

▶ with a single brutal obituary, published in the *Memoirs of the Royal Academy of Sciences of the Institute of France* in 1835.

Stott highlights the charged moment when Cuvier first examined mummified ibises collected by Geoffroy on the Napoleonic expedition to Egypt. Here was the ultimate showdown between Lamarck's evolutionary ideas, which predicted that ibises should have experienced species change in the 3,000 years since the specimens were alive, and Cuvier's insistence that this was biologically impossible. Were the ancient ibis mummies significantly different from modern birds? No — Cuvier seemed to have been proved right.

Many of the heroes of *Darwin's Ghosts* ran risks to pursue their evolutionary ideas — in 1749, for example, French philosopher Denis Diderot was imprisoned for subversive writings that touched on species variation. Many thinkers tried to sidestep the charge of heresy: de Maillet, for example, distanced himself by presenting his theories in the form of a supposed conversation with an Indian mystic, 'Telliamed' (de Maillet spelled backwards). Erasmus Darwin, anxious about the impact of controversy on his reputation as a doctor, chose to veil many of his evolutionary speculations behind a cloak of classicising poetry. Scottish geologist Robert Chambers never publicly admitted that he was the author of the anonymous Victorian best-seller *Vestiges of the Natural History of Creation* (John Churchill, 1848).

The lesson of Stott's book is that Darwin and Wallace were not just standing on the shoulders of giants scientifically. They were also at liberty to speculate and publish freely on the topic only because of the risks that these earlier writers had taken.

Stott introduces us to a sparkling cast of characters, but the biographical approach has its limitations. The book fails to illuminate the most remarkable aspect of the story of the discovery of evolution: that this long-sought-after idea was discovered independently, around the same time, by two men who both regarded themselves as pedestrian thinkers.

The Darwin–Wallace story validates the modern insistence that discovery is not about 'great men', but about a confluence of societal and technological factors that collectively make a previously inaccessible idea accessible. Nevertheless, Stott's constellation of biographies is an exhilarating romp through 2,000 years of fascinating scientific history. ■

Andrew Berry is a lecturer in evolutionary biology and teaches history of science at Harvard University in Cambridge, Massachusetts.
e-mail: berry@oeb.harvard.edu



Social Light at the Science Museum in London lets audience members act as mirrors.

Q&A Scott Snibbe

Nature's digitizer

Media designer Scott Snibbe creates software apps and interactive science-museum installations, and was executive producer of the 2011 Biophilia project by singer-songwriter Björk. As he prepares to lecture at the *Sónar International Festival of Advanced Music and New Media Art* in São Paulo, Brazil — where his visuals will accompany Björk's performance of *Biophilia* — he talks about provoking wonder.

How did you become a digital designer?

My father is an inventor who designed a geometric kite and is working on a perpetual-motion machine. My mother is an artist. From childhood I wanted to be a combination of the two. My parents let me use a machine workshop from the age of four to make anything, however useless. My dad and I built a Tesla coil, and I got a few 20,000-volt shocks, but my parents weren't afraid because we were Christian Scientists, and didn't believe that God would allow us to get hurt as long as we had a positive attitude and safety goggles. At university, I considered studying genetics or neuroscience, but I couldn't handle dissections or vivisections. Instead, I became a researcher at the computer–human interface, working on problems such as artificial touch and computer vision at places including Brown University in Providence, Rhode Island, and Adobe Systems in Seattle, Washington. Then I created my own companies, combining interactive art with business.

What draws you to interactive apps?

Other fields are limited by money, equipment and the laws of nature. But with computers, the only limits are technical ability, ingenuity and imagination. Nature has awed me since I was a child, but the educational system rarely conveys this wonder, transforming our Universe into boring multiple-choice



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questions. My programs recreate the wonder and magic to give people the kind of experiences that they have in wild places such as river banks. My apps borrow from nature, but the laws are slightly altered, as if in a parallel universe.

Can you describe your science-based apps?

With my *Gravilux*, you touch the screen and

stars are attracted to your fingertips. I started with Newton's gravity equations but didn't get controllable patterns, so I removed mutual attraction. *Bubble Harp* draws Voronoi diagrams, based on a geometric algorithm first described by seventeenth-century philosopher René Descartes, and used to model the structure of cells, the pattern of human settlements and the gravitational influence of stars. With *Antograph*, you 'paint' a pheromone that attracts ants, but they swarm off the trail, just as real ants would. I've had reports of it being used to teach what pheromones are, and one user of *Gravilux* said that it helped him to get an A grade in physics for the first time.

How did you come to work with Björk?

Björk chose to release *Biophilia* on the iPad. She asked my studio to produce the

project, and to design several of the interactive song apps. One explains how viruses work: you see them injecting RNA into a cell and hijacking its reproductive mechanism. You can flick the viruses away, but if you do, the music stalls; you have to let the cell be attacked to hear the whole song. Another app, *Hollow*, animates DNA replication using a drum machine. When you touch different enzymes, they catalyse the DNA strand and trigger gothic musical loops.

What makes a good science exhibit?

It must satisfy someone with a PhD — and a two-year-old. *Social Light*, an exhibit on electromagnetism that I designed for the Science Museum in London, allows your body to refract simulated light like a prism, reflect it like a mirror or absorb it. At the Exploratorium in San Francisco, California, *Three Drops* shows how forces of nature work at different scales. There is a screen where you can take a virtual shower as water flows around your shadow. Then the image zooms in to a single drop, which you can bounce around; the surface tension is so strong you can't get 'wet'. Then it zooms further in to show water molecules attracted to people's bodies as if they were impurities in the water. Here, we drew on the work of molecular biologist Tanya Raschke, who showed that water molecules form chains and loops.

How does the world of science differ from that of art?

There is an irreproducible uniqueness to an artist's work that makes the field less stressful than science. In science, if you don't make a certain discovery, someone else will, so even people in the same lab are competing with one another. In art, innovation and risk-taking are lauded, but in science there is an aversion to risk because people need to get grant money from conservative review boards. I know scientists who could speak a single sentence that would completely ruin their careers. And, like Barbara McClintock's pioneering work describing genetic crossover in corn, that sentence might even be true a decade later.

What keeps you excited about your work?

My imagination can take me up to Jupiter, or down to the size of atom — there is no need to actually create something unless it's for an audience. That is why I have mostly stopped showing in art galleries, because I wanted to reach the general public. I try to make an interactive app or exhibit as perfect as it can be, and then release it to see how people respond. I feel satisfied when someone says that our work was the most wonderful thing they encountered in their day. ■

INTERVIEW BY JASCHA HOFFMAN

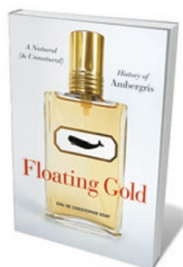
Books in brief



The Geek Manifesto: Why Science Matters

Mark Henderson BANTAM 336 pp. £18.99 (2012)

A geek revolution is upon us, asserts journalist Mark Henderson. Media stars such as physicist Brian Cox have lit the fuse by giving science cultural credibility. Now, says Henderson, with 7% of the UK electorate engaged or trained in science and more than 5 million scientists and engineers working in the United States, this sector of society is poised to gain real political clout. Ultimately, he argues, that could force change in everything from politics and government to health care and the environment as the intellectual honesty and innovative bent of the scientific mindset gains ground.



Floating Gold: A Natural (and Unnatural) History of Ambergris

Christopher Kemp UNIV. CHICAGO PRESS 232 pp. \$22.50 (2012)

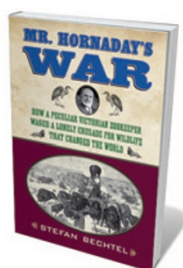
Costly it may be, but the perfume fixative ambergris is weird stuff: a waxy mix of secretions and squid beaks from the intestines of the sperm whale. As molecular biologist Christopher Kemp relates, the beaks pass through the beast's four stomachs to form a dung-drenched mass. Often released when the whale dies, the floating lumps are seasoned by sea and sunlight, developing an odour likened to sandalwood, Brazil nuts and violets. Kemp's engrossing study takes us through history, tales of present-day hunters and cetacean science, poking its nose into the perfume industry on the way.



The Universe in Zero Words: The Story of Mathematics as Told Through Equations

Dana Mackenzie PRINCETON UNIV. PRESS 224 pp. \$27.95 (2012)

Mathematician and writer Dana Mackenzie brings to life 24 of the great equations that shape our world. We get Brahmagupta's subtle discovery of zero in 628 AD, the 350-year conundrum of Pierre de Fermat's last theorem, speculation over whether apples or moons inspired Isaac Newton's laws, the economic Black-Scholes formula that failed to prevent the Wall Street meltdown — and much more. Quietly learned and beautifully illustrated, Mackenzie's book is a celebration of the succinct and the singular in human expression.



Mr. Hornaday's War: How a Peculiar Victorian Zookeeper Waged a Lonely Crusade for Wildlife That Changed the World

Stefan Bechtel BEACON 272 pp. \$26.95 (2012)

One-time taxidermist William Temple Hornaday emerges from this lively biography as a nineteenth-century conservation hero — and a rampant racist. Stefan Bechtel tells how Hornaday saved the American bison and fought for legislation to save threatened species. Yet in 1906, as director of the Bronx Zoo in New York, he displayed Congolese pygmy Ota Benga in a cage, despite the protestations of local black clergymen. A fascinating portrait of a man both ahead of his time, and deluded by gross misreadings of Darwin.



Trusting What You're Told: How Children Learn from Others

Paul L. Harris HARVARD UNIV. PRESS 266 pp. \$26.95 (2012)

Children get information in two ways: from their own observation and exploration, and from other people. When the streams conflict, says educationalist Paul Harris, children often defer to the suggestions of others. But they are not uncritical: they "monitor the messenger", choosing whom to believe. Harris's challenge to the view of children as mini-scientists in a world-as-lab is well backed by research: a gripping trawl through the young human mind confronted with moral reasoning, the separation of fact from fiction and more.