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Vol 464 | Issue no. 7289 | 1 April 2010

Nature Publishing Group
The Macmillan Building,
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In the US Nature (ISSN 0028-0836) is published weekly on Thursday, except the last week in December by Nature Publishing Group, 75 Varick St, 9th Fl, New York NY 10013-1917, USA. US Periodicals postage paid at New York NY, and additional mailing post offices. US POSTMASTER: send address changes to Nature, Subscription Dept, 342 Broadway PMB 301, New York NY 10013-3910, USA. Published in Japan by NPG Nature Asia-Pacific, Chiyoda Building, 2-37 Ichigayatamachi, Shinjuku-ku, Tokyo 162-0843, Japan.

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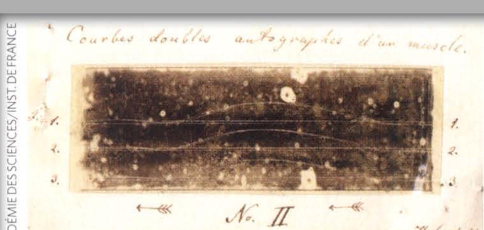
EDITORIALS

RESEARCH HIGHLIGHTS

OPINION



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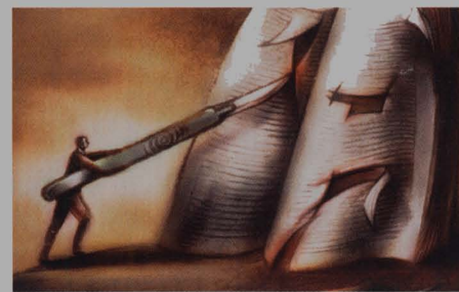
Supp info: Helmholtz's figure in print, 160 years late, p. **681**.



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Paper chase: the obstacles to getting published, pp. **799**, **800**.

BOOKS & ARTS

NEWS & VIEWS

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How ocean stirring affects climate

The Great Ocean Conveyor: Discovering the Trigger for Abrupt Climate Change
by Wally Broecker
Princeton University Press: 2010.
172 pp. $27.95, £19.95

Wally Broecker is one of the great pioneers of palaeoclimatology, the study of past climate changes in Earth's history. He introduced the term global warming and, in the 1980s, proposed that the global ocean-circulation system, which he dubbed the Great Ocean Conveyor, tends to 'flip-flop' between radically different yet stable states. The switching on and off of this overturning motion of the ocean waters, by which warm water flows northwards in the Atlantic and returns southwards in the cold abyss, could explain abrupt climate shifts during the last ice age. This period, which lasted from about 110,000 years ago until around 10,000 years ago, saw dramatic regional temperature changes in the order of 10 °C that developed in a few decades but lasted for centuries.

In *The Great Ocean Conveyor,* Broecker offers a history of his thinking on the topic. Relating his breakthroughs and setbacks, he portrays science as a "continual struggle to understand more fully and more accurately how the world really works". He describes the key data sets of palaeoclimate — drawn from ice sheets, ocean sediments, ancient corals or cave stalagmites — and the detective work of deriving climate information from them. Many historical anecdotes are included, such as the harrowing story of the Russian scientists who retrieved the Vostok ice core from Antarctica: after their generator broke down, they "survived by huddling in an ice cave heated only by candles".

The book is strong in describing work based on palaeoclimatic proxy data — indirect indicators of past climate, such as the isotopes found in microscopic sea shells or the gases in air bubbles found in ancient ice. It is weaker on climate modelling. Broecker dismisses models as having had "little predictive success". Yet models are not intended to predict past climate events; rather, they are a valid tool for quantitatively testing hypotheses about the mechanisms of climate change.

Central to the book is the explanation of abrupt glacial climate changes in terms of the Atlantic Ocean Conveyor switching on and off. These are manifested as sudden warmings, known as Dansgaard–Oeschger events, and as occurrences of iceberg armadas associated with cooling, called Heinrich events. Broecker leads his readers to the puzzle of why the two types of

Russian scientists survived with only candles for warmth while retrieving this Antarctic ice core.

M. CONNER, NATIONAL SCIENCE FOUNDATION

abrupt event leave different geographic traces in palaeoclimatic records. Extending his idea of ocean-conveyor switching to include shifts in latitude of the Atlantic overturning circulation would offer a solution to this problem — but strangely, Broecker does not discuss it.

Warm Atlantic waters in the North Atlantic Current — the extension of the Gulf Stream — may either stop south of Iceland or push north into the Nordic seas. The latter can explain the Dansgaard–Oeschger warmings. This idea, proposed by me in 1994 (see *Nature* **372,** 82–85) and popularized by Broecker in *Scientific American* in 1995, has been much elaborated, notably by Andrey Ganopolski at the Potsdam Institute for Climate Impact Research, Germany. Now widely accepted, the theory is noted as an explanation for such warming events in the most recent report of the Intergovernmental Panel on Climate Change. It would have been interesting to hear Broecker's views on this development of his original concept.

Broecker ends his book with the current geological age, the Anthropocene. In a 1975 *Science* paper entitled 'Are we on the brink of a pronounced global warming?', he correctly predicted "that the present cooling trend will, within a decade or so, give way to a pronounced warming induced by carbon dioxide", and that "by early in the next century, $[CO_2]$ will have driven the mean planetary temperature beyond the limits experienced during the last 1,000 years". He also foresaw a mean global temperature rise of 0.8 °C over the twentieth century. Broecker concludes that climate shifts induced by ocean conveyor flip-flops are relevant, but a more immediate risk is drought — the palaeoclimatic records show evidence of many major and sometimes abrupt changes in rainfall patterns. "Climate is an angry beast," he remarks.

Earth's history tells us that climate has often responded to forcing in a sensitive, nonlinear and unpredictable way. It is likely to do so again now that we are pushing it away from equilibrium with our greenhouse gases. As we struggle to understand how close we are to the climate system's tipping points, it is wise not to push too hard. ■

Stefan Rahmstorf is professor of physics of the oceans at the Potsdam Institute for Climate Impact Research, D-14412 Potsdam, Germany, and co-author of *The Climate Crisis* with David Archer.

Lost curve hits a nerve

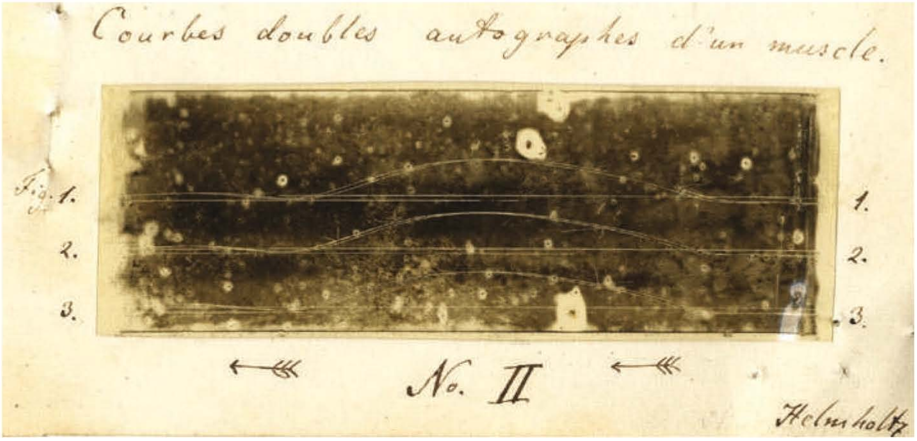
Die Helmholtz Kurven: auf der Spur der verlorenen Zeit (The Helmholtz Curves: In Search of Lost Time)
by Henning Schmidgen
Merve: 2009. 270 pp. €20

Hermann von Helmholtz (1821–1894) was a towering figure of the European Enlightenment, a physiologist and accomplished draftsman with the soul of a Prussian physicist. He conducted his research with rigorous mathematical precision, investigating his biological preparations by adapting whichever industrial-revolution technologies he saw fit.

His formidable set of skills, combined with an equally formidable intelligence, enabled him in 1850 to work out the speed of signal propagation in nerves — then a fundamental problem in the highly competitive field of nerve and muscle physiology. However, his contemporaries did not believe him.

Using the physiologist's favourite preparation of a large frog muscle still attached to its long nerve, he had declared the speed of conductance to be around 27 metres per second. This seemed improbably slow to a sceptical scientific community by now familiar with the speeds of light and sound. So Helmholtz developed yet another skill: science communication. He decided to generate visible proof of his claim, using curves that were drawn by the contracting frog muscle itself after electrical stimulation of its nerve.

Those original curves were never published and were believed to have been lost. But last summer, German science historian Henning



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Hermann von Helmholtz's rediscovered curves show how frog muscle contracts and relaxes after nerve stimulation (time runs right to left).

Schmidgen found them hidden in the archives of the Paris Academy of Sciences in France. His discovery prompted him to tell the story of Helmholtz's ingenious experiments to both measure and demonstrate the speed of nerve conductance. Schmidgen's account, *Die Helmholtz Kurven*, shows how recognition was as important for scientists then as it is today.

In his earliest 'frog drawing machine', Helmholtz suspended the frog muscle and attached a weight to it by a thread. He attached a stylus to the thread and placed a rotating glass disk coated in soot directly in front of it. When he stimulated the nerve, the muscle contracted, pulling the stylus across the disk. The scratched curve showed the asymmetric form of the muscle contraction, with its slow build up and fade. However, he was reluctant to use the system to study the speed of nerve conduction, worried that friction would distort the results.

Instead, he designed an almost friction-free system, adapting an electromagnetic approach used in ballistics to measure short time intervals. He used a galvanometer — a type of ammeter that detects and measures electric current — to transform the duration of muscle contractions into the deflection of a needle through electromagnetic force. To increase resolution, he measured the extent of the deflection through a telescope placed a few metres away.

He wrote up his results and rushed the paper to the Paris Academy of Sciences in February 1850, after it had been translated into French by his friend and colleague, the physiologist Emil du Bois-Reymond. The paper comprised three pages of abstraction and spectacularly failed to convince his contemporaries. A 90-page elaboration, full of numbers and written in German, also failed to hit the public nerve, as it were.

Helmholtz wondered whether perhaps his nerve–muscle preparation should do the communicating directly, and so returned to his frog drawing machine. He replaced the glass disk with a scaled-down drum made from a champagne glass with a smoked surface, and spun it fast enough for the stylus to scratch the shape and time course of a full muscle contraction into the soot. He compared the curves that were produced when the nerve was stimulated either close to, or distant from, the muscle. From the curve's displacement, he calculated the speed of signal propagation in the nerve — and got the same value he had calculated using his electromagnetic method.

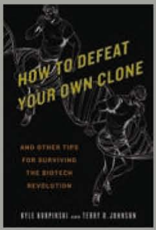
"Recognition was as important for scientists then as it is today."

He made ingenious permanent records of the scratched images, capturing them using a material called isinglass — a sticky collagen film made from the dried swim bladders of fish. Among other things, it was used as a clarifying agent for wines and in plasters and glues. He transferred the smoky images onto squares of isinglass and sent them off with a second explanatory manuscript to the Paris Academy of Sciences in September 1851. With this, Helmholtz won the recognition he desired. Ironically, the published manuscript did not include the images.

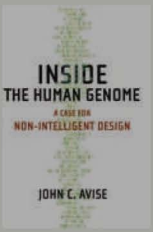
Last year, Schmidgen was studying correspondence between Helmholtz, Du Bois-Reymond and the Paris Academy of Sciences when it occurred to him that the paragraph that referred to the curves in the draft manuscript was missing from the printed paper. There was no way of knowing whether Helmholtz had decided not to send the curves after all, or whether the academy had simply not printed them. Unless, by chance, the publishers had simply kept the curves in the file. Schmidgen flew to Paris to see. And this is how he made the kind of discovery of original material that science historians dream of. ■

Alison Abbott is *Nature*'s senior European correspondent.

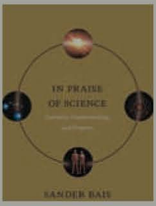
BOOKS IN BRIEF



When the biotech revolution comes, we may turn to guidebooks to advise us on which genes we should delete to enhance our intelligence, how we might regenerate a limb or how we should interact with our clone. In their quirky guide to the future of biotechnology, *How To Defeat Your Own Clone* (Random House, 2010), bioengineers Kyle Kurpinski and Terry Johnson convey with simplicity and humour the science behind stem cells, genetic variation and bioenhancements. Their first rule: don't let your clone read this book.



Genetic reproduction brings with it the risk of flaws. In *Inside the Human Genome* (Oxford Univ. Press, 2010), evolutionary geneticist John Avise celebrates our inherent imperfections, from genetic mutations to downright design faults. Taking a philosophical look across human genomics and biochemistry, he unravels the perfectionist arguments of creationists and offers a nuanced view of what it is to be human.



In his neatly packaged paean to science, physicist Sander Bais calls on researchers to be vocal in defending the scientific method in an age of voluble but often unsupported public opinion. *In Praise of Science* (MIT Press, 2010) calmly sets out Bais's reasoning on why scientists should be proud of their rationality and desire to experiment. He reflects on how science has influenced social change across history, and how scientific research is a long-term endeavour that goes beyond short-term political attention spans.