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The hard parts of the Cambrian Explosion: a palaeobiological approach to testing the 'biomineralization toolkit' hypothesis

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The Cambrian Explosion was the most dramatic event in the history of animal life on Earth, yet the processes underlying it are poorly understood not least the role of biomineralization in driving this fundamental evolutionary episode. One explanation for this event, based on observations on the developmental and molecular biology of modern organisms, is that all animals inherited a common 'toolkit' of genes, independently co-opted to similar tasks, including building skeletons. This initially imprecise 'toolkit' was subsequently honed by the acquisition of more and more complex gene regulatory networks. This predicts that animal skeletons, and by inference their organic frameworks, should exhibit a higher degree of morphological plasticity at their origin than later in their evolutionary history – a prediction that is virtually untested. Here I set out a new approach to testing this prediction, by quantifying the phenotypic variation displayed in fossil remains of some of the earliest animal skeletons, over multiple scales from microscopic variations in their component biominerals to how skeletons themselves are put together. This approach will provide direct evidence to test the importance of the genetic basis of the skeleton in the origin of the animals, making a significant contribution to our understanding of this crucial event in the history of life on Earth, including the evolution of our own ancestors.