

Afterword to “Madswitch”

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Certain types of bacteria live quite happily inside the gut of the nematode worm. The genes that allow the bugs to cling to their host are referred to as “mad” (short for “maternal adhesion”, as in “stick close to your mother!”), and these genes are turned on or off by a section of DNA known as the “madswitch”. When the madswitch is on, the bacteria are tiny and docile, but when the madswitch is flipped off, terrible things happen. After invading moth larvae the worms vomit up their bacterial partners, which have been transformed by the madswitch into a living bio-weapon - seven times larger than the dormant version, glowing red, and spewing deadly toxins. The bacteria and the worm then feed on the corpse of the larva, and the deadly cycle continues.

The idea that a switch can somehow change an individual from docile to deadly is at least as old as Jekyll and Hyde. *Transformation* - of a mother, a brother; even, with dark humour, a dog - are central to Justina Robson’s near-future vision of an existence in which “better living through chemistry” is a necessity rather than a recreation.

Carol, the narrator, plans to “fix” her dysfunctional family, but her homebrew Ecstasy - chemical creator of “peace, love, unity and respect” - is, she hopes, nothing more than a fallback position. Her real plan is to engineer bacteria to “persuade” them to produce oxytocin - the so-called “trust hormone” - and to then somehow spike her family with the modified cells.

The notion of bacteria serving as miniature drug factories is nothing new; human insulin produced by *E. coli* came into use thirty years ago. Genetic engineering is now combining with rapid advances in computer power and mathematical modelling to create a whole new field of research - *synthetic biology*. Across the world, teams of scientists and engineers are stripping down and rebuilding biology - not yet from scratch, but often with surprising, playful or profound results. Some want to make cheap biofuels, others cheap anti-malarial drugs. Teams of students show off their creations at an annual jamboree known as the “international genetically engineered machine” competition.

Until very recently, hacking biology has been available only to the professionals - trained researchers with access to the necessary, kit, chemicals, and expertise. However a growing movement - so-called “DIY (do-it-yourself) bio” seeks to bring to a much wider audience the power to tinker with life. Although, for now, these “amateur” operations often include at least one professional scientist with transferable skills, DIYbio is opening up the possibility of non-trivial genetic modification of living organisms happening in a garage, kitchen or bedroom near you. The surprising thing is how *unsurprised* by all of this we have become. Genes and DNA are now part of everyday conversation. The artist Tuur van Balen recently discussed how engineered bacteria might - in the future - produce Prozac-laced yoghurt, with the aim of encouraging debate about how synthetic biology might be used in the future. The fact that his proposal was picked up and reported as happening *right now* is testament to the surface credibility of such ideas; as Christina Agapakis

observes, our jaded imaginations now think nothing of “mixing bacteria with the `gene for Prozac` to create antidepressant yoghurt.”¹

So, perhaps engineering bacteria to produce trust chemicals is not so far away. But if “good” applications like that are possible, then questions often follow about the likelihood of equally “bad” uses. The dangers of determined misuse are perhaps vastly outweighed by the risks from casual sloppiness and poor lab hygiene. Carol’s care-free disposal of experimental detritus down the drain (thus releasing it into the wild) is a much more plausible (and perhaps common) scenario than a bunch of bio-terrorists cooking up a deadly new superbug. Why try to build your own nuclear device when you can obtain anthrax relatively easily and cheaply? As Carol is dispirited to discover, her own convoluted plan to introduce oxytocin into the family would be much more easily (and cheaply) implemented using over the counter flu spray, combined with a touch of social engineering. The negative consequences of democratising biology are much more likely to come from accidents than agitators. Carol belatedly discovers this when her *T. Carolii* organisms are let loose into the world, and she realises that it can never be undone.

But the most interesting issues raised by Madswitch do not centre on possible intentional or accidental dangers of DIYbio (the focus of most ethical discussion around the topic). Instead, the story explores the personalized, *domesticated* use of biotechnology, in a way that is credible and thought-provoking. Carol may be doing science, but her reasons are different from those of many professional scientists - they are emotion-driven and deeply personal (although many scientists, of course, also have such intense feelings about their work). The dog’s green tail is a kind of memorial to her problematic father, and she wants to produce “feel good” chemicals to calm her relatives and make her domestic environment more bearable. Perhaps one of the most interesting aspects of DIYbio is that amateurs like Carol might think about using the technology in ways that would never occur to professional scientists and engineers.

What Carol does have in common with some synthetic biologists, however, is the desire for *control*. In the quiet of the shed, and in the company of her ‘beautiful’ beakers, petri dishes and containers, she has temporary dominion in a world that is otherwise hard to manage. There are clear similarities here to one of the main aims of synthetic biology practitioners; to make “messy”, complicated living things behave rationally and predictably. However, such control may not always offer the best solution in the domain of human relationships. Carol immediately thinks scientifically when she looks for technological solutions to her troubles. Rather than trying to hormonally placate her demented mother and autistic brother, perhaps she should consider joining a social-support network for full-time carers?

Sadly, Carol concludes that maybe the problem lies not with her relatives, but with herself. Her solution is to self-medicate. The fake roses on her father’s grave look real from a distance, and so does her happiness... Or does the story actually have a happy ending? Does Carol master biological engineering, and is her family moving towards a better life, thanks her technological skills?

¹ <http://blogs.discovermagazine.com/crux/2012/03/06/the-prozac-yogurt-effect-how-hype-can-affect-the-future-of-science/>

Much discussion of DIYbio (and synthetic biology more generally) is either optimistically utopic or terrifyingly dystopic. Madswitch offers a refreshing, alternative view that is neither – it refuses to give us a simple message.