) to determine a 3D pose-space, using the novel APSE algorithm (Accelerated Pose Searching with Electrostatics). We then estimated muscle moment

arms (MMAs) across the entire pose space for all muscles crossing the shoulder and elbow joints. Models of extant species were validated against empirical measures of ROM and MMA derived from ex vivo XROMM (X-ray reconstruction of moving morphology). Among extant species, in both models and experiments, our parasagittal taxon occupied a distinct region of pose-space, with more retracted and depressed shoulder joint angles. MMA data show increased emphasis on shoulder elevation associated with a parasagittal posture, but greater shoulder depression in sprawlers. We hypothesised the fossil taxa would follow trends in these postural variables – e.g., increasing shoulder retraction and elevation MMAs through time – but they instead showed complex, non-linear patterns of forelimb transformation. We demonstrate that the 'sprawling-parasagittal' transition is characterized by considerable homoplasy and continuous postural variation throughout mammalian evolution.

A14.25 RESURRECTING THE PAST: USING DATA FROM LIVING ANIMALS AND BIOMECHANICAL SIMULATIONS TO UNDERSTAND FEEDING, FORM AND FUNCTION IN FOSSILS.

Friday 7 July 2023 **12:0 0**

Emily J Rayfield (University of Bristol, United Kingdom)

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The discovery and description of fossil animals frequently precludes questions such as, how did this animal live, how did it function? A challenge for palaeobiologists is, therefore, if and how we can address these queries within a scientific framework. Functional morphology has advanced from Gould's famous 'Just-so stories', through to the first introduction of rigours such as Rudwick's paradigm approach, and the conceptual framework of Seilacher that recognised the influence of adaptation, but also phylogeny, development and other environmental and material constraints on the evolution of form and function. Today, palaeobiologists have a range of tools available to interrogate the function and evolution of organisms and 'bring fossils back to life'. In this invited talk I will discuss two fruitful approaches: (1) the integration of biological and palaeobiological data, particularly as applied to study of the origin of tetrapods and the origin of mammals; and, (2) the application of physical principles to define and test biomechanical hypotheses in palaeobiological analysis. Both approaches hold much promise, but have limitations. Biological data can be difficult to obtain and may require expensive data capture equipment. Conversely, barriers such as software cost and access have diminished over recent years, promising equity and inclusivity within palaeobiomechanics, yet the application of physical principles requires careful application of hypotheses and an understanding of the utility and drawbacks of the model systems employed.