



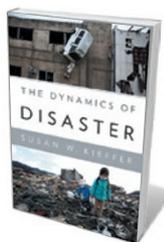
DISASTER MANAGEMENT

Preparing for the worst

A study on natural disasters puts fizz into the physics, finds **Roger Bilham**.

Susan Kieffer's *The Dynamics of Disaster* will attract readers much as a road accident slows a passing motorist. But those seeking Hollywood-style gore and fright are in for an education. Kieffer's geophysical study is much more than a litany of bad things happening to people who are in the wrong place at the wrong time. It delves into the physics responsible for many of the extreme events that society finds inconvenient, and offers hope that, rather than meekly accepting the rubbish that nature throws at us, we can attempt a societal fix.

Do not be put off by the rather dull introductory chapter, in which Kieffer dispenses some necessary definitions of disaster and places her book in context. Catastrophic surprises (such as earthquakes) or insidious change (global warming) have an obvious common denominator: in a world without people, disasters do not exist. One is reminded of graffiti scribbled in the 1960s on a wall in Cambridge, UK — “Hair needs a comb” — beneath which an undoubtedly long-haired student had scrawled “but not as much as a comb needs hair”.



The Dynamics of Disaster
SUSAN W. KIEFFER
W. W. Norton: 2013.

The book's theme is that disasters are characterized by a change of state from normal to briefly abnormal. What is intriguing is the breadth of extreme geological events that Kieffer invokes and explains, given this basic view of Earth's processes. We expect to read about earthquakes, volcanoes, cyclones, landslides and tsunamis, but lurking within these pages are some less familiar oddities — quick clay, lateral blasts, explanations of Mach numbers and rotating volcanic plumes.

It is Kieffer's gung-ho approach to the underlying mechanisms of all these extreme events that really makes this book interesting. Throughout, she invokes analogies and personal experiences to explain some of the more elusive concepts, and many that are less so. Her well-meaning comparisons are sometimes a bit odd, for instance: a tsunami taller than any mountain in Minnesota; “to

sprint eighty-six storeys up to escape this wave”; “landslides are like robbers”; and “waves are rather like teenagers”. But, as literary tools in the hands of a clever scientist, they do force the reader to grapple with the sometimes prodigious numbers involved.

Some will find the exuberant subheadings vexing. But at least lines such as “Shake, bake, zap, and glow” will grab the attention of politicians (and undergraduates who are poised to start texting in class), drawing them into the easy authority with which she explains the atmospheric features known as Hadley cells and the complexities of tsunami generation.

Kieffer is at her best when describing the fluid dynamics of the climate, atmosphere and oceans — this section is a good read for a solid-Earth scientist who wonders what all the fuss is about above ground. For example, I found her discussion of rogue waves (which may be responsible for the loss of 30 ships each year) surprisingly interesting.

On earthquakes, her explanations are a trifle misleading. Although liquefaction certainly contributes to the damage caused by earthquakes (such as those in Christchurch, New Zealand, in 2010 and 2011), its onset

MARTIN O'NEILL

NEW IN
PAPERBACK

Highlights of this
season's releases



The Future: Six Drivers of Global Change

Al Gore (Random House, 2013)

Former US vice-president and prominent voice in climate politics Al Gore tackles six areas of rapid change that are transforming our world — from the Internet and environmental crises to globalization and population growth. Gore's analyses of the scientific, political and economic aspects of each are thorough and compelling as he works towards a cautiously optimistic synthesis. (See Barbara Kiser's review: *Nature* 494, 429; 2013.)

is not instantaneous but follows minutes after the earthquake. Liquefaction in Haiti's earthquake disaster of 2010 was responsible for few fatalities, with most of the damage occurring on bedrock.

The occasional jibes at the insensitivity and ignorance of myopic politicians will raise a cheer from many readers, as will Kieffer's championing of the precautionary principle. Simply stated, it is not up to the suffering world to prove that it is suffering. More precisely, if a government sanctions actions that may be harmful to our environment, it is up to the perpetrators to prove that their deeds are harmless. The principle applies well to profitable corporations. But how does it apply to unregulated deforestation by the world's poor, or to those who drive their cars to work?

At the end of each chapter, Kieffer explores the societal implications of the disasters, the threads of which she gathers in her concluding chapter. For instance, the double disaster in L'Aquila, Italy (the fatal earthquake of 2009 and its unexpected legal consequences), raises an important issue all scientists must face — how to describe uncertainty to a public that wants a black-and-white view of the future. In Italy, government representatives have chosen the moral high ground in condemning the absence of a clearly stated probabilistic assessment of potential future seismicity. Kieffer rightly views the L'Aquila process as a wake-up call for improving tools for characterizing future disasters. In a post-Fukushima world, we cannot afford to suppress an honest discussion of low-probability extreme events. But assessing what constitutes an acceptable risk to society is currently something that scientists and present societal structures are ill-equipped to handle.

Anyone interested in the processes that underlie catastrophic events within Earth will welcome this book, part riveting and all informative. We cannot prevent disasters, but with a little bit of foresight and a lot of common sense, we can reduce their impact on our growing population. Give a copy to your local politician! ■

Roger Bilham is a professor of geology at the University of Colorado in Boulder. He has published more than 200 articles on aspects of earthquakes and their effects on society. e-mail: roger.bilham@colorado.edu



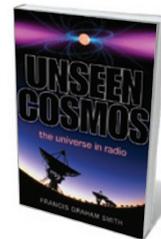
RADIO ASTRONOMY

Finger on the pulsar

Bernie Fanaroff probes a study on how radio telescopes have opened up our understanding of the Universe.

Francis Graham-Smith's *Unseen Cosmos* sets out the unique role of radio telescopes and observations at radio wavelengths in transforming our understanding of the Universe. The former UK Astronomer Royal describes the many important discoveries in radio astronomy and the techniques that made them possible. It is an extraordinary tour, from the rotating ultra-dense neutron stars known as pulsars and the cosmic microwave background left over from the Big Bang to powerful, distant radio-wave-emitting galaxies and the radio emission from molecules in galactic regions where stars are born.

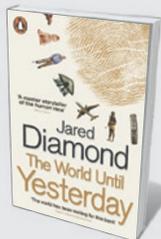
Astronomy today is a multi-wavelength discipline. Observing astronomical objects and even the structure of the Universe at wavelengths from radio waves to gamma rays allows us to see different processes and often different parts of these objects.



Unseen Cosmos: The Universe in Radio
FRANCIS GRAHAM-SMITH
Oxford University Press: 2013.

Observations in the infrared reveal cool galactic gas and dust; in the ultraviolet, hot young stars. At radio wavelengths, we spot neutral hydrogen gas and its motion, as well as synchrotron radiation (from electrons moving in a magnetic field at close to the speed of light) in galactic or intergalactic magnetic fields. X-ray telescopes detect very hot gas in and between galaxies, and optical wavelengths reveal the light from stars and ionized gas clouds. All of these data must be combined for a full understanding of objects. ▶

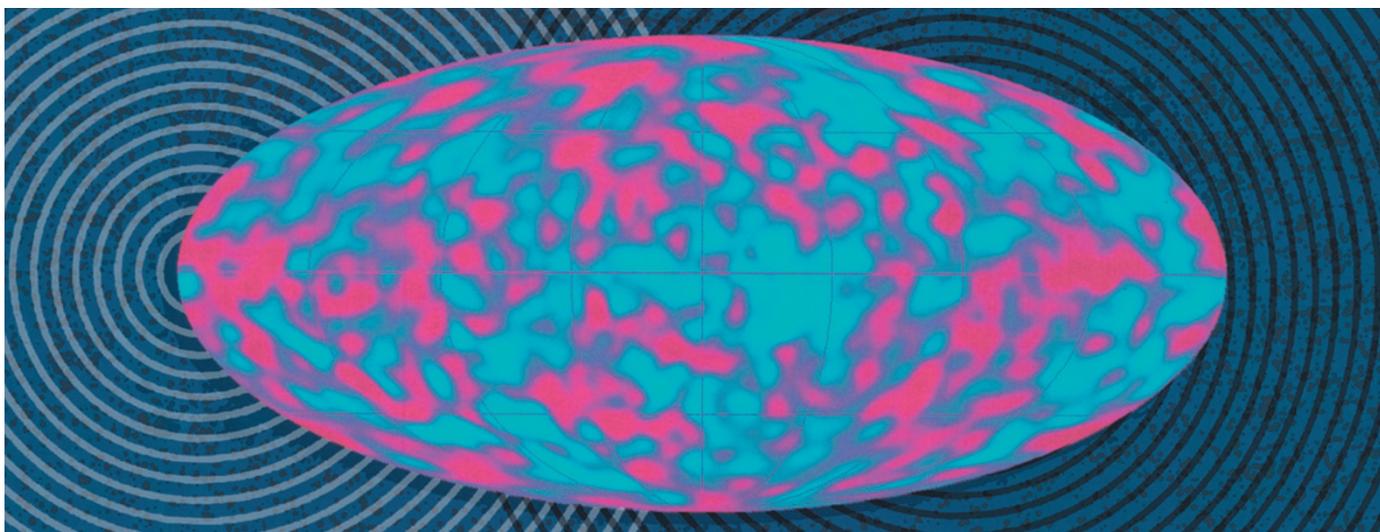
MARTIN O'NEILL; BASED ON A PHOTO BY NELLID/BIGSTOCK



The World Until Yesterday
Jared Diamond (Penguin, 2013)
The cultural gap between traditional societies and the West is a rich seam for anthropologist Jared Diamond. Here, he explores what indigenous cultures can teach the West in areas from childcare to dispute resolution. (See Monique Borgerhoff Mulder's review: *Nature* **493**, 477–478; 2013.)



The Universe Within: The Deep History of the Human Body
Neil Shubin (Vintage, 2013)
Palaeontologist Neil Shubin unpicks the intertwined evolution of Earth and life, finding intriguing links, for example, between continental break-up and mammalian evolution. (See Birger Schmitz's review: *Nature* **493**, 25; 2013.)



MARTIN O'NEILL; NASA/COBE SCIENCE WORKING GROUP

► Multi-wavelength observation is also needed because many astronomical phenomena are now known to be intimately linked. The evolution of galaxies and clusters of galaxies is a good example: there are complex, still little-understood relationships between phenomena such as radiation and jets from active galactic nuclei (AGNs, regions at galactic centres that emit vast amounts of energy, powered by supermassive black holes), accretion of gas, star formation and galaxy mergers. Observing galaxies at different epochs, stages of development and wavelengths is helping to clarify how energy is transferred between AGNs and the gas in and between galaxies, and how this affects the rate of star formation.

Against these new trends in astronomy, it is easy to forget radio astronomy's special role over the past 80 years. Graham-Smith reminds us that the existence of the Big Bang was confirmed initially by counting distant radio galaxies and radio quasars — remote, extremely luminous AGNs — and then by the discovery of the cosmic microwave background. He describes the beautiful experiments that measured the irregularities in this radiation and how they have transformed cosmology from a science based at least in part on aesthetics to one in which key parameters have been determined to an extraordinary level of precision. He details the discovery of pulsars by Jocelyn Bell and Tony Hewish and the extreme physics of

these stars. The use of rapidly rotating pulsars as clocks has allowed astronomers to probe physics in very strong gravitational fields and has repeatedly confirmed the predictions of Einstein's General Theory of Relativity.

The new radio telescopes — such as the Square Kilometre Array (SKA) to be built in southern Africa and Australia, which will be the largest ever — also open up big possibilities. We could discover how the Universe was re-ionized by the first stars and/or quasars, detect the gravitational waves predicted by Einstein and possibly even detect extraterrestrial intelligence. The SKA will be sensitive enough to see ambient radio emission (the equivalent of airport radar) from habitable planets orbiting stars in our vicinity, and is by far the most likely way to find ET.

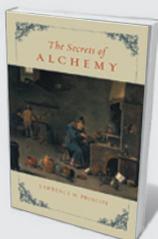
The first radio-astronomical observations were carried out by Karl Jansky and Grote Reber in the 1930s, but the key technological advances took place after the Second World War. Astronomers such as Martin Ryle, John Bolton, Bernard Lovell and Graham-Smith himself were amazingly innovative in designing and developing new instruments, such as radio interferometers. I was lucky to be a research student at the University of Cambridge, UK, from 1970 to 1974, with access to the One-Mile Telescope and 5-km Array. This was a unique opportunity — everything observed was new, exciting and publishable. *Unseen Cosmos* describes this history. And the tradition of innovation has persisted: the

technology challenges in designing and building the SKA are immense. They range from wide-field and wide-bandwidth receivers to innovative algorithms for calibrating and making images from observations. The vast data output will stretch researchers' capacity.

Although much of the history has been told before, I found *Unseen Cosmos* interesting and informative. Combining history with explanations of particular topics and their contemporary development has its limitations, however. And like most books that try to describe very complex physics in a simple way, this book succeeds in some places and not in others. I found the description of pulsars lengthy but hard to understand. I would also have welcomed more on current developments and what capabilities will be provided by the new radio telescopes, such as the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile and the SKA.

Because radio astronomy is developing rapidly, it is perhaps safer to write a book that includes a large dollop of history than to write one that could quickly become dated. Nonetheless, this book is a useful reminder of why we want to build huge, technically challenging and expensive radio telescopes like the SKA. ■

Bernie Fanaroff is the project director of South Africa's SKA project. He was Deputy Director General of President Nelson Mandela's Presidency.
e-mail: bfanaroff@ska.ac.za



The Secrets of Alchemy

Lawrence Principe (University of Chicago Press, 2013)
The practice of alchemy overlapped with the birth of chemistry, reveals Lawrence Principe in this magisterial study. He traces its trajectory from ancient Egypt through its development in the Islamic world, Latin Europe and beyond. (See Jennifer Rampling's review: *Nature* **491**, 38; 2012.)



Round About the Earth: Circumnavigation from Magellan to Orbit

Joyce E. Chaplin (Simon & Schuster, 2013)
The ultimate round trip, circumnavigation has seduced scientists and explorers for five centuries. This riveting history covers sea, land, air, space, and transport from feet to Sputnik. (See Andrew Robinson's review: *Nature* **491**, 39; 2012.)

PHYSICS

Science under the Nazis

Robert P. Crease applauds the story of three great physicists who struggled to maintain their integrity during the Third Reich.

Beware! This book is not what it seems. The subtitle suggests a black-and-white tale of good and evil, to be read in detached comfort from high moral ground. Instead, science writer Philip Ball delivers an ambiguous yet moving saga of well-intentioned people compelled to act in “the grey zone between complicity and resistance”. Its disturbing implications will leave attentive readers uneasy.

Ball follows the lives of three Nobel laureates under the Third Reich: Max Planck, Peter Debye and Werner Heisenberg. Planck was a humble member of the German intellectual elite who devoted himself to state service and, as head of the Kaiser Wilhelm Society (KWS), which promoted the natural sciences in Germany, was the titular representative of German science. Debye, a political and scientific pragmatist, was born in Maastricht, the Netherlands, but obtained nearly all his scientific training in Germany and professed himself culturally German. In 1934, he became director of the Kaiser Wilhelm Institute for Physics in Berlin. The ambitious and arrogant Heisenberg often acted as though he was the personification of German physics.

The disturbing saga begins in 1933, when Adolf Hitler was appointed Reich chancellor, paving the way for a totalitarian state. The Nazis increasingly forced Planck to use the KWS for political ends, such as by purging Jewish members — including Planck’s friend Albert Einstein. Debye was coerced into a similar situation at the Kaiser Wilhelm Institute until he left for the United States in 1939. Heisenberg was a principal architect of the German atomic-bomb project. Ball traces how the Nazis ruthlessly exploited these and other scientists by preying on personal weaknesses and political naivety — citing “Debye’s occasional self-interest and limited



Serving the Reich: The Struggle for the Soul of Physics Under Hitler

PHILIP BALL
Bodley Head: 2013.

moral engagement, Heisenberg’s insecurity and egotism, Planck’s prevarication and misconceived notion of duty” — to wheedle and compel them into actions that now look



“disturbingly compliant” at best, and utterly immoral at worst.

Yet Ball does an outstanding service by reminding us how powerful and sometimes confusing the pressures were, and how it was not implausible to think that scientists could and should stay ‘above politics’. Nazi

tyranny and genocide were unprecedented, yet aspects of their programme seemed progressive, including their welfare and health-care policies, and efforts to eliminate class differences. Moreover, the Nazi party was not monolithic, but comprised rival factions competing for Hitler’s favours throughout the Reich, and was plagued by incompetent leaders and an inept bureaucracy. Many observers, inside Germany and out, including the three physicists in question, assumed not unreasonably that the Nazis would be forced to moderate their behaviour or lose power.

For these and other reasons, Ball writes, understanding moral behaviour under the Nazis is not “a matter of simply collating the documentary evidence and totting up episodes of compliance or resistance”. He contends that we have to mine the ambiguous phrases and equivocal actions of scientists, and explore their inability to fathom their own motivations to reach a deeper understanding of their characters in a burgeoning atmosphere of paranoia and brutality.

Serving the Reich is packed with dramatic, moving and even comical moments. One is the harrowing story of Austrian-Jewish scientist Lise Meitner’s escape from Germany in 1938. Her Nazi neighbour alerted the authorities, but word failed to reach the border patrol in time. More touching is an anecdote about Planck presiding at an official function and only managing to utter the abhorrent phrase ‘Heil Hitler’ on his third attempt. And Debye, anticipating that the Nazis would refuse to let him rename a science institute after Planck, carved Planck’s name into the stone above the entrance. When ordered to remove it, Debye covered it with a wooden plank (the pun also works in German).

Ball recounts Heisenberg’s famous visit to occupied Copenhagen in September 1941, ▶

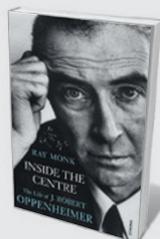
MARTIN O’NEILL



Mirror Earth: The Search for Our Planet’s Twin

Michael D. Lemonick (Bloomsbury, 2013)

Science writer Michael Lemonick explores astronomers’ interest in sister worlds. Focusing on NASA’s Kepler space telescope, this book is studded with in-depth portraits of exoplaneteers such as David Charbonneau, hunter of super-Earths. (See Sara Seager’s review: *Nature* **490**, 479; 2012.)



Inside the Centre: The Life of J. Robert Oppenheimer

Ray Monk (Vintage, 2013)

This testimony to the triumphs and foibles of J. Robert Oppenheimer is illuminating. Ray Monk follows the physicist from adolescence to his role in the construction of the first atomic bomb. (See Istvan Hargittai’s review: *Nature* **491**, 670; 2012.)

▶ where he annoyed fellow scientists with his grandiosity. His self-delusion persisted: early in 1945, after a special allied mission had raced across a collapsing Germany to apprehend him, Heisenberg arrogantly assumed that he held a powerful bargaining position and evidently failed to grasp that he was a prisoner. When he heard that the United States had dropped an atomic bomb on Hiroshima, at first he refused to believe it, claiming that some “dilettante” American had to be bluffing.

Although such scenes make *Serving the Reich* a page-turner, Ball keeps the moral and existential ambiguities at the forefront. He lets us see that for many scientists, to abandon one’s work and post — especially during such a crisis — would seem “a dereliction of duty, not a moral act of protest”. And defying the Nazis was not always an act of rebellion: Planck’s insistence on holding a memorial in 1935 on the first anniversary of the Jewish scientist Fritz Haber’s death was less a protest against anti-Semitism than an honour extended to a deceased, esteemed colleague.

But Ball has no sympathy for journalists who have bought scientists’ self-serving apologies or condemned the scientists on the basis of cherry-picked evidence. Dutch journalist Sybe Rispens’s 2006 accusation that Debye was a Nazi sympathizer, for instance, led the University of Utrecht in the Netherlands to drop the physicist’s name from its nanomaterials institute.

Ball insists that, rather than simplistically condemning or absolving the German scientists, we should look at their moral behaviour as a perpetually open question. Most daringly, he suggests that the way they coped with entanglements of science, politics and life is still representative of scientists now. By the end of this book, careful readers will be left with the queasy feeling that our own moral high ground has disappeared, and that Ball has revealed the ‘soul’ of physics to be no more intrinsically noble than any other. ■

Robert P. Crease is professor of philosophy at Stony Brook University, New York, and author of *World in the Balance*. e-mail: robert.crease@stonybrook.edu



BIOLOGY

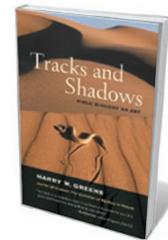
The love of pit vipers

Stuart Pimm follows a fellow biologist’s evolution from wide-eyed wonder to a life chasing snakes in the field.

I shake the hand of my fellow guide on a tour group along the Amazon. Feeling missing fingers, I blurt out, “You’re a herpetologist?” Quickly forgiving me, he names the species of snake responsible. Harry Greene, in his engaging autobiography *Tracks and Shadows*, tells us of others who have lost digits. Greene himself still has a full set. He has been lucky — and careful.

We learn much about snakes from Greene, but more about the academic lineages and personalities that shaped his field. Greene and I are academic cousins, sharing a distant academic ancestor in the form of field biologist Joseph Grinnell, who worked at the University of California, Berkeley, from 1908 until his death in 1939. The theme of Greene’s book is that the shadows cast by academic family mould our lives, but so do the species we track.

The field guide is the beginning. I vividly remember getting my first. It had to be of birds (my lifelong passion), because all Britain’s amphibians and reptiles would form a



Tracks and Shadows: Field Biology as Art
HARRY W. GREENE
University of California Press: 2013.

small volume indeed. Only in graduate school in the American West, when my taxonomic passion was set, did I meet the groundbreaking guides to America’s exceptional diversity of amphibians and reptiles by Robert Stebbins and Roger Conant. Greene flips through Conant’s pages, and I imagine him thinking, “I want

to see that one. No, that’s the one I just have to find!” And although the taxa differed, the experiences and outcomes were the same: we had to find what we saw that so intrigued us.

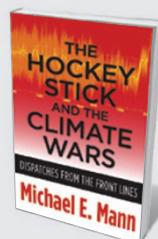
Two things follow. Soon, you are looking in places where you might find the real thing. Creeks, wetlands, woodlots and barren land — all places others might pass

MARTIN O’NEILL



The War of the Sexes: How Conflict and Cooperation Have Shaped Men and Women from Prehistory to the Present

Paul Seabright (Princeton University Press, 2013)
An economist examines animals’ tactics for ensuring reproduction, and ponders how human evolution can explain gender inequities in the West. (See John Whitfield’s review: *Nature* **484**, 317; 2012.)



The Hockey Stick and the Climate Wars: Dispatches from the Front Lines

Michael E. Mann (Columbia University Press, 2013)
Meteorologist Michael Mann recounts the attack on his seminal 1998 global warming paper. The lengths to which deniers have gone to discredit the research continue to astound. (See Simon Lewis’ review: *Nature* **483**, 402–403; 2012.)



without notice — become magical when one thinks they might hold desired species. Here, my path diverges from Greene's. I have never wished to turn over old planks to find rattlesnakes, to have my heart race as I pick up a cottonmouth, or to have to conceal being bitten by a copperhead from my parents.

The second discovery is that there are people just like you, with the same eccentricities, whose mentoring is vital. Greene writes a deeply respectful chapter about the herpetologist Henry Fitch, whom he met shortly after finishing high school. The sheer joy of learning more about natural history becomes an obsession, and mentors such as Fitch prove that it can be life-long. It carried Greene through an early job as a mortician's assistant, then the unavoidable Vietnam War years. As a medic, he looked after people battered and disabled by the conflict and contemplated his own imminent departure for battle. Sightings of whip-tailed lizards and black-tailed rattlesnakes near the training hospital provided welcome distractions. Seven of his colleagues were then posted to Vietnam and their fates still haunt him; he was posted to Germany.

After military service, graduate school was the University of Tennessee with a superb set of professors who, soon after Greene left, became my colleagues for 17 years. Greene's adviser, Gordon Burghardt, challenged him to think like a snake. "What are the *private*

experiences of animals?" Burghardt asks.

For the next two decades, Greene was at Berkeley, where he inherited Grinnell's desk. In those decades, technology made thinking like a snake easier. Radio transmitters revolutionized snake biology by allowing access to their secret lives.

Greene radio tracked rattlesnakes in deserts and bushmasters in rainforests, understanding what exceptional predators they are. We tend to view lions and tigers as

TRACKS AND SHADOWS IS AS PACKED WITH PEOPLE AND DRAMA AS A NOVEL.

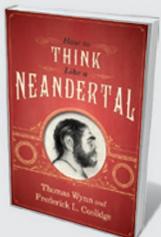
iconic hunters. Snakes, especially poisonous ones, are very different. They may sit and wait, catching prey only three to five times each year, yet must be ready to strike in a fraction of a second. Then, remarkably, they must use their tongue to sense the scent trail along which the fatally poisoned victim is fleeing. Digestion can take a week or more.

Sex is different too. Jesús Rivas, another of Burghardt's students, found his green

anacondas by feeling for them with his bare feet in the muck of the Venezuelan Llanos, a tropical grassland. Think like an anaconda: males are much smaller than the females. "Imagine lying for hours in ... a tropical slough, among a dozen seven-foot suitors for an eighteen-foot female, entangling your muscular, scaly tail with others competing for her vent." Males may need to be large enough to compete, but not so large as to be mistaken for a female, he explains.

Tracks and Shadows is as packed with people and drama as a novel, as Greene ventures forth with friends and revered mentors, records marriages and divorces, happiness and tragedies — some via snakebites — all uniquely wrapped in his herpetologist's world. As the 'art' in the subtitle indicates, he sees similarities between the immersive work of field biology and the worlds of the Amerindian rock artists of Texas and the painters of the caves at Chauvet in France — ancients who suffered life's vagaries in direct connection to the living world. Animals dominate as images. Modernity separates most of us from that life, but not so field biologists. ■

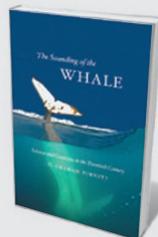
Stuart Pimm is professor of conservation at the Nicholas School of the Environment, Duke University, Durham, North Carolina, USA, and author of *The World According to Pimm: a Scientist Audits the Earth*. e-mail: stuartpimm@me.com



How to Think Like a Neandertal

Thomas Wynn and Frederick L. Coolidge (Oxford University Press, 2013)

This study of mental similarities between *Homo sapiens* and Neandertals suggests that the powerful early humans had language, attended to their dead — and might have appreciated slapstick. (See Clive Gamble's review: *Nature* **479**, 294–295; 2011.)



The Sounding of the Whale: Science and Cetaceans in the Twentieth Century

D. Graham Burnett (University of Chicago Press, 2013)

Sobering insights abound in a history of cetacean science that powerfully reflects the mixed human response to Earth's largest mammal. (See Philip Hoare's review: *Nature* **481**, 141–142; 2012.)

ECONOMICS

Fixing the climate odds

Gail Whiteman welcomes a take on climate economics that is strong on strategy.

The power of intelligent economics permeates William Nordhaus's *The Climate Casino*. In it, he presents an overview of climate science, economic theory and modelling, and outlines a number of economic strategies to resolve our climate challenges. He argues that economic growth is driving "unintended but perilous changes in the climate and earth systems" — and that we are, effectively, "rolling the climatic dice".

Not all may agree with this metaphor. But for US audiences in particular, the book convincingly makes the economic case for changing governmental policy, and our production and consumption habits, by offering economic incentives for low-carbon choices. The market alone cannot account for externalities stemming from climate change, such as ocean acidification, without being prodded by measures such as carbon taxes.

More debatable is what Nordhaus says about keeping the maximum global average temperature to 2°C above pre-industrial levels — a target of the Copenhagen Accord, the political compromise resulting from the 2009 United Nations Climate Change conference. Nordhaus views this goal as primarily political, and not well grounded in natural science, although numerous climate studies do support it. He suggests instead a rise of just under 3°C, as the review by Timothy M. Lenton and colleagues (T. M. Lenton *et al. Proc. Natl Acad. Sci. USA* **105**, 1786–1793; 2008) indicates that below it, large-scale tipping points such as widespread dieback in the Amazonian rainforest are unlikely.

But Nordhaus misses the point here. There is more to threshold setting than the avoidance of isolated tipping points. For example, the "planetary boundaries" model of Johan Rockström and others defines a "safe operating space" for humanity by pinpointing nine interlinked boundaries in Earth systems beyond which irreversible damage occurs (J. Rockström *et al. Ecol. Soc.* **14**, 32; 2009).



The Climate Casino: Risk, Uncertainty, and Economics for a Warming World
WILLIAM NORDHAUS
Yale University Press: 2013.

Although Nordhaus acknowledges this model's importance, he does not sufficiently integrate its range of critical boundaries into his own.

Nordhaus usefully differentiates between managed and unmanageable risks of climate impacts, underscoring the urgent need to prevent economies from triggering unmanageable risks from biodiversity loss,

for example. It is unfortunate, however, that the book's timing precludes the inclusion of reports by the Intergovernmental Panel on Climate Change Working Groups I and II (released last month and due in March 2014, respectively), as these would strengthen the chapters on climate science and impacts.

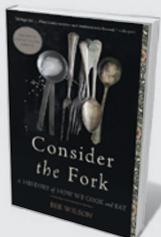
In his discussions on the strategies, costs, policies and institutions involved in slowing climate change, Nordhaus relies on his own integrated economic and geophysical model of climate-change economics, DICE (Dynamic Integrated model of Climate and the Economy). He offers a convincing comparison of carbon tax and cap-and-trade options, concluding that both are equally useful. And he argues strongly for a carbon price of US\$25 per tonne, using a 4% discount rate to bring future costs back to present-day dollars. However, other analysts support a much higher price for carbon and a lower discount rate, such as the one used in Nicholas Stern's groundbreaking 2006 review *Economics of Climate Change*. Nordhaus concludes: "We should aim for a lower temperature target if it is inexpensive, but we might have to live with a higher target if costs are high or policies are ineffective." Although

he is sensitive to the normative judgements of others, he does not perceive any normative sentiment in his own work.

Nordhaus's impassioned review of the politics around government (in)action on climate change and climate scepticism is largely US-centric. A more detailed analysis of the dramatic drop in European carbon prices in April 2012, following a decision by the European Parliament, would be welcome, for instance. What is interesting for all of us is Nordhaus's emphatic re-confirmation that his research using DICE does not support the position of climate sceptics, despite its use by some of these camps to argue that because climate change has economic benefits, there is no need to curb it.

Nordhaus is right in saying that economic incentives facilitate and encourage low-carbon behaviour. But managing climate change demands more. Markets are influenced by regulations and changes in accounting and valuation techniques that determine new rules of the game. The question of how best to deal with the thorny issue of stranded assets — obsolete or overvalued assets such as non-viable coal plants — remains unanswered in this book. Another missed opportunity is a deeper engagement with management theory, which has empirically shown that corporate behaviour across various industry sectors is driven by values, biases, emotions, culture and hyper-competitiveness as well as the pursuit of profit. Without delving deeper into corporate boardrooms, we are left wondering where change will come from if governments, as the architects of global policy frameworks, remain deadlocked. ■

Gail Whiteman is professor-in-residence at the World Business Council for Sustainable Development in Geneva, Switzerland, and is Chair in Sustainability and Climate Change at Erasmus University, the Netherlands.
e-mail: gwhiteman@rsm.nl



Consider the Fork: A History of How We Cook and Eat

Bee Wilson (Basic Books, 2013)

Food historian Bee Wilson looks at how need sparks culinary innovation. She reveals, for instance, that China's lack of firewood led to the ultimate 'fast food' technique, stir-frying. (See Barbara Ketcham Wheaton's review: *Nature* **489**, 500; 2012.)



Big Data: A Revolution That Will Transform How We Live, Work and Think

Viktor Mayer-Schönberger and Kenneth Cukier (John Murray Publishers, 2013)

Big data is key to numerous fields and social-networking sites. Among many case studies, the authors contend that Google Flu Trends monitors influenza's spread better than traditional systems.

MARTIN O'NEILL: IMAGE OF AL-BIRUNI; QINGWA/ISTOCK. ILLUSTRATION OF MOON PHASES BY AL-BIRUNI
REPRODUCED COURTESY OF SEYED HOSSEIN NASRY WORLD OF ISLAM FESTIVAL PUBLISHING COMPANY



HISTORY OF SCIENCE

Science spun on the Silk Road

Christopher I. Beckwith assesses a study probing Central Asia's pivotal role in Islam's golden age.

Between Europe, the Near East, South Asia and East Asia lies a shockingly poor and underdeveloped region. But Central Asia — comprised mainly of Afghanistan, Uzbekistan, Turkmenistan, Tajikistan and East Turkistan (now Xinjiang) — was pivotal in pre-modern world history and cultural development, including science. Mathematician and astronomer al-Khwārizmī, for instance, systematized algebra, introduced decimal system mathematics and lent his name to algorithms (his Latinized name is Algorithmus). As Frederick Starr shows in *Lost Enlightenment*, Central Asia was a glittering, populous, wealthy world of advanced urban civilization in the mid-seventh century, when the first Arab armies reached Merv and Balkh, the “mother of cities”, in what are now,

respectively, Turkmenistan and Afghanistan.

Over the following decades, their armies crossed the Amu Darya (Oxus River) to Bukhara, Samarkand and Khwarizm. Less than two centuries later, the scholars of this region were mostly Muslim. They dominated the intellectual life of the entire Islamic world, stretching from Spain to India, and made fundamental contributions to the natural sciences, medicine, philosophy, music and literature. The philosopher al-Fārābī's *Great Book on Music*, for instance, became, as Starr writes, “the foundation stone of Western musicology”. And Western medicine was dominated until a few centuries ago by the works of al-Rāzī (Rhazes), the greatest clinical physician until early modern times, who was the first to precisely describe smallpox.

Starr argues rightly that the region's

brilliant culture rested on a highly cosmopolitan mix of ethnic groups, languages and religions; a long, rich pre-Islamic intellectual tradition (mainly Buddhist); and prosperity. That prosperity was built primarily on high-tech hydraulic engineering: Central Asians developed nine kinds of machinery for irrigation, drinking water and public baths. Soon after 1100 AD, the enlightenment waned under attacks on “reason and logic” led by the Sufi ex-philosopher al-Ghazālī.

At that point, medieval Western Europeans acquired science from the neighbouring Islamic world. They joined science to other Central Asian borrowings that institutionalized it and provided it with a formal scientific method that enabled it to survive and grow in Europe while science was dying in the Islamic world.

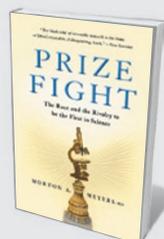
It is increasingly recognized that many of the greatest scientists, philosophers, poets and artists of the Islamic golden age were from Central Asia. A few of their works have been studied or translated, such as al-Birūnī's famous ethnography of India. But Starr's book is the first to identify the leading lights of that age as Central Asians, place them squarely in Central Asia, and detail their accomplishments.

During the region's three centuries of world intellectual leadership, the dominant literary language was classical Arabic (except in East Turkistan, which became Islamic later). However, this was not due to the Arabs destroying Khwarizm's libraries, a claim repeated by Starr but shown by Wilhelm Barthold in 1928 to be folklore.

In most of the world before the seventh century, people simply did not write much. Under the Arabs, the writing bug caught on and books in Arabic, and bookshops, became widespread in Central Asia. Starr relates how in the eleventh century, Ibn Sīnā (Avicenna) was chased down the street by a bookseller in Bukhara, eager to offer a bargain on an insightful ▶



Lost Enlightenment: Central Asia's Golden Age from the Arab Conquest to Tamerlane
S. FREDERICK STARR
Princeton University Press: 2013.



Prize Fight: The Race and the Rivalry to be the First in Science

Morton A. Meyers (Palgrave Macmillan, 2013)
A burning urge for discovery is often allied to a burning ambition for a Nobel. Among the cases here is that of Albert Schatz, who found streptomycin in 1943 but saw the prize go to his supervisor. (See Hidde Ploegh's review: *Nature* **486**, 318–319; 2012.)



Gravity's Engines

Caleb Scharf (*Scientific American*, 2013)
Astrobiologist Caleb Scharf investigates black holes — regions of space-time that pull in matter and light. He shows how those in galactic centres gobble stars, belch out plasma, and are the most efficient energy generators in the cosmos. (See Mario Livio's review: *Nature* **488**, 278; 2012.)

► volume about Aristotle's *Metaphysics* by the philosopher al-Fārābī. Ibn Sīnā later wrote many great works, including one of the most influential natural-science texts of the central Middle Ages, *De Visu* (*Optics*). This was translated into Latin in mid-twelfth century Toledo, Spain, by the Jewish philosopher Abraham ibn Daud and Dominicus Gundisalvi.

Linguistic unification by the Arabs meant that the flourishing of science and philosophy under Islam took place almost entirely in Arabic, as Starr suggests. Unfortunately, Starr uses his coinage “Persianate” throughout to refer specifically to the non-Persian peoples of Central Asia, making it sound as if the entire area was somehow “Persian” in language and culture. It was not. Persians, from what is now Iran, were conspicuously absent until the golden age was largely over, as Starr notes.

By calling his book *Lost Enlightenment*, Starr courageously rejects claims that there was no decline of Islamic civilization. He does, however, ignore recent work that explodes myths about Eurasian steppe peoples being aggressors, and even obliquely suggests that Chinggis Khan “attempted genocide” of Central Asians. Nevertheless, Starr firmly rejects the theory that the Mongols triggered the intellectual collapse. That, he writes, had happened a century before the Mongol conquest; at that time, taxes and trade were still “pouring gold into the coffers” of Central Asian rulers, who simply stopped using the money to support intellectual life. And after losing a great war — the Mongol ‘invasion’ (which historical sources agree the Khwarizmians started) — they failed to completely rebuild.

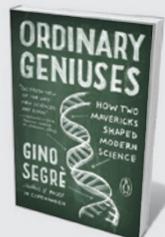
Starr shines in his core chapters, where he presents the great achievements of the Central Asian philosopher–scientists at a time when their homeland was the creative intellectual capital of the world. ■

Christopher I. Beckwith is professor of Central Eurasian studies at Indiana University, Bloomington, and author of *Warriors of the Cloisters: The Central Asian Origins of Science in the Medieval World*.
e-mail: beckwith@indiana.edu

PSYCHIATRY

America the traumatized

Andrea Tone assesses a history of the mass release of US psychiatric patients into an uncertain future.



Ordinary Geniuses: How Two Mavericks Shaped Modern Science

Gino Segre (Penguin, 2013)

In these intertwined stories of cosmologist George Gamow and biologist Max Delbrück, we see how Gamow explained the creation of hydrogen and helium in the Big Bang, and Delbrück's study of bacterial viruses opened a new approach to genetics.



Memory: Fragments of a Modern History

Alison Winter (University of Chicago Press, 2013)

A subtly nuanced cultural and scientific history of our ‘recording mechanism’. Alison Winter reveals how memory has been tested variously in ‘labs’ like the courtroom, where phenomena such as false-memory syndrome have emerged. (See Barbara Kiser's review: *Nature* **479**, 475; 2011.)

In *American Psychosis*, E. Fuller Torrey turns to the past to determine why the United States has failed to care for the seriously mentally ill since de-institutionalization began in the mid-1950s. Between 1955 and 1969 alone, more than 220,000 patients were discharged from public psychiatric asylums. The scale of the problem this process has unfurled is visible today in parks, subway stations and emergency rooms where the under- and untreated go, partly because there are no other places for them. This serious issue deserves a one-two punch of compassion and political action.

Torrey, a psychiatrist, focuses on the federalization of mental-health care that began after the Second World War, when the National Institute of Mental Health was established (in 1946), federal grants were given to advance neuropsychiatric research, and outpatient community health centres were set up through the Community Mental Health Act of 1963. The number of beds in state-run institutions decreased as new medications, such as chlorpromazine (which contained the symptoms of illnesses such as schizophrenia), became available, and as families, politicians and activists sought to support patients outside the asylum. Torrey contends that this shift continues to fail psychiatric patients and that the state 'system' that federalization ostensibly usurped would have done better. He also argues that the Kennedy family, which has produced so many prominent US politicians, had a key role in this story.

Torrey begins his tendentious tale with Joseph P. Kennedy (1888–1969), businessman, social climber, diplomat and head of the clan. Torrey pinpoints what he regards as Kennedy's most serious failing: the decision to lobotomize his daughter Rosemary in 1941, after what was referred to as mild retardation became a major psychiatric disorder. According to Torrey, "mental retardation had been a family disgrace, but mental illness would be a debacle".

The result of that decision, Torrey argues, was a disaster for the future of the nation's mentally ill, not just for Rosemary. As he sees it, guilt over her lobotomy set the agenda of the family's political legacy, becoming "a family sin that demanded expiation". Decades later, in 1963, Joseph's son, President

John F. Kennedy, signed legislation to continue federalization with the establishment of publicly funded community mental-health centres. According to Torrey, by the end of 1976, 548 centres were running and almost 200 more had been funded. These, Kennedy stated in a speech to Congress, would spare the mentally ill the "cold mercy of custodial isolation" in state asylums. Torrey, however, avers that the centres were a flawed approach, based on the belief that serious psychiatric illnesses could be prevented or managed in outpatient centres.

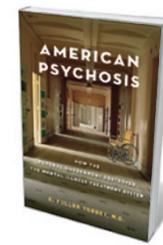
I disagree with much of this argument. First, the United States never had what Torrey refers to as a singular mental-illness treatment system. In the 1940s, it was just a maze of unevenly funded state public asylums. Their overcrowding, understaffing and often filthy conditions, and their cost to taxpayers drew public criticism and provided the impetus for political reform.

As historians have shown, lobotomies were a treatment of last resort, propelled by therapeutic nihilism, abominable conditions and the hope invested in new, radical, therapies. Fear that admission into a state institution might portend a life sentence of custodial care prompted families to authorize at least 20,000 lobotomies in the United

LOBOTOMIES WERE A TREATMENT OF LAST RESORT.

States between 1936 and the mid-1950s. To assert, as Torrey does, that if the federal government had not become involved, state hospitals would perhaps have provided something better, romanticizes what did not happen, while discounting the disturbing history that prompted federal intervention.

Also missing is a discussion of the influence of private hospitals on the demographics of psychiatric treatment since the mid-1950s. The affluent can access the best treatment; the poor are denied it. And by the 1960s and 1970s, as Jonathan Metzl's book, *The Protest Psychosis* (Beacon Press, 2010) shows, public



American Psychosis: How the Federal Government Destroyed the Mental Illness Treatment System
E. FULLER TORREY
Oxford University Press: 2013.

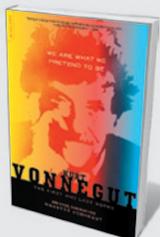
psychiatric hospitals were not a panacea, especially for African-American male patients, who came to represent a majority in many hospitals and whose treatment reflected racist views. Torrey also fails to discuss how the advent in the 1970s of private health plans provided by health maintenance organizations (HMOs) further impeded access to quality psychiatric care by offering financial incentives

to primary physicians to reduce referrals to specialists. HMOs and programmes to reduce health costs cemented a pattern that began in the 1950s. Now, increasingly, GPs make most front-line psychiatric diagnoses.

Torrey also ignores how a seismic shift in emerging psychiatric disorders, such as social phobia, has restructured psychiatric care. As less serious mental-health disorders such as mild depression became the therapeutic domain of psychiatry, such outpatient treatment claimed a larger part of psychiatrists' time, leaving less time and fewer institutions for patients battling serious illnesses with different needs.

In my opinion, *American Psychosis* fails to deliver a compelling explanation for the United States' present predicament, bogged down as it is in a tangle of initiatives — community, state and federal, public and private, medical and non-medical — and people in need. The book is nonetheless timely. It reminds us of the urgency of this problem and the need for fresh solutions to galvanize change. As Torrey contends, like President Kennedy before him, the nation's sick and most vulnerable citizens deserve better. ■

Andrea Tone is the Canada Research Chair in the Social History of Medicine in the Departments of History and Classical Studies, and Social Studies of Medicine at McGill University, and the author of *The Age of Anxiety*.
e-mail: andrea.tone@mcgill.ca



We Are What We Pretend To Be: The First and Last Works

Kurt Vonnegut (Vanguard Press, 2013)
The fiction of trained chemist Kurt Vonnegut touches on themes of societal ignorance and anti-authoritarianism. In this posthumous collection, Vonnegut's first and last pieces of fiction are pervaded by his trademark dark humour.



The Techno-Human Condition

Braden R. Allenby and Daniel Sarewitz (The MIT Press, 2013)

Technology is progressing so rapidly that we may be unable to fully prepare for it. This insightful take on a tangled issue points to the looming possibility of technological evolution outpacing human intent.