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Experimental palaeobiomechanics: What can engineering tell us about evolution in deep time?

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What did Tyrannosaurus rex eat? This is the sort of question that immediately bombards any palaeontologist when interacting with the general public. Even among scientists, how extinct animals moved or fed is a major objective of the palaeobiological research agenda. The last decade has seen a sharp increase in the technology and experimental methods available for collecting biomechanical data, which has greatly improved out ability to examine the function of both live and extinct animals. With new technologies and methods come new pitfalls and opportunities. In this review, I address three aspects of experimental biomechanics that exemplify the challenges and opportunities it provides for addressing deep-time problems in palaeontology. 1) Interpretation: It has never been easier to acquire large amounts of high-quality biomechanical data on extinct animals. However, the lack of behavioural information means that interpreting this data can be problematic. We will never know precisely what a dinosaur ate, but we can explore what constraints there might have been on the mechanical function of its jaws. Palaeobiomechanics defines potential function and becomes especially effective when dealing with multiple examples. 2) Comparison: Understanding the potential function of one extinct animal is interesting; however, examining mechanical features across multiple taxa allows for a greater understanding of biomechanical variation. Comparative studies help identify common trends and underlying mechanical principles which can have long reaching influences on morphological evolution. 3) Evolution: The physical principles established through comparative biomechanical studies can be utilized in phylogenetic comparative methods in order to explore evolutionary morphology across clades. Comparative evolutionary biomechanics offers potential for exploring the evolution of functional systems in deep time utilizing experimental biomechanical data.