Magic squares and circles

Benjamin Franklin's Numbers
by Paul C. Pasles
Princeton University Press: 2007.
266 pp. $26.95, £15.95

Jared Wunsch

Benjamin Franklin was a brilliant amateur scientist in an era when amateur science mattered. His experiments on electricity won him the Royal Society's Copley Medal in 1753 — it is to Franklin that we owe the notion of positive and negative charges. He charted (and named) the Gulf Stream. His prodigious inventions include the lightning rod, the glass harmonica, bifocals and the Franklin stove.

Even bent rows (1, 8, 13, 12, for instance) of Franklin's notes sum to 34.

In *Franklin's Numbers*, a book mixing intellectual history and mathematical puzzles (with solutions appended), Paul Pasles brings out a less-celebrated sphere of Franklin's intellect. He makes the case for the founding father as a mathematician. Franklin's main contribution to the subject was his work on magic squares, and these are the focus of the book.

A magic square is, in its traditional formulation, an $n \times n$ grid containing the numbers 1 to n^2, such that all rows, all columns, and both diagonals sum to the same number. Franklin, characteristically, improved on the usual form, producing squares that could be summed in more intriguing ways, along 'bent rows', for example. He also concocted several magic circles as a further novelty.

Franklin was diffident on the subject of his work on magic squares, sheepishly admitting to having spent time on them out of proportion to the subject's utility. Pasles takes up the defence of Franklin's squares, correctly pointing out that utility is not a suitable measure for a piece of mathematics and that future applications are notoriously hard to predict.

It is here that the case starts to become shaky. The number theorist G. H. Hardy wrote in his *Mathematician's Apology* in 1940 that "the best mathematics is serious as well as beautiful", going on to assert that "the 'seriousness' of a mathematical theorem lies not in its practical consequences ... but in the significance of the mathematical ideas which it connects". By this measure, magic squares, entertaining though they are, rank mathematically just a little higher than chess problems (Hardy's example of real but unimportant mathematics).

Perhaps Franklin just came too late to pure mathematics, already a mature field in his era, but early to electricity, where the work of a gentleman researcher could still be ground-breaking. It was Franklin's electrical work, viewed in the light of Maxwell's equations, that gave us genuine mathematical magic. ■

Jared Wunsch is associate professor of mathematics at Northwestern University, Evanston, Illinois 60208, USA.

Fruits of their labour

Status of Pollinators in North America
by The Committee on the Status of Pollinators in North America, National Research Council of the National Academies
The National Academies Press: 2007.
307 pp. $56

Susan J. Mazer

Forests, prairies, meadows, seashores and wetlands all depend on a diverse and healthy community of pollinators. Wild pollinator populations living in intact and healthy forests, woodlands and fields contribute to the success of a variety of crops — including coffee, watermelons, cucumbers and sunflowers.

It is therefore troubling to hear that pollinator populations are declining or at risk of extinction, the sobering subject of the *Status of Pollinators in North America*. This is a report by a US National Research Council committee, created in 2005 to assess the reality and causes of pollinator declines in agricultural and natural systems, and to offer recommendations to ensure the long-term stability of pollination services.

The committee synthesized the results of some 1,200 research articles and reports, focusing on empirical studies of pollinators and their effects on wild and domesticated plant species. No pollinator escapes: changes in population size and distribution of pollinating ants, bees, wasps, beetles, flies, butterflies, moths, birds and bats are all summarized.

The committee casts an even wider net by enlisting the expertise of applied researchers, honeybee specialists, non-governmental organizations, managers of pollinator databases and industry consultants, who all participated in a symposium at the National Academies in 2005.

A few basic facts highlight the value of domesticated and wild pollinators, and the risks that they face. Honeybees (*Apis mellifera*), the most widely managed, carefully monitored, and commercially distributed pollinator, are used for the fruit and seed production of more than 100 crops (all non-cereals) in the United States. Estimates of their economic value in the United States range from $150 million (at present, the total annual cost of bee-colony rental) to almost $19 billion (the estimated value that farmers would pay if pollinators weren't freely available in nature).

For some crops, honeybees are ineffective pollinators compared with native bees or man-


W. MANNING/CORBIS

Unhappy honeybee: efforts are afoot to restore plummeting pollinator populations.

aged wasps. Some of these alternative pollinators are managed, at a much smaller scale, which itself is risky because rare events — such as disease or environmental change — are more likely to wipe out small populations than large ones. Other domesticated plant species rely exclusively on native bats or birds, whose fate is linked to habitat destruction.

Changes in abundance have been monitored for only a small fraction of the species known to be effective pollinators; there is a growing list of factors implicated in population declines. In the United States, honeybee colonies have more than halved since 1947 (from 5.5 million to 2.4 million). Parasitic mites and pathogens, insecticides used to control crop pests and displacement by Africanized honeybees, are all to blame and may also affect managed populations of non-*Apis* pollinators. Toxic effects of secondary compounds produced by genetically engineered plants are suspected. Habitat modification is probably still the prime culprit in the decline or endangered status of several species of wild pollinators.

A sustained pollinator decline in North America, for example, would mean lower yields from crops that depend on animals for pollination, and so prices would increase; or there would be less variety available as farmers switch from growing insect-pollinated crops to the restricted range of self-fertilizing ones that give reliable fruit or grain production.

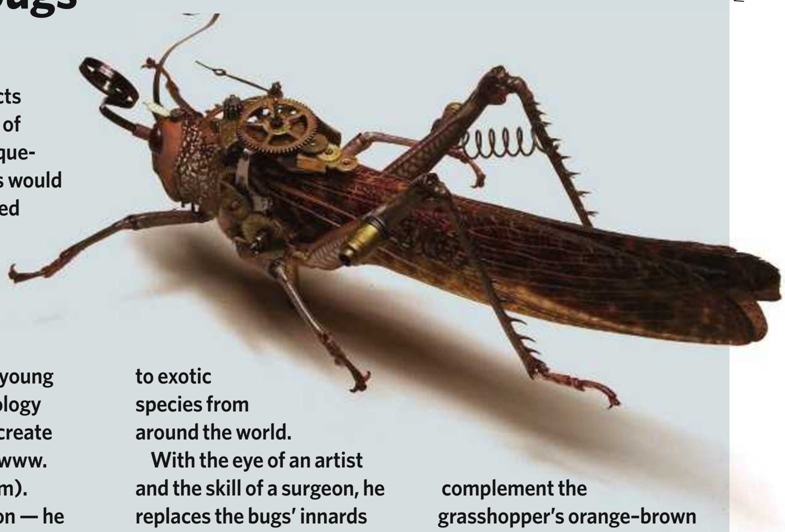
Farmers have known for centuries what the public and legislators may be accepting just in time: a field of crops without pollinators is a harbinger of a greater calamity. *Status of Pollinators* offers a host of straightforward and complementary recommendations to help prevent crop failures and the collapse of native plant communities. There isn't a silver bullet to zap the problem: simultaneous application of a variety of solutions will be necessary to sustain a healthy and diverse community of pollinators nationwide.

For example, we need more research entomologists, plant-population biologists, geneticists, agricultural ecologists and systematists. To identify regions vulnerable to pollination failure, we should run international pollinator-monitoring programmes. For long-term pollinator security, Mexico, Canada and the United States should pursue collaborative breeding programmes to identify and manage pollinators other than *Apis*. Land-use practices friendly to pollinators should be adopted by industrial, public and residential landowners. Educational institutions should promote awareness of the intimate connection between plants, their pollinators, our diets and our economy.

In the United States, only a continent-wide commitment to the protection of pollinators will allow future generations to enjoy the fruits of their labour. ■

Susan J. Mazer is professor in the Department of Ecology and Evolution, University of California, Santa Barbara, California 93106, USA.

Glitter bugs



M. LIBBY

Nick Thomas

A pile of dead insects and an assortment of disassembled antique-watch mechanisms would probably be destined for the rubbish heap in most homes. In the pretty coastal town of South Portland, Maine, a young artist combines biology and technology to create bioart sculptures (www.insectlabstudio.com).

Artistic inspiration — he refers to it as his 'epiphany' — first struck Mike Libby in the late 1990s. He happened on a particularly colourful beetle lying dead beside a vending machine. Months later, he assembled his first gear-laden insect from the salvaged workings of an old Mickey Mouse watch, which he transplanted into the beetle.

Libby calls his blending of nature and technology "a celebration of natural and man-made function". He collects local insects such as butterflies, dragonflies and beetles, but many of his specimens now come from companies that supply insect collectors and entomologists, enabling him to adapt his art to exotic species from around the world.

With the eye of an artist and the skill of a surgeon, he replaces the bugs' innards with recycled cogs, springs, dials, steel and brass gears, as well as more modern resistors, capacitors and light-emitting diodes (LEDs). These he carefully glues together to create the bionic bugs. The operation takes 20 to 40 hours.

One of his largest projects, shown here, is the 12-centimetre-long Central American grasshopper, *Tropidacris dux*, more commonly called the giant brown cricket. So large is the wingspan of this mega-insect that hunters have been known to blast it with shotguns, mistaking it for a bird.

Libby adorns *T. dux* with brass and copper parts to complement the grasshopper's orange-brown body and wings. The massive specimen carries a suitably hefty price tag: $950.

With today's microelectronics, a logical extension to Libby's art might be to make it interactive — an LED that actually glows, or a wing that flaps. Yet the artist deliberately avoids applying active electronic components in his works.

"I don't want them to look cheap or toy-like," he says. "Any activity or function should be in the mind and imagination of the viewer." ■

Nick Thomas is an associate professor of chemistry at Auburn University at Montgomery, Montgomery, Alabama 36124, USA.

Multicultural legacy

The Mathematics of Egypt, Mesopotamia, China, India, and Islam: A Source Book
edited by Victor J. Katz
Princeton University Press: 2007. 712 pp. $75.00, £44.95

George Gheverghese Joseph

Mathematics was an important part of many ancient cultures, not just the Greek. These peoples were also at the forefront of notable discoveries, as recorded in *The Mathematics of Egypt, Mesopotamia, China, India, and Islam*.

This pioneering work provides English translations of mathematical texts from each of these regions and cultures, and a better understanding of their contributions to mathematics. There are nuggets of information difficult to find elsewhere. The use of non-mathematical sources, particularly letters and administrative documents from Egypt and Mesopotamia, reveals the practical applications of mathematics and the scribes who composed and used the documents.

Each chapter is devoted to one region and presented by a well-known scholar — Annette Imhausen for Egypt, Eleanor Robson for Mesopotamia, Joseph Dauben for China, Kim Plofker for India and J. Lennart Berggren for the Islamic world. Each author examines the content and impact of primary mathematical sources on the individual cultures. Chapters are roughly structured so that a selection of texts and commentaries follow an introduction, and end with a list of sources and secondary references.

Dauben's study of Chinese mathematics is notable for its length (roughly 200 pages) and