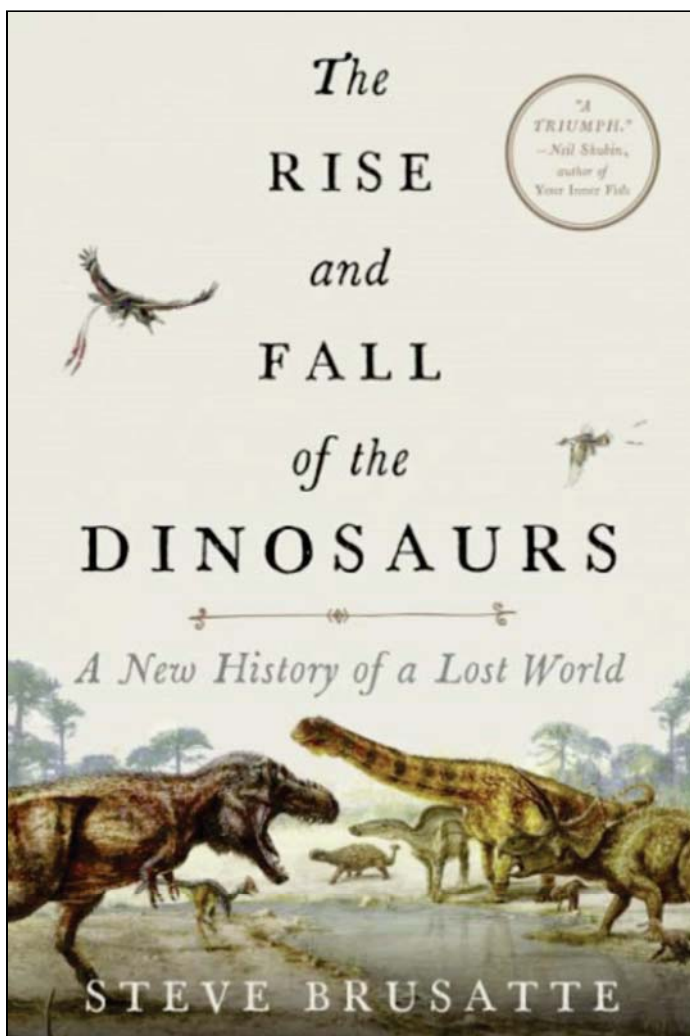


REVIEW



The Rise and Fall of the Dinosaurs: A New History of a Lost World

Steve Brusatte

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Serendipity lies behind this review. About three months ago, I spent a few days at an Airbnb owned by a couple with two teenage sons. Browsing their bookshelves, I was intrigued by the number of books on dinosaurs. There must have been at least a dozen, many well illustrated, ranging from non-scientific kids' books depicting herds of herbivores unsuspectingly munching lush foliage while being stalked by voracious blood-thirsty carnivores, to much more sophisticated tomes including encyclopedia complete with statistics and detailed reconstructions of hundreds of different dinosaur species. The books belonged to the teenagers, and it struck me that theirs was the generation that grew up with dinosaurs — dinosaur stickers, dinosaur images on their t-shirts and pyjamas, and dinosaur film stars in Steven Spielberg's 1993 blockbuster Jurassic Park (based on Michael Crichton's 1990 book of the same name). As in the movie, it appeared that the extinct animals had literally become alive for these two members of the post-millennial generation, many of whom apparently can name and recognize more than a dozen dinosaur species from a very young age. Moreover, the cornucopia of information in the encyclopedia was evidence that this surge of public interest in extinct animals was based on much new scientific research and information. Among the books was a hefty tome by Steve Brusatte entitled *The Rise and Fall of the Dinosaurs: A New History of a Lost World*, with resounding endorsements from The Washington Post ('a masterpiece'), The New York Times (bestseller), The Economist (recommended reading), The Smithsonian, The Times of London, Science News, Popular Mechanics, etc. (best popular science book of the year), and Scientific American ('the ultimate dinosaur biography'), among many others. After a short browse, I realized my education was in serious need of an update and I got my own copy a couple of weeks later.

Steve Brusatte is a young professor of paleontology at Edinburgh University, who in his own words has been a dinosaur nerd since a very young age. An American from small-town Illinois, he studied paleontology at the University of Chicago, Bristol University (UK), and Columbia University in New York, and this book combines his accumulated expert-

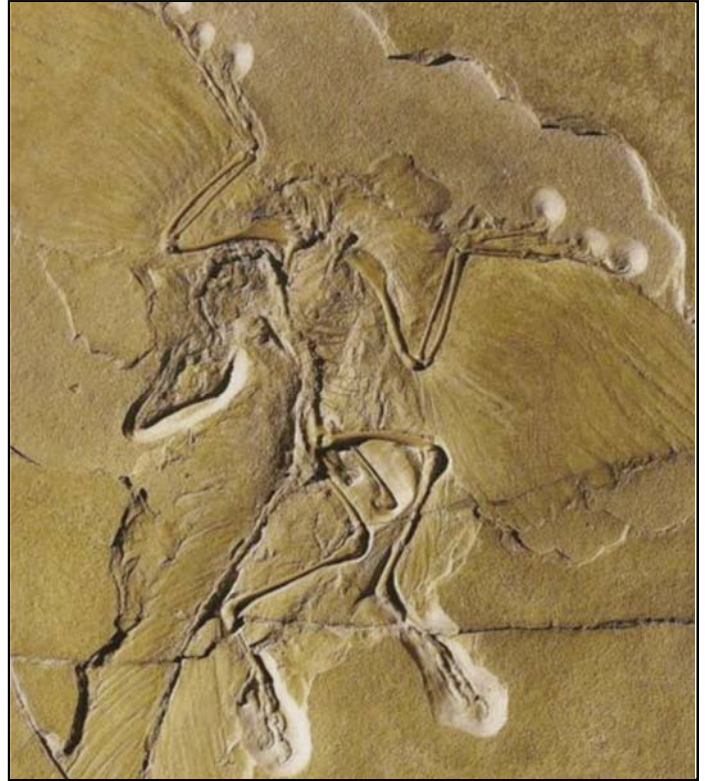


Tyrannosaurus Rex, indisputably the best known of all dinosaurs, and fully deserving of its own chapter in Steve Brusatte's book. This impressive skeleton forms part of the exhibits at the Tyrrell Museum, in Drumheller, Alberta. Photo by A. Kerr.

ise and 'raw enthusiasm for dinosaurs' with his love of science writing and communication of popular science.

The storyline is bookended by two major extinctions, the end-Permian extinction at 252 Ma and the end-Cretaceous extinction at 66 Ma. The intervening 186 M.y. of the Mesozoic has yielded fossil evidence that the early, small bipedal proto-dinosaurs in the Triassic evolved from sprawling Permian precursors, dramatically diversified their anatomy, size, modes of locomotion and living, and flourished, becoming the dominant actors in the animal world on all the continents during the Jurassic and Cretaceous. The arrangement of the book is approximately chronological, from Triassic through Jurassic to Cretaceous, and much of the story is written through the first-hand experiences of the author as he travels through the world to research critical issues in dinosaur evolution. Thus the reader gets a world tour, meets Brusatte and his mostly male buddies in the field and famous museums, and vicariously relives the excitement as they collect and document key dinosaur fossils, both bones and tracks, in Poland, Portugal, Romania, Italy, Montana, Wyoming, New Jersey, Scotland, China, Brazil, Argentina, and elsewhere. The field and museum experiences enliven the storyline and provide insight into the personalities involved — like Brusatte, many seem to be extrovert characters who caught the dinosaur bug at a young age, but Chinese expert Xu Xing, who has described and named more than fifty new dinosaur species, is an exception — he grew up poor in rural western China, won a scholarship to university in Beijing, and was told to study paleontology, a subject he had never heard of.

The book is about much more than evolving dinosaur anatomy and speciation from the small marginal Triassic *Eoraptor* and *Herrerosaurus* to the familiar Jurassic and Cretaceous giants such as *Brontosaurus*, *Tyrannosaurus* and *Triceratops*. The final assembly of Pangea took place in the Permian and the supercontinent had largely broken up by the end of the Cretaceous, and Brusatte is effective in incorporating paleo-



Although a great deal smaller than T. Rex, Archaeopteryx is every bit as important, as it provided the first clear evidence of a link between dinosaurs and birds. Reproduction at the Tyrrell Museum, Drumheller, Alberta. Photo by A. Kerr.

ecology and showing how it and the changing arrangement of the continents affected dinosaur speciation and size, and the relative abundances of dinosaur lineages. There are also imaginative descriptions of the two extinctions that bookend the story, discussion of the climate on Pangea in the Triassic, climate change during the Mesozoic, and the dramatic sea-level rise in the Cretaceous — themes for our times. In addition, after a brief primer on the history of evolution and the origin of species, there is a compelling discussion of dinosaur 'missing links' in a chapter devoted to the origin of birds. The critical fossils, only discovered in the last twenty years or so in the Liaoning region of northeastern China, and more recently in Alberta, are exceptionally preserved specimens complete with impressions of feathers that are described by Brusatte as "*the fossils that help us untangle one of the biggest riddles of biology: how evolution produces radically new groups of organisms, with restyled bodies capable of new behaviors... what biologists call a major evolutionary transition?*".

Also woven into the text are descriptions of the increasingly sophisticated methods employed by vertebrate paleontologists. For example, CAT scanning of dinosaur skulls is now routinely used to estimate brain volume, morphology and function; dinosaur body weight estimation, formerly little more than guesswork, now involves either algorithms based on dimensions of the femur, or more sophisticated species-specific techniques using photogrammetry to construct precise three-dimensional computer models of their skeletons to which muscles, internal organs, skin, etc. are added. These

fleshed-out models can then be loaded into animation software and made to walk, run and jump — and finally, mechanically-plausible behaviour modes can be evaluated by stress analyses of bones and joints using finite element analysis. Another recent advance, statistical analysis of large datasets derived from measurements and observations of dinosaur fossils, has provided insight into dinosaur lineages. For example, it has been instrumental in showing that birds are theropods, a group of meat-eating dinosaurs that includes several famous names such as *Allosaurus*, *Tyrannosaurus*, and *Velociraptor*. Interestingly, in the context of the late 19th century subdivision of dinosaurs into saurischians (lizard-hipped dinosaurs) and ornithischians (bird-hipped dinosaurs), theropods are saurischians. The new research has shown that development of both feathers and the super-efficient bird lung, in which oxygen is extracted from the air during both inhalation and exhalation, occurred in the theropod lineage prior to the evolution of avian dinosaurs (yes; that terrible *Tyrannosaurus rex* was probably covered in a fuzz of proto-feathers).

This is a popular science book about the present ‘golden age of discovery’ in which about fifty new species of dinosaur are described in the paleontological literature each year and new research methods are constantly being added to the paleontologists’ toolkit. The text is well-organized, fast-moving, and informative, each chapter covering a discrete topic while allowing the author scope for personal anecdote and historical vignettes. Chapter headings such as *The dawn of the dinosaurs*, *Dinosaurs become dominant*, *Dinosaurs and drifting continents*, *The king of the dinosaurs*, *Dinosaurs take flight*, and *Dinosaurs die out* indicate the accessible approach employed. For those wanting to follow up on details, there is an extensive list of sources at the end of the text, and the book also has an index. Frontispiece illustrations include a geological time chart, a dinosaur family tree, and plate tectonic reconstructions showing Pangea in the Triassic, and its breakup in the Jurassic and Cretaceous; and also each chapter is headlined by simple elegant black and white drawings of a dinosaur featured in the ensuing text. In addition, many chapters include photographs of the author and his colleagues in the field and laboratory, as well as images of exquisitely preserved dinosaur fossils. Brusatte obviously had fun writing this book, and frequently uses metaphors from popular culture to make his point; for instance this line: “*You could call T. rex the James Dean of dinosaurs: it lived fast and died young*”. These analogies generally drew the desired reaction from me, but I found myself grimacing occasionally, for instance at the use of the word ‘critters’, anthropomorphic descriptions of ‘plucky’ proto-dinosaurs emerging from the Permian mass extinction, and the description of *Ankylosaurus* as ‘stupid’. On the other hand, this metaphor for the Cretaceous–Paleocene boundary in Gubbio, Italy, where the abundant Cretaceous marine fossil record gives way above the iridium anomaly to a complete absence of fossils in the early Paleocene, hit the sweet spot for me: “*Walter [Alvarez] was observing a line between life and death. It’s the geological equivalent of listening to those last few moments on a cockpit voice recorder before it gives way to silence*”.

Did I mention serendipity? As a moderately sized mammal, I would not be writing this review if a large bolide had not impacted Earth at the end of the Cretaceous, forming the Chicxulub crater and that iridium anomaly and wiping out the non-avian dinosaurs and much else besides, thereby making way for the rise of the mammals in the Cenozoic.

