The biologists strike back

Time machines, spaceships, atomic blasters — the icons of science fiction tend to come from the physical sciences. But science fiction has a biological side too, finding drama and pathos in everything from alien evolution to the paradoxes of consciousness. *Nature* brought together four science-fiction writers with a background in the biological sciences to talk about life-science fiction.

A shorter version of this round-table was published in *Nature* on 5 July 2007 (see *Nature* **448,** 18–21; 2007). For reasons of clarity it was edited in a different way from this fuller version of the discussion, and so the two do not necessarily match up word for word. The technical name for this procedure is cheating.

When you were children, which bit first: an interest in biology or an interest in science fiction?

Paul McAuley: Both at once, I think. I can remember being interested in science fiction at 7 or 8 and being interested in creepy crawlies and doing lots of leaf drawings when I was about that same age.

Ken Macleod: In my case I think it was science fiction first, actually. I got interested in science fiction and, partly through science fiction, roundabout the same time I got interested in science. However, I very soon discovered that I wasn't very good at maths and if you're interested in science and not very good at maths, you're left pretty much with biology, which is what I ended up doing as my first degree.

Peter Watts: It was pretty much simultaneous for me, too. I was six years old, a friend showed me his aquarium and I heard an old CBC dramatization of *20,000 Leagues Under the Sea*. That kind of sold me simultaneously on science fiction and marine biology.

Joan Slonczewski: I was always going to be a scientist. My father was a world-class physicist, but when I was around age six, I really liked biology because it was so colourful. I was amazed by the animals in Heinlein.

I ended up in microbiology because microbes are the most fantastic creatures, more diverse than any other kind of creature in the natural biosphere. In fact, for much of my career it's been hard to tell which is more bizarre, the kind of research that I'm doing or the kind of science fiction I'm trying to write. In the textbook I'm doing now I've been writing about organisms that live 2 kilometres below the earth in gold-mines and that live off hydrogen atoms produced by uranium decay. I have yet to see nuclear-powered creatures much in science fiction.

Creating creatures stranger than those already known to science must be hard.

Peter: Every now and then I think I'm taking a shot at it, but it always trips my ass ultimately. In my latest book, *Blindsight*, I thought I had come up with the ultimate alien: they didn't even have genes, and most of their metabolic processes were mediated by external magnetic fields. I thought I was really striking off into new and unexplored territory. But when it comes right down to it, I had described, at least in terms of gross morphology, brittle stars. Something that essentially had a whole series of pinhole cameras across its entire body surface, something like a very large telescope array. And that's pretty much what brittle-stars have. Back when I was 12 years old I must have read all this in *Our Friend the Echinoderm*, and I'd just forgotten it and it sort of bubbled back up and I took credit for it. Fortunately, not too many people who read *Blindsight* know much about marine biology, so it's working, but I'm a fraud.

Joan: I actually teach a course on biology and science fiction for students who have trouble with a standard science course. There are certain books that do a wonderful job of teaching science through science fiction — Kurt Vonnegut's *Galapagos* is a great example. Too many people think that evolution is teleological and always ascending, but evolution can just as easily descend by natural selection for loss of traits. It's an idea that's important in understanding evolution generally.

Peter: I've got to second that. I think that was Vonnegut's best: it got evolution right. The idea that what is left of our civilization a million years hence is that when one of our seal-like descendents farts on the beach, the others just laugh and laugh — that's a wonderfully ironic and potent summation of human achievement.

Joan: *Galapagos* picks up where H. G. Wells left off. The opening quote in *Galapagos* is a throwback to *The Time Machine*, and my students and I usually read those two paired. But *Galapagos* goes into it in more detail, with examples that are related to contemporary things. And Vonnegut also tries to show how the science relates to religion. He shows how a religious view of his story can be juxtaposed with the scientific view and enables students to see the difference between religious questions and scientific questions. So he's a tremendously humane author.

Paul: Evolution is a keynote that runs through most of H. G. Wells's science fiction. The human race was going to slip down into unthinking Morlocks and Eloi or we could continue to rise and become the big-brained, small-limbed creatures that are the kind of epitome of science-fiction cliché of future man. Wells was taught by Huxley, had a zoology degree and so on, so he had a good grounding in it. But there were plenty of other people following on.

Ken: One of the good examples, I think — not exactly darwinian, but a successor to Wells in this respect — was Olaf Stapledon, who certainly had the idea that the human future could be quite diverse and very far from onward and upward. I think one of the post-human species of last men were some kind of not very intelligent burrowing creatures on Venus.

Peter: I'd like to set Larry Niven up for some backhanded praise. I mean, the idea that humans are descended from aliens and so on is just totally dead wrong, but he had technically advanced aliens that were not very smart, because they had abilities that would

Who's who

Ken Macleod took a master's in biomechanics and worked as a computer programmer before becoming a full-time writer based in Edinburgh. He is the author of the *Engines of Light* novels, the *Fall Revolution* novels and most recently of *The Execution Channel*.

Joan Slonczewski is a microbiologist and a professor of biology at Kenyon College in Gambier, Ohio. She is the author of six science-fiction novels, most recently *Brain Plague*.

Paul McAuley has been a full-time writer, almost exclusively of science fiction, since the late 1980s; before that he was a lecturer in botany at the University of St Andrews, Scotland. His latest novel is *Players*.

Peter Watts says he has a spent much of his adult life trying to decide whether to be a writer or a scientist, ending up as a marginal hybrid of both. Having done research in marine biology, he is the author of the *Rifters* trilogy and most recently of *Blindsight*.

allow them to control other aliens and therefore obviated the need for a huge amount of intellectual prowess on their own. He had kin selection. He had highly intelligent technological species that would switch sides in a series of bloody wars the moment they found out that they were more closely related genetically to one side than to the other. And he was doing this back in the 1960s and early '70s. His nuts and bolts were almost invariably wrong, but I think he had a feel for the sense in which darwinian processes trump brains. He showed aliens that tended to adhere, I think, more strictly to darwinian principles than most of us would like to think of ourselves as behaving, and I would give him props for that.

Joan: I think one of our least appreciated authors is Octavia Butler. In her *Dawn* trilogy she develops an alien race that engineers itself to perfection, the Oankali, but that becomes too perfect to survive. They have to interbreed with other races in order to become diverse again, even though becoming diverse means becoming inferior. I think that question of what we're going to do with our genomes, I think that's a fundamental question that biology's looking at.

Paul: In Wells's time, evolution was some blind force. We've now got the opportunity to start directing evolution ourselves.

Joan: We can change our genes based on cultural views, what we believe are better genes. That's what the aliens in Butler's books are doing when they mate with humans. But what happens when it turns out the environment changes and that's not the best gene or we make a mistake? And what happens if we lose the variation that's required in the environment?

Those are great questions, but is science fiction good at answering them? Take cloning — how helpful has the vast amount of pre-existing science fiction about cloning been in informing the post-Dolly debate?

Joan: My impression is that for the students it was more helpful than not. That is, if Dolly had happened and there was no context at all, where would you begin to discuss what had happened? Whereas because there was a whole science-fiction tradition of questioning the ethics of cloning and the ethics of making people for spare parts, you had at least somewhere to start.

Ken: I think the prior art provided by science fiction was distinctly unhelpful in dealing with Dolly and cloning: ludicrous drek about cloning armies of soulless robots and *The Boys from Brazil* cloning Hitler, and the whole Frankenstein mess. And the actual ethical issues that arose with cloning were essentially none of the above. It was the fact that so far, as far as I know, cloning produces only somewhat defective copies of the original, and that you couldn't ethically clone a human being simply because the clone would quite possibly have congenital problems, which you can inflict on a sheep but you can't inflict on a human.

Joan: I used to agree with your point that bad science fiction was an obstruction to learning, but as a biology professor I learned that sometimes bad science fiction is better than none at all. For example, you could poke Michael Crichton's portrayal of dinosaur cloning full of holes, but those stories encouraged a whole generation of molecular-biology students. As a result, we have a molecular-biology programme now at Kenyon College.

And that's really due to *Jurassic Park*?

Joan: Yes, we call it the *Jurassic Park* generation.

Paul: The big problem I have with Michael Crichton is he's basically anti-science. That old cliché of things that man wasn't meant to know embodies most of his work. Science is always running out of control, with people coming in to mop up afterwards. I think that the effect that Joan is seeing is from the film more than the novel, the wonderful scene of the dinosaurs up there on the screen. In the novel the hero was a lawyer. That's how anti-science it was.

My stuff gets compared to his stuff occasionally and I just have to say, 'Well, no'. Because I like science, I like scientists. I like what science does and I think that on the whole it's a good thing — and I think Crichton thinks the opposite, mostly. But the good thing about Crichton's work is that he does show, usefully I think, that science is not ethically valueless. Some scientists tend to argue that knowledge is knowledge for knowledge's sake and that we should just find out what we can and damn the consequences. Crichton does actually cast the shadow of what we find back on to society and what's going to happen to it if we take these things to their logical conclusion.

That said there's the argument, put forward by Brian Aldiss, that science fiction springs from the gothic-horror tradition, with *Frankenstein* as its founding text, and that therefore 'there were things man was not meant to know' is a fairly central idea to the genre.

Joan: I think the problem with science fiction is that it embraces so many different things. It also embraces the anthropological fiction of Ursula Le Guin, who is one of my founding mentors. For science fiction, I think the broadest definition is that it's fiction involving extrapolation in science, involving extrapolation of our science into future science; and I think that you can't say that because someone likes science or not that they're not writing science fiction.

Peter: There's a cautionary tale, the whole idea of 'If this goes on…', that is a very strong branch of science fiction, but I think that's only a subcategory of the larger literature dealing with the impact of scientific and technological change. When I start writing, I like to think of it as a sort of thought experiment. I go where the data lead, and I do not explicitly start off with a goal of writing a cautionary tale of saying that the world is turning to shit. That does seem to be where my stories all end up ultimately, but that's just because I'm following the data and there is an inertia to big systems and we can't realistically imagine a situation in which things would be better by 2050 unless we had actually had gotten serious about cleaning things up 20 years ago.

Ken: I'm kind of dubious about Aldiss's whole argument — although when I read it many years ago I was quite impressed with it at the time. If we look at *Frankenstein* as the founding text of science fiction, what offspring did it have? And looking at it that way, it's more like a kind of Piltdown man than an ancestor.

I tend to agree with Gary Westfahl, a science-fiction critic who has said that in fact the real founding father of science fiction as we know it today was Hugo Gernsback, who edited *Amazing Stories* in the 1920s. Science-fiction stories still tend to abide by what Westfahl called the gernsbackian contract, which is that basically we give the reader some kind of adventure and we give them some sugar-coated science education while we're about it. I think that kind links us to the distinction between science fiction and techno-thriller. The sort of thing that Michael Crichton writes is different from the sort of thing that Paul McAuley writes. Even when what Paul McAuley writes looks like a techno-thriller, he's actually sneakily writing science fiction in disguise. I attempt now and again to do the same thing.

The difference is that in the techno-thriller, the lab eventually gets burned down, the genie gets back in the bottle, the evil scientist is defeated and so on. That's not the spirit of science fiction at all.

Paul: Ken's hit the nail on the head there. Science fiction posits that change is good and that change will happen and doesn't necessarily say in which direction change will go.

Joan: Women in the 1960s developed a whole different view of anthropological science fiction: if society was structured differently so that women were the dominant gender, or if society was structured differently so there was no gender or if there was a third gender. Ursula Le Guin, Sherri Teppler and Octavia Butler devised whole different kinds of biology because at the time science fiction was the only way to write about these different kinds of society. Ironically, since that time, zoologists have discovered many different kinds of biology in the animal kingdom that were perhaps imagined by these authors.

Ken: There's a lovely example of something like that in Mary Gentle's novel *Golden Witchbreed*. Reading it, you very soon discover that there is no distinction between the expectations of the two sexes on this planet, and the reason is that nobody knows what sex they're going to be until puberty, so everyone has to be raised pretty much the same. I thought that was a wonderful way of creating a kind of feminist utopia — although the society in the book doesn't have any other utopian characteristics.

Paul: I think that in the vast lab that is the Earth, you can find just about any variation on sex. The interesting thing is when you start applying that to human nature, as these books do. The great power of science fiction is first of all it's able to do that, and second that it's able to get away with it without causing so much fuss. Science fiction gets away with much more radical stuff than Salman Rushdie. Fortunately, not so many people pay attention to it. We can sneak in under the radar with all these outrageous notions, and these manipulations and speculations about human nature. In the end it comes down to human stories.

Peter: Just to play devil's advocate for a moment, how would you guys react to the argument that if we can get away with it, we're not really doing the job? That if nobody gets pissed off by what you're doing, you are essentially conceding defeat when it comes to actually trying to provoke action.

Ken: I don't see science-fiction writers as agents for change. I think we're here not so much to bring about change but to investigate and imagine change. What happens as a result is the responsibility of the readers, not of the writers.

Joan: I think the imagination of change has to come first. If you don't do that, you're not a science-fiction writer. But I think there are some science-fiction writers who attempt to be scandalous. I think Robert Heinlein's *Stranger in a Strange Land* was considered extremely scandalous when it first came out — it posited a religion where there is cannibalism at the core of it, which was an attempt to imitate the Eucharist, and had all kinds of things that were then considered scandalous.

Ken: Yes, but have you ever come across anyone who was genuinely scandalized by *Stranger in a Stranger Land*? I mean, I was a little Christian fundamentalist when I first read it as far as I can remember and I wasn't scandalized. I was kind of mildly titillated, but…

Joan: In Ohio we're a little more easily scandalized, perhaps.

Science fiction has always been interested in 'the other' — and these days that other is as likely to be a computer program as an eight-legged alien. How does the interaction between biology, technology and artificial intelligence feature in your work?

Joan: One of the things that fascinates me is how people react to ideas of aliens or of artificial intelligence, and it seems to me that the way we treat artificial intelligences has a lot in common with the way we treat immigrant labour and the lower classes, or slaves. We think about these machines as slaves to do our work, but the more like us the machine is, the more effective a servant it is. This is the kind of dynamic we don't like to think about, but that has gone on in the way we treat either immigrant labour or slaves historically. Some studies have shown that even people who are very computer literate will treat their desktop computer as if it were another person. What if their computer were to become so powerful it actually wakes up and demands human rights?

In my book *Brain Plague*, there are technological entities that have sentience, whether they're robots or an entire transit system and it's just assumed that although they're robots, they're also just another ethnic group. My view as a molecular biologist is that our own bodies are machines composed of molecules and the computer on my desk is a machine composed of molecules, and the only difference is which one has woken up.

Ken: When I wrote my first novel, *Star Fraction*, I wrote it partly under the impulse of the feeling that Richard Dawkins and his selfish gene and the propagation of memes were something not widely enough known. I had to spread the word about these new and exciting ideas, and you know that whole thing of darwinian evolution going on in electronic systems seemed to me to be an enormously exciting and fruitful line of work and now it's pretty much all-pervasive on the talk shows. I think I was pretty much behind the curve even when I wrote it, though it didn't seem like it.

Paul: I found Kevin Kelly's *Out of Control* quite inspirational back in the 1990s. It was one of the first non-fiction books — there's a bunch of them around right now — to start templating biological paradigms onto technological behaviour. It was a wonderful idea, and he spun off a bunch of further ideas from that, seemingly without caring where he was going or how ridiculous he looked. I think that's part of the thing for science-fiction writers — not to be bothered to be ridiculous, Because let's face it, people think we are already.

Peter: When the critics review my stuff, review my books, there's the usual reference to you can tell this guy's a marine biologist, but people don't jump up and down and say what groundbreaking marine biological concepts. But in my *Rifters* trilogy I wrote about Maelstrom, which was a far-future, massively super-evolved descendent of the Internet; all I did there was apply darwinian principles, assume you get your computer viruses, set them loose to breed in the wild, and end up with a seething electronic ecosystem that reproduces 200 times a second. It didn't strike me as a particularly radical innovation and I don't think any biologist would find that. But people who were in AI [artificial intelligence] found this a massively innovative idea. I started getting letters from this guy who works in the Lawrence Livermore lab who told me that he had found my portrayal of digital ecosystems inspirational in his own work, which I found a little bit creepy because of the kind of things they do at the Lawrence Livermore labs and the fact that he couldn't tell me exactly what his work was.

The way my ideas about marine biology fall by the wayside and my ideas about AI get taken up makes me think that our imaginations are hamstrung in our own area of expertise. We know too many reasons why this, that or the other wouldn't work. We're perhaps a little too cognizant of our colleagues peering over our shoulders and ranking us as one or two steps above child pornographers because we write that sci-fi stuff in the first place. I wonder if some of the most innovative stuff comes when you retain the respect for logic and the respect for consequence, but you leave behind that infestation of fact and dogma that you used in getting your degree.

Paul: Well, that's why I quit science, folks. To get away from that self-censorship thing. I'm partly joking, but only partly. One of the useful things that science fiction does is to get out from under self-checking circuits that scientists must use when they're doing their work and just let rip and dance away with it. Doing science is like slogging through mud. Science fiction straps on mud shoes and dances off over the surface and onto the horizon, gesticulating madly and doing all sorts of silly little dances, but sometimes doing useful stuff.

Joan: I actually find science to be inspirational for science fiction. I can still remember seeing an isolated photo-pigment that a grad student had got in a test-tube that was purple, and he shone light on it and it bleached white and this idea of the colourful switch enabled me to imagine: 'What if people had symbiotic microbes that would turn a switch depending on the environmental situation'. Later, that same pigment was used in a molecular switching device to make biochemical computers. So I think that science can be inspiring if you're doing it; you just have to be willing to not be inhibited in taking it a little farther.

Ken: In the novel I'm working on, one of the assumptions in it is that some AIs become self-aware because they're combat-robots and

they're required to have ever more sophisticated theories of mind to work out what the guys they're about to shoot are going to do. But the other AIs, the ones that do our dirty work for us, like the police national artificial intelligence, which is one of the characters in my story, don't necessarily have self-awareness in the human sense at all.

Peter: The US military is developing a battlefield personnel-recovery robot that looks like a teddy bear. You think I'm joking, but I'm not.

Ken: In Iraq, US soldiers have developed quite intense attachments to their 'bots.

Paul: I'd like to ask what the bomb-disposal robot's opinion is of being treated like a teddy bear rather than an actual bomb-disposal robot. It might be quite cross.

Peter: The creepy thing about self-awareness is that 'the other' may in fact have been inside us all along, it may really be the one in control. The conscious decision to move your arm occurs half a second after the motor nerves have started firing, the conscious event is an executive summary received after the fact. This little self-aware homunculus behind the eyes doesn't seem responsible for nearly as much as it gives itself credit for; the heavy lifting seems to be done by something deeper, something we don't have conscious access to. I played with this idea in *Blindsight*, in which although there are aliens, there is no 'other'; the things our heroes meet are hyperintelligent but utterly nonsentient. And maybe that thing inside us that we can't feel, that makes the real decisions, that lets us think we're in control — maybe that's the same way.

Let's end with your favourite biological moment in science fiction.

Paul: In *Blood Music*, by Greg Bear, when the protagonist looks down the microscope and he sees the bacteria have created little circuits that look like cities. A moment of 'Wow' like that is quite rare in science fiction, even though the 'Gosh, wow' thing is something we all aspire to. And it happened really early on in the novel, as well, which got even weirder after that. So I knew I was in for a good time.

Peter: Mine was Alice Sheldon's *The Screwfly Solution*. The idea is a rampant, literally epidemiological spread of homicidal hatred towards women, which society insists on treating as mass hysteria, whereas in fact it's been pheromonely introduced by aliens who want to clean up the real estate without using radioactive devices. So it's essentially a form of biological pest control.

Joan: For me, if it's a defining moment, it's the moment in Vonnegut's *Galapagos* in which the narrator of the story has the opportunity to decide whether to stick around for the next million years of evolution or to be taken off to heaven. And he decides that observing the next million years, no matter what, no matter how bad it is, that the next million years of human evolution are more compelling to him than going off to heaven. That to me is an inspiring moment.

Ken: I think that my sort of favourite biological science-fiction story is *Sunken Universe* [aka *Surface Tension*] by James Blish. It's an absurd idea that in the far future there are engineered human beings on another planet who are the size of protozoans. They're living in a puddle and they build what they call a spaceship, a little device made of bits of leaf and twig and so on that has wheels propelled by paramecium, and they laboriously drag this device across the dry land to the next puddle and at the end of it wonder if they have actually built this spaceship and crossed space like their ancestors did. And I loved that as an image of where we are and what we can do. ■