Boning up on dinosaurs

The Microstructure of Dinosaur Bone: Deciphering Biology with Fine-Scale Techniques
by Anusuya Chinsamy-Turan
Johns Hopkins University Press: 2005. 216 pp. $85, £56.50

Luis M. Chiappe

Studies of the microstructure of dinosaur bone began soon after the first scientific reports of these Mesozoic behemoths, but it took nearly 150 years for this discipline to enter the mainstream of dinosaur palaeontology. Nowadays, these studies are used to infer numerous aspects of dinosaur biology, from growth rates and physiological strategies to skeletal biomechanics and developmental patterns, and are even used as a source of new characters for phylogenetic inference. *The Microstructure of Dinosaur Bone* by Anusuya Chinsamy-Turan is the first book-length review of this rapidly advancing line of palaeontological research.

Chinsamy-Turan begins by introducing a host of topics, including the basics of bone composition, histological studies, the changes that occur on death and fossilization, and dinosaur evolution and ecology. Next, she examines the biological meaning of bone microstructure. She looks at bone-tissue dynamics (the rate at which it is deposited, and whether it occurs without interruption or with growth rings) and vascularization (the number of blood vessels), and explains how they can provide clues to the ontogenetic, biomechanical and ecological contexts of bone.

After that she turns her attention to dinosaurs, with a brief history of dinosaur-bone histology and a review of the diverse tissues found in their bones. We then reach the heart of the book, with a discussion of how microstructural studies of fossil bone inform our understanding of the growth patterns of extinct vertebrates. Particularly useful is the author's emphasis on the caveats for inferring some aspects of growth dynamics from fossil bones. Then she covers a number of studies, mostly her own, on the bone histology of premodern, Mesozoic birds — dinosaurs' most immediate descendants — and the important changes in growth patterns thought to have occurred during their evolution. Finally, she delves into dinosaur physiology to see if bone microstructure can tell us whether some, all or none of these animals were warm-blooded.

The book draws on Chinsamy-Turan's extensive studies of the bone microstructure of living tetrapods. It is perhaps her deep understanding of the complexity of skeletal growth that leads her continuously to warn against making a strong connection between the different types of tissue preserved in fossilized bones and either specific rates of bone formation or dinosaur physiology. Throughout the book, Chinsamy-Turan is resolute in defending her views from opposing perspectives; at times it feels like we are watching a television commercial for a video-game. Fortunately, however, the different contenders in the modern arena of dinosaur-bone microstructure agree on several fundamentals. Thanks to work by Chinsamy-Turan and her colleagues and mentors, we know that even if the growth strategies of dinosaurs varied greatly, these animals grew at rates substantially faster than extant non-avian reptiles (even the largest dinosaurs reached adult size in less than three decades). We have also learned that the same rate of bone formation may lead to the creation of different types of bone tissue, and that growth series and data from different skeletal elements are critical for confidently inferring the growth patterns of extinct dinosaurs.

Not surprisingly, the area of greatest disagreement is the largely conjectural issue of whether, in a physiological sense, dinosaurs more closely resembled cold-blooded reptiles or warm-blooded birds and mammals. Most researchers agree that rapid growth cannot be confidently correlated with warm-bloodedness, and most of the disagreement seems to be akin to whether a glass is viewed as half full or half empty. Chinsamy-Turan highlights how the bone microstructure of dinosaurs shows features that are either frequently found in non-avian reptiles or widespread among birds and mammals, but she wisely advises us not to draw definitive physiological conclusions from bone microstructure.

Chinsamy-Turan is at her best when she discusses the microstructure of bone and its significance for understanding the biology of fossil vertebrates. However, her conclusions about the linkage between the origin of warm-bloodedness and the divergence of ornithurines (the group including *Hesperornis*, *Ichthyornis* and all living birds) are weakened by the endorsement of views that have a morphological and functional basis that is not clearly substantiated. Despite these shortcomings, Chinsamy-Turan's book is a tour de force that gives readers an updated synopsis of a fast-growing field of vertebrate palaeontology. The book is a must-read for anybody interested in the biology of one of the most fascinating animals in the history of our planet. ■

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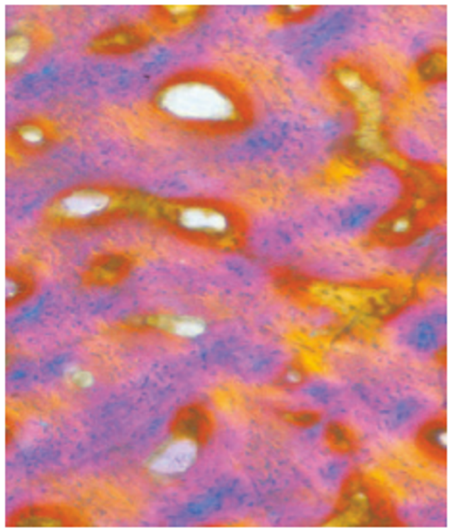

A. CHINSAMY-TURAN

Growth area: microstructure study reveals stages of bone formation in the dinosaur *Dryosaurus*.

Summing up physics

The Equations: Icons of Knowledge
by Sander Bais
Harvard University Press: 2005. 96 pp. $18.95, £11.95, €17.50

Malcolm Longair

Perhaps the most common comment I receive after delivering a public lecture is: "I enjoyed the lecture, but I couldn't understand the maths." This difficulty doesn't just affect the public but is one that students and scientists encounter throughout their careers: how does one connect the behaviour of the real world with the mathematics used to describe it? After years of practice and hard thinking, professionals become adept at making this connection, which I regard as perhaps the greatest challenge in teaching mathematical physics.

Sander Bais's little book *The Equations* tackles this problem from the point of view of 17 of the basic sets of physics equations, which the subtitle refers to as "icons of knowledge". In a book of only 96 pages, it is a real challenge to do much more than indicate to the reader the enormous richness of these equations and the imaginative ways they can be used to extend our understanding of the workings of nature at all levels. The equations are presented in their final definitive forms without any discussion of how they came about or why they have these forms. This latter aspect is not part of Bais's agenda, which is a pity. Still, if it were, the book would have grown out of all proportion.

In the first few pages there is a lightning review of elementary mathematical operations, and this helps the reader understand the simpler equations, such as Newton's laws of motion and the continuity equation. It is debatable, however, whether these insights enable the reader to understand the importance of

lagrangians, tensors, spin matrices and so on. As the equations progress through the Dirac equation, quantum chromodynamics and electroweak theory to the superstring action, Bais simply writes down the equations in their most compact and elegant form and discusses what the solutions mean. This is fair enough if we are to regard the equations simply as icons of knowledge.

But when reading the book, I kept thinking: "If only he had said..." For example, why are complex numbers the natural language of quantum mechanics? Where do the horrendous complexities of turbulence come from in the Navier–Stokes equations? What was the step of genius that led James Clerk Maxwell to the final form of his equations for the electromagnetic field? If the key concept of the relativity of simultaneity had been introduced, so many of the problems of special relativity would have disappeared. For me, these would have added to the insight and value of the exposition. However, this is not really what the book is about — it is much more a concise exposition of what the equations can do, and the reader has to trust that the author has got it right. Indeed I cannot fault what he says about the meanings of the equations, and the main text is enlivened by brief sketches of the lives of some of the principal players. I only wish he had included Galileo's pivotal contributions as the founder of the whole business: "The book of Nature is written in mathematical characters."

Who will gain most from reading this book? It has to be someone who wants an introduction to the power of mathematics in describing natural phenomena without actually having to do the maths. The average interested public should be encouraged to dip into the book and see how they get on. My suspicion is that the most important target audiences are young people who aspire to become mathematically oriented scientists and who will find the scope of the book inspiring. It would be a lovely birthday gift for them.

At a recent public lecture on Einstein and the arts in the first decades of the twentieth century, my co-presenter from the perspective of art history commented on the sheer physical beauty of the equations that I risked presenting to the audience. In addition to its pedagogical value, Bais's book presents these icons of our physical world in all their beauty. It is very good to be reminded of this. ■

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SCIENCE IN CULTURE

Porcelain perception

Not everything is as it seems in the ceramics of Pauline Wiertz.

Colin Martin

Contemporary applied artists sometimes suppress any national or historic references in their work, perhaps to make it more universal and hence more appealing on the global fine-art market. Whatever the reason, much of the work exhibited at Collect, an international contemporary art fair held in London last month, was aesthetically unadventurous and almost 'stateless' in its lack of cultural interest.

One outstanding exception was the covetable slip-cast porcelain and earthenware exhibited by Dutch ceramist Pauline Wiertz. Unashamedly relishing her national artistic heritage, her recent work evokes the sumptuous still-life canvases of heaped fish, meat, fruit and vegetables familiar from the seventeenth-century 'golden age' of Dutch painting.

R. ZULSTRA

Neither fish nor fowl: Pauline Wiertz uses chicken feet in *Garnalen Cocktail*.

At first glance, *Garnalen Cocktail* ('shrimp cocktail') seems to be a typical assortment of marine species. Life-like pink prawns are heaped on lustrous black-glazed shells and starfish, and the piece is given height by an armature of what appears to be black coral prettily tipped with rose pink at the rear. On closer inspection, however, it becomes clear that Wiertz used severed chicken feet to cast the coral, although the shellfish were cast from real specimens.

This playful hoax echoes the contents of a seventeenth-century *Wunderkammer*, or chamber of wonders, a cabinet filled with curiosities by a wealthy, private collector. Although a *Wunderkammer* typically housed preserved animals, skeletons, horns and tusks, it might also include man-made oddities that mixed fact with fiction. The cabinet of Ole Worm (1588–1654), who taught medicine at the University of Copenhagen in Denmark, contained a woolly fern masquerading as a 'Scythian lamb', thought to be a hybrid of a plant and a sheep.

In its verisimilitude, Wiertz's work resembles the eighteenth-century rococo porcelain produced by the Meissen factory in Germany. By using chicken feet to cast moulds for her ceramic coral, Wiertz encourages us to think about the nature of perception: if we expect to see coral in the context of other marine species, then that is what we will discern. There is also the hint of a wry comment on our contemporary preoccupation with the spread of the H5N1 strain of avian flu. This point is made more clearly in her appositely named *Kippenpootjes* ('chicken legs' or 'chicken fever'), a series of individual chicken feet slip-cast in porcelain and colourfully glazed.

Wiertz's ceramics can be seen at the Galerie Terra Delft in the Netherlands from 25 March to 22 April.

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