tendency to follow Jung in maintaining that the language used by Paracelsus must be seen symbolically as an expression of his unconscious mind. It is too easy to argue that, for this reason, the lexicons provided by scholars of Paracelsus must be taken "with a pinch of Paracelsian salt". To my mind, one of the most urgent tasks of the historian is to find out what precisely Paracelsus meant. Without making this effort, the description of his work can only remain superficial.

This criticism notwithstanding, *The Devil's Doctor* is a fascinating read, rich in content and hugely entertaining. Moreover, it shows that magic was as much at the root of modern science as were the famous discoveries of our modern scientific heroes. It is this awareness that makes Ball's account of Paracelsus essential reading for historians and scientists alike. ■

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The soldier's tale

Won for All: How the *Drosophila* Genome was Sequenced
by Michael Ashburner
Cold Spring Harbor Laboratory Press: 2006. 107 pp. $19.95

Matt Ridley

When the history of genome sequencing at the turn of the millennium is written, it will centre on two battles. The battle over the sequencing of the human genome was bigger and more bitter than the one over sequencing the fruitfly genome; if the human genome was Waterloo, *Drosophila* was barely even Ligny or Quatre Bras. So why would anybody trouble to read, let alone write, a book about the lesser battle?

Michael Ashburner's answer is simple: for the story, not the history. He has written — or rather, he wrote, for these are his immediate reactions, mostly committed to paper at the time — an idiosyncratic, gonzo romp through the crazy days of 1998–99. His purpose, he writes, "frankly, was therapy". This is not like General John Sulston's biographical justification of the genome campaign, *The Common Thread*, written with Georgina Ferry (National Academies, 2002), or James Shreeve's compendious war report from the camp of Marshal Craig Venter, *The Genome War* (Alfred A. Knopf, 2004). Rather, this is a field diary from a colonel in the infantry.

The story is by now a familiar one. In 1998 Venter burst into the human genome project, promising to produce a sequence quickly, privately and commercially, thanks to new sequencing machines and the shotgun technique he had used on bacteria. He announced that he would test his method first on fruitflies, winning the cooperation of Gerry Rubin, hitherto the chief sequencer of *Drosophila*, by promising the immediate release of data. Many arguments later, in November 1999, a flock of scientists gathered to witness an eleven-day 'jamboree', organized mainly by Ashburner, at the Maryland headquarters of Venter's Celera, to find, understand and count the genes in the finished fruitfly sequence.

Ashburner's book covers the year-and-a-half between these two events. It is a time of constant travel for the author: Cold Spring Harbor, Crete, Florida, Heidelberg, Washington (twice), Iceland (a bird-watching holiday), Heidelberg again, Florida again, Washington, Zurich, Maine, Bloomington, Washington again… I may have missed a few. Being a scientist, Ashburner hates hotels (especially Marriotts), Microsoft, bad coffee and suits — the ones who negotiate on behalf of Celera. He likes or needs sushi, espresso, Lewis Carroll, beer and bouts of bird-watching.

The book rattles along with immediate, chaotic, rambunctious prose, digressing several times on every page into chatty and irreverent footnotes to explain who people are, how and why to find a certain restaurant, or where an aphorism comes from ('Box and Cox' is from an Arthur Sullivan operetta, apparently). Ashburner says that his education in the works of Geoffrey Chaucer taught him the value of footnotes.

The wheels came off the sequencing project on 1 November 1999, when Ashburner was frantically trying to finish several tasks before leaving for the jamboree. On that day, Celera released the fly genome to the NCBI's GenBank database, but with restricted access — to see any sequence, the user had to agree not to copy, re-sell or distribute it. This was not the open access that Venter had promised Rubin the year before. Venter was in a bind, desperate to show his backers that sequence data could have commercial value, and anxious to prevent rivals such as Incyte from selling Celera's data to others. So Venter tried it on. "The best way to find out if he was crossing the line," wrote Shreeve in his history of the event, "was to stick out a toe and see if any alarms went off."

This moment is a little hinge in history. Venter might have got away with it. Rubin was travelling. The NCBI thought this was what had been agreed. It was Ashburner in Cambridge who exploded. His expletive-ridden e-mails sent that afternoon to Rubin and Francis Collins have passed into legend. Rubin was found, Venter confronted. To the fury of Celera's business-development team, Venter backed down, and within 24 hours the fly sequence was freely available on GenBank. Arguably, this was the moment when it became clear that nobody would make serious money from genome sequencing; the pressure to share would prove irresistible. Indeed, given the way the world was going that autumn, maybe it was an omen for the whole 'dot com' frenzy in whose slipstream Celera's share price had accelerated. Celera was not the only overvalued company with a flawed business model for making money out of digital information.

Not that Ashburner portrays himself as a hero or Venter as a villain. The delightful sequel is that within a week of this stressful incident, Ashburner was at the Celera jamboree playing happily in the toybox that was the fruitfly genome, exhilarating in the new knowledge and even joshing with Venter. At one point, while celebrating the end of the jamboree, Ashburner persuaded Venter to pose in headphones like a NASA flight director in Celera's mission-control room.

The history of genome sequencing drives home the message that science is usually the daughter, not the mother, of technology. Sequencing the human, fruitfly and all other genomes was made possible by new machinery. The resulting information was a glorious and far-reaching addition to human knowledge, but only a distant harbinger of new commercial applications. But at least it has generated some enjoyable literature, of which this is a good example. ■

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