genomics, that this technology makes possible.

Each book contains, as a core element, the story of Google itself, from the initial meeting of the founders, through its intellectual and technological evolution as a university research project, and on to its emergence as a public company, a verb and a potent icon of pop culture. It is a fascinating and compelling story, even for those who know its broad outlines. And given the company's origins, it can be read as a parable on the value of fundamental research — on the way the pursuit of long-range, scientifically challenging goals can have pay-offs that extend to the public at large and can ultimately change the world. ■

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The bright side of life

Aglow in the Dark: The Revolutionary Science of Biofluorescence
by Vincent Pieribone & David F. Gruber
Belknap Press: 2006. 288 pp
$24.95, £15.95, €23.10

Thomas G. Oertner

Creatures that glow in the dark have evolved independently many times in various branches of the phylogenetic tree, and it is safe to assume that it has always been for communication of one kind or another. Whether you are trying to lure prey at the bottom of the sea, startle or confuse attackers, keep your swarm together, or signal your availability to potential mates, being able to send out light in a controlled fashion will give you an edge, especially in deep-sea environments. But although the evolutionary value of bioluminescence seems obvious, the question of how it works has proved difficult to answer.

The first clue was found 120 years ago by the French physiologist Raphaël Dubois. From his experiments with the light organ of the beetle *Pyrophorus*, he concluded that it must contain a two-component system: a heat-sensitive catalyst that he termed luciferase, and a fuel component, luciferin. Purifying the components turned out to be quite difficult, however, and it was only 50 years ago that a young Japanese scientist, Osamu Shimomura, finally succeeded in producing crystals of pure luciferin.

A few years later, Shimomura managed to reveal the light-production machinery of the jellyfish *Aequorea*, in which luminescence is tightly controlled by the concentration of intracellular calcium. He also noted that the light emitted by aequorin molecules in a test tube is bright blue, whereas the jellyfish glows with a greenish hue. The green fluorescent protein (GFP) responsible for this energy conversion received little attention at the time but revolutionized biology 30 years later. Today, customized fluorescent proteins are used as reporters of gene activation and cell identity, to visualize the subcellular localization of tagged proteins, and to monitor cellular activity by tapping in to various second-messenger systems. The most spectacular emerging application is probably the visualization of nerve-cell activity in the brains of living animals.

Given its multitude of uses, I was surprised to learn that the publication announcing the complete sequence of GFP (D. C. Prasher *et al. Gene* **111,** 229–233; 1992) was greeted by just two requests for the complementary DNA clone. The second clone, however, ended up in the hands of a man who not only immediately realized its scientific (and economic) potential, but also had the creativity and skills to transform it into the powerful tool it is today. Even if you can already guess his name (it was Roger Tsien), you will probably still enjoy *Aglow in the Dark*, Vincent Pieribone and David Gruber's well-narrated and beautifully illustrated book. It combines character studies of the people involved with a thoroughly researched story of the unlikely events that led to the main discoveries. The authors interviewed many of the key players, including the Russian scientists who were first to discover a red fluorescent protein. The book's journalistic style gives it a more 'real' feel than its forerunner *Glowing Genes* by Marc Zimmer (Prometheus, 2005), which relies mostly on secondary information.

Interspersed with the main narrative are chapters that explain basic concepts, including the nature of light and the genetic code. Although these excursions might help to reel in readers from other disciplines, in some cases the authors go off on a tangent to cover subjects with no obvious relevance to the central theme, such as Schrödinger's cat. The authors' lengthy explanation about the brevity of laser pulses used for two-photon microscopy seems designed to 'wow' an unsophisticated audience with far-out facts. Not only do they get the calculation wrong, but why should we care about it anyway?

These quibbles aside, the main narrative is riveting, and the authors capture the sometimes curious way that science progresses through an alternation of chance discoveries and systematic, goal-directed experiments. Students wondering whether they are cut out to become scientists ought to be encouraged by the diverse cast of characters involved in solving the mystery of bioluminescence.

Obscure marine invertebrates have been a significant resource for discoveries of fundamental importance, from Alan Hodgkin and Andrew Huxley's first recording of action potentials in the squid to the highly specific neurotoxins that Baldomero Olivera found in Pacific cone snails. In this sense, the story of fluorescent proteins is another timely reminder of the value of biodiversity. The discovery in 2003 of light-activated ion channels from the photosensor of the green alga *Chlamydomonas* makes one wonder what else is out there waiting to be found and put to use. It also suggests that the optical brain–machine interface that the authors discuss in the final 'sci-fi' chapter of the book could soon become a reality, using light not only as a readout of activity, but also for the precise stimulation of individual nerve cells.

These are exciting times for biology, and this accessible and lively introduction conveys the sheer pleasure of discovery, as well as the enormous technological potential of fluorescent proteins. ■

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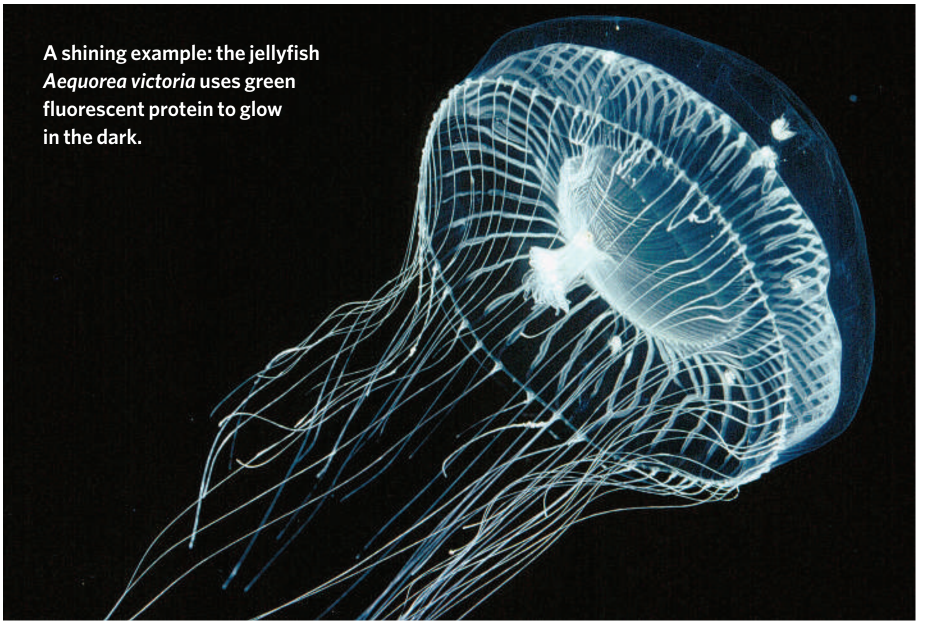

A shining example: the jellyfish *Aequorea victoria* uses green fluorescent protein to glow in the dark.

C. MILLS