evidence that the recent debunking of them as a nationalist myth has gone too far. His chief input to the Britishness debate is that biologically and culturally, the Anglo-Saxons were not the first English nation.

Bryan Sykes agrees. In *Blood of the Isles*, a shorter and less well-illustrated volume supported by a website, he reports on the Oxford Genetic Atlas Project. The added interest is his account of racist scientists such as Robert Knox, who distinguished between the hard-working Anglo-Saxons and the indolent Celts on the basis of hair colour and head size. Sykes is particularly good at demolishing these repugnant myths with his genetic data, although I was alarmed by his impudent claim that "my art is oblivious to the prejudice of the human mind". Historical genetics is just as much an interpretation for its time as the shape of skulls was in the nineteenth century.

So, where does all this leave Britishness? As Sykes says, "this really is the history of the people, by the people". We carry our past in our genes and, as Oppenheimer shows, if we are looking for that common ground where science and education meet, then it was 15,000 years ago when small groups of highly mobile hunters entered a postglacial wasteland. Getting there first, rather than in large numbers, is the key to the dominance of these founders in our British genes, and this applies to both women (mitochondrial DNA) and men (Y chromosome). Gordon Brown's Britishness needs to be extended back by at least 13,000 years from the familiar world of Celts and Romans to consider those who contributed most to our common heritage. A further 700,000 years needs to be added if we are to understand the full evolutionary picture.

And what is the policy implication? This concerns an overhaul of the UK national curriculum, where presently the debate on British identity starts with the Middle Ages. As a result, education is being denied access to scientific progress.

These three books show why we can no longer ignore our earliest ancestry in deciding who the British think they are. It is time to celebrate those first economic migrants, because that is who we are. ■

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Treasure islands

H. & J. ERIKSEN

The Socotra islands, in the Arabian Sea off the Horn of Africa, are home to many plant and animal species found nowhere else, including the Socotra sunbird shown here. First settled by man several thousand years ago, this unique environment is populated by a small group of fishers and pastoralists. In 2003, Socotra became a UNESCO Man and Biosphere Reserve. *Socotra: A Natural History of the Islands and their People* by Catherine Cheung and Lyndon DeVantier (Socotra Conservation Fund/Odyssey, £39.50) is the first full natural history of the flora, fauna and people of these islands.

A physics travelogue

From Clockwork to Crapshoot: A History of Physics
by Roger G. Newton
Belknap Press: 2007. 352 pp. $29.95, £19.95, €27.70

David Lindley

If you have just an afternoon to spare for your first visit to the British Museum in London, you have a choice to make. You can trot smartly up and down the corridors, trying to glimpse as many items as possible, or you can choose to linger thoughtfully in a handful of rooms, hoping to absorb a sense of the entire collection's scope. In his role as tour guide to the complete history of physics, Roger Newton seems to have had trouble deciding which strategy to adopt. Sometimes he pauses to reflect on the meaning and significance of the most crucial exhibits; at other times he seems determined to march briskly down the centuries, ticking off names and discoveries great and small with bewildering haste. As a result, the truly interesting perspectives that he points out along the way get lost in the confusion.

From Clockwork to Crapshoot begins by defending Aristotle against the bad press he sometimes gets in histories of science. While Plato mused abstractly about the ideal nature of things, Aristotle turned his attention to the 'efficient causes' of empirical phenomena — meaning, in a nutshell, that if something happens, there must be something else that makes it happen. That is a modern philosophy of science, but in his specifics, Aristotle was mostly wrong. It was medieval scholars, rediscovering Aristotle from Arab writers, who treated his writings as a revealed truth, insisting on scrupulous adherence to his incorrect explanations but failing to grasp his style of reasoning.

After dropping in on Roger Bacon, William of Ockham and Nicole Oresme, we're onto Copernicus, Galileo, Kepler and Newton — the beginning of science as we now understand the term. This is familiar territory, and although the author's travelogue is fluent and intelligent, the narrative interest starts to flag. With the basic method of science settled, the story is one of advancing enlightenment on many fronts, and our guide is determined to give at least a brief wave to everyone who contributed. Taken individually, his sketches of Laplace, d'Alembert and Gauss, of Henry, Faraday and Maxwell, and of Rumford, Joule and Clausius, are engaging enough. Thrown at the reader one after the other, they become rather wearisome.

The story picks up again when the author tackles the emergence of statistical mechanics and then quantum mechanics. As the book's title suggests, the evolution away from strict determinism into a world governed by laws of probability marked a tectonic shift in the foundations of science. Quantum theory raised questions about the meaning of physical reality that remain unresolved today. And of late, Roger Newton suggests, Plato is staging a comeback against Aristotle. Now that we have a pretty good understanding of how electrons and other particles behave, we are returning, in attempts to find a 'theory of everything', to the deeper problem of understanding why these particles exist, and what determines their qualities.

The author is most compelling when he tackles these broad historical trends in the scope and purpose of physical theorizing. But these large themes only occasionally come to the fore. It is also unclear what kind of reader he imagines he's writing for. Discussing the emergence of quantum mechanics, for example, he observes in passing that Dirac's formulation derived more from the poissonian than the hamiltonian version of classical mechanics, a remark that will mean something only to those who already know what it means.

Readers with some general knowledge of the development of physics will find in Roger Newton a companionable guide who points out familiar and vaguely remembered landmarks and offers occasional illuminating commentary. If his aim was to enlighten a less well-versed audience, he could have said more by saying less. ■

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On the right path

The Best of All Possible Worlds: Mathematics and Destiny
by Ivar Ekeland
Chicago University Press: 2006. 191 pp. $25

Joseph Mazur

Thomas Aquinas argued that evil helps the good in the world. St Augustine maintained that God brought evil into the Universe to bring about a greater good. And Gottfried Leibniz, after confessing in his *Theodicy* that God was free to create a world without evil, asserted that the best plan for a Universe is "not always that which seeks to avoid evil, since it may happen that the evil is accompanied by a greater good". He concluded that of all the worlds God could have created, the one we live in is "the best of all possible". We remember this phrase best through *Candide*, Voltaire's satire of Leibniz's philosophy: "If this is the best of possible worlds," asks Dr Pangloss, Candide's teacher, "what then are the others?"

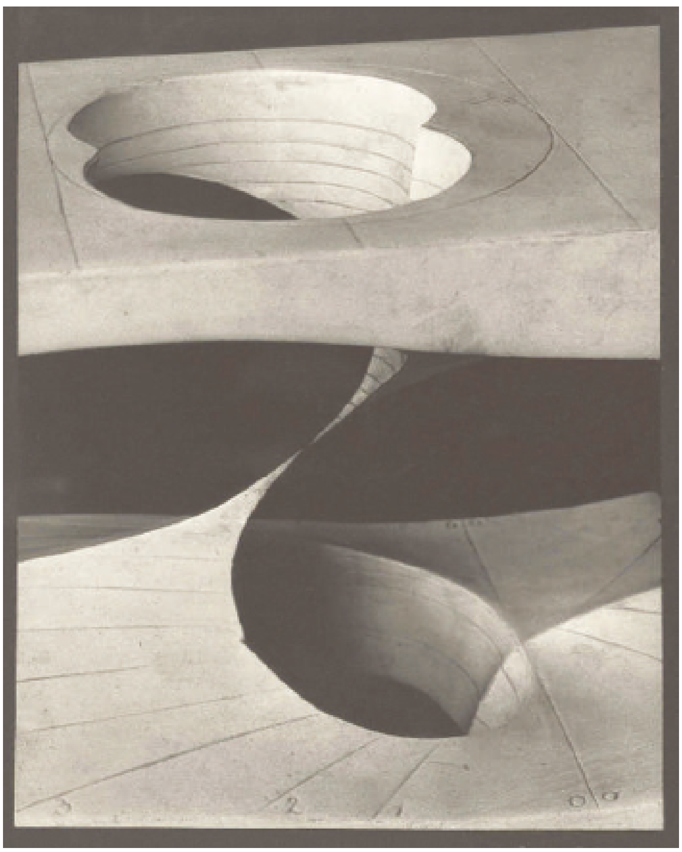
How much evil is needed to maximize good? It seems that God has chosen one world from an infinite collection of possibilities by seeking to minimize evil under the constraint of maximizing good. The eighteenth-century French philosopher Pierre-Louis Moreau de Maupertuis gave us the principle of least action: in all natural phenomena, a quantity called 'action' — for him, the product of mass, distance travelled and velocity — tends to be minimized. In his view, God, being the supreme mathematician, had created the "best of all possible worlds" by insisting that everything in it obey the principle of least action, an economy of effort — a metaphysical rule designed to support the laws of mechanics.

In *The Best of All Possible Worlds*, Ivar Ekeland skilfully traces the historical developments of de Maupertuis' principle as it matured from a metaphysical directive in physical two- or three-dimensional space to a mathematical principle in a conceptual space where the action is not just minimized but stopped altogether. He then tracks it further to our modern notions of randomness measured by probabilities. This complex story can be read with a minimum of effort, and we are left feeling that Maupertuis' principle works, even though we know that randomness is hardly compatible with minimizing actions. Ekeland — a distinguished mathematician and director of the Pacific Institute for Mathematical Sciences in Vancouver — goes on to say: "If there is a God, he has left no tracks in the laws of physics; or if he has, he has covered them up very well."

The real question behind Ekeland's magnificent book is this: how does nature do it? Of all the possible actions, from travelling photons to rolling billiard balls, how does nature choose what path to follow? You are reading a book review of Ivar Ekeland's *The Best of All Possible Worlds*, but how did you get to be reading it at this precise moment and in this place? Was it a dictate of nature that led to this action? Was it the perturbations caused by the proverbial butterfly flapping its wings over the Pacific? Did nature have some purpose in making you read it?

Ekeland says 'no' to all three questions. Yes, some mechanical systems are modelled by criteria of optimizing performance that could be interpreted as minimizing some kind of action or energy. But most mechanical systems of the world are unpredictable. "Since classical mechanics has dealt exclusively with integrable systems for so many years, we have been left with wrong ideas about causality," writes Ekeland; we have ignored non-integrable systems — those that do not admit exact solutions to differential equations. World events are not linear. History does not follows parallel causal chains; each event "is like the trunk of a tree, plunging a network of roots deep into the past, and raising a crown of branches high into the future". Ekeland refutes Blaise Pascal's remark that if Cleopatra had a shorter nose, the world would be very different.

Ekeland competently weaves the philosophical views of scientists through the warp of metaphysics dealing with nature's directives. We hear how Ernst Mach believed that the role of science is to explain the facts as accurately and simply as possible, and how Henri Poincaré believed that science is not really about objective reality or truth, but rather the ease and expediency of human comprehension. Over the weave, Ekeland embroiders some lively anecdotes involving illustrious individuals and great historical moments, ranging from the Peloponnesian Wars and Venetian concessions to the Hapsburg emperor Maximilian to Darwin's voyage to the Galapagos. His explanations are clear and elegant, in the brilliant, effortless manner of Richard Feynman, and his prose is fluid, exhilarating and suspenseful. I tried to put this superb book down after chapter 4 but couldn't. It was as if some compelling force of nature had a purpose, an opposing directive in the best of all possible worlds. ■



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