

► of details — such as that British sailors did not have soap in their rations until the 1780s, or that Cook's small ship *Endeavour* had more than 90 people on board, in part because it was expected that half the crew on a round-the-world trip would die of scurvy. (In the event, Cook engaged in a medical experiment with a diet of sauerkraut for the crew, and not a single sailor was lost to the condition.)

Both Wulf and Anderson give much attention to Chappe, the only observer to time the entrance and exit of Venus on both transits. Chappe wrote vivid and extensive travel notes, which both authors use to great effect. His wide-ranging interests would have made him, thinks Anderson, the French Benjamin Franklin. Alas, in a scene drenched with pathos, Chappe died of typhus within two weeks of writing his last journal entry in Baja California.

Unfortunately, neither book explains in simple terms why the astronomers were so keen to record to the second when Venus entered and exited the solar disk. They were triangulating the distance to the Sun with long skinny triangles, the base being the separation of the stations on Earth — which is why it was crucial to know the terrestrial coordinates of the stations.

Venus provided a reference point by which apparent positions on the Sun's face could be measured from two different locations. The duration of the passage gave the length of the path across the Sun, which could then be fitted uniquely onto the observed solar disk. The angular separation of the apparent lines of transit as seen from two different stations, plus the relative distances of Venus and Earth from the Sun and the distance between the two stations, then yielded the distance to the Sun. The numbers from the three principal stations (Tahiti, Vardø and San José del Cabo) gave a mean distance within 1% of the 149,598,000 kilometres accepted today.

The eighteenth-century efforts to track the transit helped to establish the distance to the Sun, but the accuracy was far from what astronomers had hoped for. The results of the campaigns to track the next pair of transits, in 1874 and 1882, were better but still ambiguous. Yet these simultaneously competitive and cooperative efforts set the international stage for our now-accurate measure of the solar distance — the baseline from which all cosmic distances, and ultimately the age of the Universe, are reckoned. ■ [SEE COMMENT P.303](#)

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WESTEND61/REX FEATURES

Breast milk aided the evolution of the large human brain — but it can contain toxins.

BIOLOGY

Mammary chronicles

Josie Glausiusz celebrates an environmental history of the human breast.

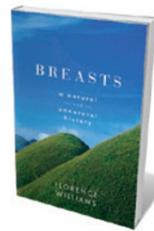
The breast looms large in human culture and biology. The essential proteins and long-chain fatty acids in breast milk help to build babies' big brains, and the cornucopia of other components, such as virus-slaying macrophages and oligosaccharides that feed beneficial bacteria in the baby's gut, offer crucial immune protection. Unfortunately, breast milk can also contain pesticides, mercury, benzene and minuscule amounts of paint thinners, dry-cleaning fluids, rocket fuel and flame retardants.

This contaminant-crammed elixir is uniquely modern, as Florence Williams details in *Breasts*. This is no salacious tell-all, but a lively, absorbing, meticulously researched book covering all aspects of breasts, from anatomy to their role in evolution, attraction and infant bonding; changes during puberty, pregnancy and cancer; and Western society's passion for flaunting, grading and inflating them. At heart, however, the book is an environmental history of "how our breasts went from being honed by the environment to being harmed by it".

Williams, a US science journalist, uses her own body as a research tool. She sends her milk to Germany to be tested for flame retardants, delves into her family history of breast cancer and visits a suave Texas surgeon for advice on silicone breast implants. To mimic a study on early puberty, she and her seven-year-old daughter, Annabel, valiantly try to give up plastic-wrapped food as well as products containing endocrine-disrupting phthalates — including Williams's car.

Intimate explorations of breast biology have a distinguished history. In 1840,

British surgeon Astley Cooper published *The Anatomy and Diseases of the Breast*, in which he observed — after injecting dyes into more than 200 disembodied breasts — that blood is transformed into milk in grape-like lobules, inside tissue cavities called alveoli. The milk then enters a network of lobes that empty into 12 or so orifices in the nipple.



Breasts: A Natural and Unnatural History
FLORENCE WILLIAMS
Norton: 2012. 352 pp.
\$25.95, £16.99

Unlike any other organ, human breasts do most of their development well after birth. These plump orbs are also unique in that no other primate is so endowed: females of other species develop swellings only during lactation. Evolutionary biologists have devised elaborate stories to explain the permanent adult presence of human breasts; the most popular is that they are an adornment, like a peacock's train, for attracting the opposite sex. Williams leans more towards the ideas of anthropologist Frances Mascia-Lees, who posits that breasts' ever-present fat reserves are easily mobilized during lactation to keep pace with the baby's rapidly growing brain.

The immune support offered by human breast milk is formidable. The average new mother produces roughly 454 grams of milk from each breast every 24 hours. This elixir is not unlike cultured yoghurt, carrying 100–600 species of live bacteria, most new to science. (Mysteriously, the US National

Institutes of Health's Human Microbiome Project, which is decoding the genes of microbes from every major human surface or orifice, is not analysing breast milk.) One theory suggests that the bacteria in breast milk work as a kind of gut vaccine.

The stuff is so beneficial that companies that produce substitute breast milk are racing to replicate its ingredients, with little success so far. But Williams's investigation suggests that there may be good reasons to hope that they succeed: breast-milk toxins can include "the mercury in last week's sushi, the benzene from your gas station, ... the chromium from your nearby smoke stack". Moreover, even a tiny dose of these contaminants can be harmful to babies, and such toxins have been implicated in low intelligence and cancer.

Williams reports that flame retardants, found in sofas, nursing pillows and infant car seats, can impede brain growth and affect thyroid hormones. When Williams's milk is tested for polybrominated diphenyl ethers (PBDEs), she learns that her levels are slightly above average for US women — and notes that mothers offload about 30% of their PBDE burden onto their babies if they nurse for a year. Williams breast-fed her two children for 18 months each.

It is not just infant development that may be affected: the author describes how hormone-disrupting phthalates and bisphenol A (BPA) may be advancing puberty in girls by prematurely switching on oestrogen receptors in breast tissues. Williams looks at possible reasons behind the rise in breast cancer — globally, the leading cause of cancer-related death in women, with 1 million diagnosed each year — including better detection, hormone-replacement therapy and exposure to untested chemicals.

In one alarming account, she reports on an epidemic of male breast cancer among US marines at Camp Lejeune in North Carolina. Over three decades, starting in the 1950s, fuel tanks leaked more than 3.8 million litres of petrol into the base's groundwater. One well, which supplied drinking water to 8,000 people, contained 76 times the legal limit of benzene, a known human carcinogen.

As Williams points out, breast milk boosted brain size in our ancestors, but those brains have helped us to change the environment — which, in turn, is channeling to infant brains toxins that may impede their development. There is hope for the future, however: in 2004, the United Nations implemented the Stockholm Convention on Persistent Organic Pollutants, in which 177 countries have agreed to ban or restrict such chemicals, including some PBDEs. The United States has yet to ratify the treaty. ■

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Books in brief



Run, Swim, Throw, Cheat: The Science Behind Drugs in Sport

Chris Cooper OXFORD UNIV. PRESS 288 pp. £16.99 (2012)

Whether sprinting, swimming, lifting or leaping, elite athletes in action are phenomenal — and, as biochemist and sports scientist Chris Cooper shows in this pacy account, some are also assisted by performance-enhancing drugs. To understand a problem that is unlikely to disappear from sport completely, Cooper lays out research on the substances in question, how they work, which are illegal and the methods for detecting them. He explores a number of contexts, ranging from sexual dimorphism and the need for oxygen and key nutrients to gene doping and the science behind the tests.



Digital Vertigo: How Today's Online Social Revolution Is Dividing, Diminishing, and Disorienting Us

Andrew Keen ST MARTIN'S 256 pp. \$25.99 (2012)

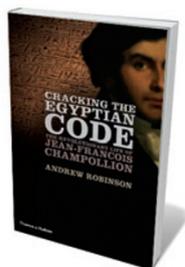
In a world gripped by digital utopianism, Silicon Valley insider Andrew Keen is an uber-sceptic. Those in online communities are, says Keen, besotted with a corpse, much like James Stewart's character in Alfred Hitchcock's 1958 film *Vertigo*. Rather than offering a vast, benign e-neighbourhood, he argues, forms of social media breach privacy, encourage narcissism and promote commodification of personality. Aloneness, he says, is a necessary antidote to the hypervisibility of the social-media in "Web 3.0" — and a basic human right.



The Fate of the Species: Why the Human Race May Cause Its Own Extinction and How We Can Stop It

Fred Gutel BLOOMSBURY 224 pp. \$25 (2012)

Scientific American's executive editor, Fred Gutel, pulls no punches in this succinct round-up of the global trends that threaten humanity. He considers, in turn and backed by intriguing research, the rise of superviruses, rapid species extinctions, climate change, the disruption of ecosystems, synthetic biology and bioweaponry, and our over-dependence on machines. Ultimately, argues Gutel, the solutions lie in the very technology that propelled us into the current chaos — along with plain human adaptability.



Cracking the Egyptian Code: The Revolutionary Life of Jean-François Champollion

Andrew Robinson THAMES & HUDSON 272 pp. £19.95 (2012)

In the first English-language biography of nineteenth-century "father of Egyptology" Jean-François Champollion, Andrew Robinson offers a vivid portrait of a prodigy, and richly contextualizes Champollion's work decoding the hieroglyphs on the Rosetta Stone. The book takes in Egyptomania from ancient Greece to eighteenth-century Britain, Champollion's rapid rise to professorhood, his rivalry with English polymath Thomas Young, years of preliminary work and travels in Egypt, and the advances that followed him — all beautifully illustrated.



Silent Spring Revisited

Conor Mark Jameson BLOOMSBURY 288 pp. £16.95 (2012)

Natural-history writer Conor Jameson uses Rachel Carson's 1962 work *Silent Spring* as a focus for reflection on conservation and environmentalism in the decades since then. He begins with tens of thousands of UK birds dying in the 1960s, felled by pesticides, and moves through oil spills, the work of the UK Royal Society for the Protection of Birds and the steady decline in avian species. The 'silencing of spring', Jameson notes, continues — but reintroduction programmes, given the right support, are beacons in the gloom.