JOHN WEINSTEIN/THE FIELD MUSEUM

One of the 34 aisles of cabinets that house the fossil-plant collection at the Field Museum.

NATURAL HISTORY

Backstage at the museum

Richard Fortey questions the level of derring-do in an account of the life curatorial.

When I was a young scientist, I was informally interviewed for a job at the University of Chicago in Illinois. The process involved dinner with one of the faculty members. My host introduced his guests by reciting the number of papers they had published and their impact on their field; it was that kind of place. I was left with a comparable feeling of slightly abashed awe after reading about the stars of *Curators*, palaeontologist Lance Grande's book on the life scientific at Chicago's Field Museum of Natural History. Grande's colleagues are all one helluva guy or gal, out there at the cutting edge. They win the medals. They bring back the most precious or the most prestigious natural-history objects for display or research.

The Field houses one of the great collections of the natural world (alongside the Smithsonian Institution's National Museum of Natural History in Washington DC and the American Museum of Natural History in New York City). It includes everything from the rare Morelet's crocodile (*Crocodylus moreletii*) to dozens of the earliest

fossil birds. Behind the scenes, a dozen or so curators analyse the collections for research papers that help to unravel the wonders of the history of life and humanity. There are even meteorites more than 450 million years old that help us to understand our own planet's early evolution within the Solar System.

The Field's curators study some of the greatest treasures of Native American cultures and some of the rarest minerals on Earth. Far from the popular image of introverted specialists tending drawers deep in the vaults, they are Indiana Jones figures swashing and buckling their way to remote regions, dealing with drug barons or cantankerous farmers as needs must, bent on returning with scientific treasure. They're persistent, too: Grande has visited the same rich fossil-bearing beds in Wyoming "for two or three weeks each summer over the last thirty-one years", with students and devoted amateurs in tow. The site,

called the Fossil Butte Member, has yielded thousands of specimens from the Eocene epoch (56 million to 34 million years ago), including astonishingly complete skeletons of early relatives of the horse (*Protorohippus*), and primitive bats.

Grande retells the story of the Field's most famous fossil — the largest, most complete skeleton of the uber-carnivore *Tyrannosaurus rex* yet found. It's known as SUE, a curiously appropriate name, given that this magnificent specimen has been the subject of several lawsuits and charges of outrageous skulduggery (literally). In fact, the great beast was named after palaeontologist Susan Hendrickson, who discovered it in South Dakota in 1990.

It is good to have this story recounted by an insider, and one sympathetic to the major excavator, Peter Larson, who was prosecuted for collecting fossils from federally owned land. The outcome of complex legal machinations was the right one. SUE on display — the 'real thing' and not a cast, as so often — is the major attraction of a great museum. Grande has proved equally adept at adding to the

Curators: Behind the Scenes of Natural History Museums

LANCE GRANDE
University of Chicago
Press: 2017.

priceless collection of minerals and jewels, mostly by charming wealthy patrons, but bones beat baubles in my book.

Like my own *Dry Store Room No. 1* (Harper, 2008), based on my decades as a palaeontologist at London's Natural History Museum (NHM), *Curators* is both an autobiography and a hymn to some of Grande's more remarkable predecessors and colleagues. He is generous in their praise. Each year, he attends the Alabama Deep Sea Fishing Rodeo on Dauphin Island, where anglers give scientists first dibs on species that will contribute to the understanding of fish evolution. He secures important specimens — including a 175-kilogram Warsaw grouper (*Epinephelus nigritus*) — and fosters the prospects of his students by involving them in collaborative research projects.

I have shared several colleagues with Grande: Colin Patterson from my place, who is one of the founding fathers of phylogenetics, the study of evolutionary relationships; the amiable ichthyologist William Bemis; and Grande's own teacher, the determinedly eccentric Robert Sloan.

What is missing is the life of the curator between adventures. The job does entail a lot of rifling around in drawers, discovering tiny details, consulting rare books and even writing labels. I love

fieldwork, but it rarely takes up more than 10% of my time; laboratory work and often rather dry scholarly research account for the rest. Some museum curators rarely

venture into the field at all. And even Grande's account loses immediacy as soon as he steps into the role of administrator.

Sadly, the importance of science centred on museum collections is losing traction. Fundraisers and public-relations people are replacing curators, even in national museums. At the NHM, the number of full-time fossil researchers has more than halved since the peak era of the 1970s. In some regional museums, curators are rarer than the specimens they study. This is tragic. Creeping philistinism values only the bottom line, and there is little money to be made in (say) fish evolution. Maybe Grande's book will help to reverse the trend. ■

Richard Fortey is a research associate at the Natural History Museum, London. His latest book is *The Wood for the Trees*. e-mail: r.fortey@nhm.ac.uk

METASCIENCE

Reproducibility blues

Marcus Munafò enjoys a stinging survey of unreliable findings in biomedical research.

As scientists, we are supposed to be objective and disinterested, careful sifters of evidence. The reality is messier. Our training can give us only so much protection from natural tendencies to see patterns in randomness, respond unconsciously to incentives, and argue forcefully in defence of our own positions, even in the face of mounting contrary evidence. In the competitive crucible of modern science, various perverse incentives conspire to undermine the scientific method, leading to a literature littered with unreliable findings.

This is the conclusion of *Rigor Mortis*, a wide-ranging critique of the modern biomedical research ecosystem by science journalist Richard Harris. He describes how a growing number of claims over the past decade that many published research findings are false, or at least not as robust as they should be, has led to calls for change, and the birth of a new discipline of metascience.

He begins with the revelation in 2012 by Glenn Begley that only 6 (11%) of 53 'landmark' publications in preclinical cancer research could be confirmed by the biotechnology firm Amgen (C. G. Begley and L. M. Ellis *Nature* **483**, 531–533; 2012). Since then, numerous studies (most recently in psychology and cancer biology) have confirmed that failure to replicate published findings is the norm. The reasons are complex and contested. Harris identifies potential culprits, from the complexity of modern biomedical science to the limitations of tools and training, and perverse incentives in modern academia.

Mice are often poor models for human therapies.

Rigor Mortis: How Sloppy Science Creates Worthless Cures, Crushes Hope, and Wastes Billions
RICHARD F. HARRIS
Basic: 2017.

The scale of the problem is laid bare: apparently trivial methodological differences (such as how cells are stirred in culture, or the medium on which they're grown) can mean a complete failure to replicate results. Animal models often poorly predict results in humans; sample sizes can be too small to give reliable results; and some

12,000 studies may have used contaminated or misidentified cell lines. It is not just that the published research is unreliable — we may also be missing out on good drugs because poor preclinical data is an unreliable guide to whether to pursue human studies. The term "Eroom's law" (the reverse of Moore's law) has been coined to describe the worsening state of drug discovery. How much funding is wasted? Is the self-correcting nature of the scientific method functioning optimally? And, can we do better?

Harris introduces us to the growing field of metascience — the scientific study of science itself — and some of those working in it. These reproducibility firefighters are providing answers to such empirical questions, and identifying interventions. Robert Kaplan and Veronica Irvin at the US National Institutes of Health (NIH) showed that when the National Heart, Lung, and Blood Institute required preregistration of primary outcomes (the main outcome against which success should be judged) in clinical trials, the proportion of studies reporting a benefit fell from 57% to 8%.

Failure is a normal part of science, but dressing it up as success (for example, by presenting a secondary outcome as the primary outcome) is misleading. So is packaging exploratory, hypothesis-generating work as confirmatory, hypothesis-testing work. Unfortunately, with few ways to publish negative results, such practices are encouraged by incentives to present clean results with a compelling narrative, and be the first to do so.

Unsurprisingly, views differ on the reproducibility 'crisis'. Some believe we are in the dark ages; others, that attempts at direct replication are naive. The truth is probably in