GEOSTILLS/ALAMY

The Panamanian golden frog (*Atelopus zeteki*) is among thousands of species that have become critically endangered.

ENVIRONMENTAL SCIENCES

The long goodbye

A study of Earth's declining biodiversity deftly traces patterns and processes, finds **Bob Bloomfield**.

On page one of chapter one of Elizabeth Kolbert's *The Sixth Extinction,* the golden frogs of Panama are described as "taxicab yellow". Later, miles, acres and degrees Fahrenheit are mentioned. Coming as I do from a country that uses the International System of Units, and where cabs are blacker than the European starlings that Kolbert tells us have invaded her native New York, I began to wonder. But in the event, this is a truly global exploration of mass extinction.

Kolbert's 'hook' is a dramatic decline in biodiversity that has already begun and will inevitably accelerate over the coming decades. Her scope, however, is a wider synthesis of what we know about extinction. Kolbert intertwines her narrative with visits to the field sites and laboratories of leading scientists, which reveal the unfolding calamity. At a remote research station on Australia's Great Barrier Reef, for instance, she meets Ken Caldiera, who she says is credited with coining the term ocean acidification. And in the Manú National Park in Peru, she explores Miles Silman's altitudinal transects of a forest already responding to climate change. Each of the book's 13 chapters uses an emblematic species studied by these scientists as a springboard for the discussion, although she has rightly drawn evidence from a much wider range.

Kolbert begins with the concept of extinction itself, which emerged in the eighteenth century. Until then, the belief that species were divinely created precluded the idea that they could be irretrievably lost. The realization that fossil deposits contained the remains of long-extinguished species arose amid a growing clash of ideas. Catastrophism, the brainchild of naturalist Georges Cuvier, allowed for revolutionary loss of fauna and flora, but did not provide an evolutionary explanation for their replacement. Uniformitarianism, the concept of gradual, imperceptible geological change favoured by Charles Lyell, extended to Charles Darwin's explanation of evolution by means of natural selection — but sat uncomfortably with the idea of sudden, cataclysmic events.

The Sixth Extinction — An Unnatural History
ELIZABETH KOLBERT
Henry Holt: 2014.

Kolbert explores the five mass extinctions that punctuate the story of life on Earth, deftly exploring the principal evidence of probable causes. She begins with the Cretaceous–Palaeogene boundary event 66 million years ago, and the controversial theory posited by theoretical physicist Luis Alvarez and his geologist son Walter that a meteor impact destroyed the ruling reptiles, making way for the rise of small mammals. For the Ordovician–Silurian mass extinction 444 million years ago, Kolbert looks at a possible cocktail of effects that triggered the loss of 85% of marine life. Was it the absorption of carbon dioxide by the first land plants that plunged Earth into an ice-house glaciation? The resulting ocean shrinkage, falling temperatures and increase in oxygen-altering marine chemistry would have devastated life.

Next, she examines the ecological consequences of human activity over the 40,000 years since the loss of Australia's megafauna. She points to the unprecedented scale and pace of our impacts from prehistory to today, including the appropriation of fossil fuels and the conversion of forests and other ecological systems, driven by demand for food and commodities. These will leave indelible traces — hence the

growing scientific consensus that we live in a new geological epoch, the Anthropocene. Kolbert drills into the mechanisms through which climate change, ocean acidity, ecological fragmentation and the movement of alien species are catastrophically acting on many populations. Those alien invasions are leading to what has been called a new Pangaea: just like on that supercontinent 300 million years ago, biodiversity is mixing — but this time it is causing a reduction in species.

Kolbert's romp through these themes is necessarily selective, and some may take issue with aspects of her concise narrative. For example, Darwin did dismiss the sudden loss of species across boundaries between geological epochs as vast periods lost in an incomplete fossil record. But it seems somewhat disingenuous to implicate him in something that happened a century later: the resistance to the meteor-impact idea by George Gaylord Simpson and other palaeontologists of the hard-nosed uniformitarian tradition. Had Darwin been there, he would, I think, have based his response on evidence rather than dogma. As Kolbert herself summarizes, mass-extinction events occur on a grander scale than the inexorable chipping away of Darwin's 10,000 sharp wedges of nature. The Alvarezes pointed to a clear mechanism by which well-adapted organisms were swept aside and the pattern of life-forms upon which natural selection could act reset.

The Sixth Extinction lucidly introduces the context and process underlying the current doom-laden prognosis for life on Earth. In the penultimate chapter, Kolbert writes of the search for the bits of genetic code that endow humans with our unique restlessness, use of symbols, creativity and ability to work socially. We may be a "weedy species" but we have hugely changed our surroundings since we first appeared. The book's subtitle, *An Unnatural History*, holds only as long as we see ourselves outside of nature. The reality is that our future is not decoupled from that of the biosphere. The breaching of planetary boundaries — the potential tipping points in Earth systems such as climate — will have non-linear, unpredictable consequences for all species, including our own.

The five mass extinctions demonstrate that past success is no guarantee of survival: a catalogue of dominant species failed to bridge each of these "moments of panic". Kolbert touches on, but stops short of probing, what we can do to make a difference for the future of all life on Earth. The possibilities for ecological adaptation and mitigation leave significant scope for a sequel. ■

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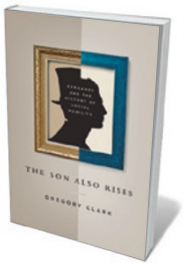
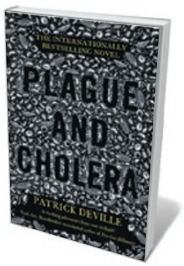
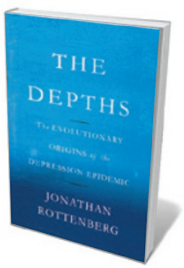
Books in brief



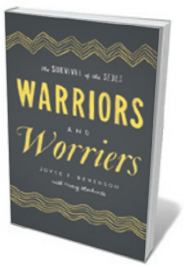
The Son Also Rises: Surnames and the History of Social Mobility
Gregory Clark PRINCETON UNIVERSITY PRESS *(2014)*
Bloody revolutions, policy upheavals and a deluge of social-science theories have been sparked by social inequality. So how porous is the class divide? Not very, reveals economic historian Gregory Clark in this audacious study based on tracking family names through history. Examining names in areas as far-flung in time and space as today's Sweden, Qing Dynasty China and medieval England, Clark shows how little social mobility has altered in 800 years. The solution to the status lottery, he argues, is for society to rectify the imbalance in rewards given to rich and poor.



Plague and Cholera
Patrick Deville (Translated by J. A. Underwood) LITTLE, BROWN *(2014)*
In 1894 Alexandre Yersin, a protégé of Louis Pasteur, discovered the bacillus behind a disease that had ravaged Europe for centuries: bubonic plague. It was dubbed *Yersinia pestis* in his honour. Patrick Deville's novel — a French best-seller now translated into English by J. A. Underwood — eloquently chronicles Yersin's eventful life. Starting with the scientist's flight out of Paris during the Second World War, the story swerves back in time to chronicle his explorations of Vietnam, the Philippines and "the new frontier of microbiology" in the tumult of the twentieth century.



The Depths: The Evolutionary Origins of the Depression Epidemic
Jonathan Rottenberg BASIC BOOKS *(2014)*
Depression, avers psychologist Jonathan Rottenberg, is an evolved trait: a way of stopping us in our tracks so that we can perceive the hurdles facing us. But in today's relatively safe environment, he argues, this useful adjunct of self-analysis can ramp up in severity — and strictly biological approaches and talking cures are not universally effective. Rottenberg brings clinical findings, experimental research, anecdotal evidence and personal experience of depression to his study of triggers, exacerbating factors, psychobiology and evidence for routes to recovery.



Warriors and Worriers: The Survival of the Sexes
Joyce F. Benenson with Henry Markovits OXFORD UNIVERSITY PRESS *(2014)*
In this provocative treatise, psychologist Joyce Benenson overturns the prevalent social-science theory that women are the more sociable sex and men more competitive. Benenson posits that the sexes exhibit the strongest differences in behaviours that support their long-term survival. The tendency among girls to discuss others is linked to the evolutionary need to sift out people who will help with childcare, she argues, but women often compete over men. Men, by contrast, cooperate in competing against other groups.

Heimlich's Maneuvers: My Seventy Years of Lifesaving Innovation
Henry J. Heimlich PROMETHEUS BOOKS *(2014)*
Forty years ago, a thoracic surgeon first described a technique to halt choking by administering abdominal thrusts. Henry Heimlich's manoeuvre is now a globally recognized first-aid intervention. In this matter-of-fact memoir, Heimlich lays out a life spent crafting pragmatic health-care innovations. Along with inventions such as a 'flutter valve' to drain chest fluids, he touches on more controversial potential treatments, such as fighting HIV by inducing infection with malaria. **Barbara Kiser**