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Slowing things down: Lessons from the GM controversy

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Abstract

This paper stages an encounter between one strand of the controversy around genetically modified food crops and some conceptual resources from the field of science and technology studies, with the aim of illuminating the relationship between science and politics. Contrary to some suggestions, it is argued that the spatial, temporal and material imagination encapsulated in the figure of Progress remains central to their contemporary articulation. Best described as an 'anti-political' strategy, Progress does not leave room for anything else but one story of the world. Through following the attempts of both scientists in the field and protestors on the streets to make public some of the trajectories which this story leaves out, what emerges is the possibility of an alternative to Progress that is not based simply on its rejection. Instead, such efforts offer resources for inventing another way of collectively going forward which chime with some more theoretical attempts to elaborate how things might be productively 'slowed down'. An example of how government was forced to construct a way of dealing with things that is more adequate and appropriate to life in a full world is compared with Bruno Latour's model of due process for nonhumans, before some conclusions are drawn about whether we should be depressed or hopeful about our ability to move on in the lights of such attempts.

Keywords: Progress; Isabelle Stengers; Bruno Latour; GM controversy; Bt crops; Monarch butterflies

> 'The biggest mistake that anyone can make is moving slowly, because the game is going to be over before you start.'
>
> Henrik Varfaille, Senior Vice President of Monsanto Company
>
> '[T]he collective obliges us to slow down, that is to represent, again and again, the pains of the progressive composition of the cosmos.'
>
> Bruno Latour, *Politics of Nature*

1. Introduction

One would not normally expect to see the distinctive orange and black markings of the monarch butterfly on the streets of Seattle, certainly not in late November, early December anyway. And yet there they were all over the city in the winter of 1999, hard to miss even in the crowds. On closer inspection, these flashes of brightness did not actually belong to monarchs in their biological form, but were instead the sign of costumes lovingly constructed to give the unofficial 'national insect' of the US a shimmering (quasi-)presence amongst the shifting multiplicity that constituted the protests at the pre-millennial WTO ministerial.

What I want to suggest in this paper is that understanding how this unscheduled appearance of the monarchs at Seattle came about can tell us something important and perhaps even useful about the relationship between science and politics at the start of the twenty-first century. Their colourful cameo, I will argue, dramatically illustrates at once the significance of that relationship and why it needs some attention. Specifically, it confirms sociologist Sheila Jasanoff's recent assertion that 'democratic theory cannot be articulated in satisfactory terms today without looking in detail at the politics of science and technology' (Jasanoff, 2005, p. 6).

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To explore how and why this might be so, I will bring the story of how the monarch came to be represented at Seattle into conversation with the body of conceptual work known best as science and technology studies (STS). In particular, I shall be drawing on the writings of Isabelle Stengers and Bruno Latour (for introductions in Geography see for example Whatmore, 2003; Bingham and Thrift, 2000, respectively). As I hope to demonstrate in what follows, there are at least a couple of reasons for staging this encounter. Firstly, because Stengers and Latour have begun to provide the philosophical resources required for doing justice to the increasing visibility of nonhumans (such as the monarch) at the centre of political struggles. Resources which allow these 'things' to be figured much less as dead (and buried) objects and much more as live (and lively) issues (e.g. Stengers, 2000; Latour and Weibel, 2005); not simply as matters of fact but instead as matter of concern (Latour, 2004). In other words, without seeking to reduce science to politics (or vice versa) as in some of the more classically critical engagements with 'technoscience', they separately and together offer a means of thinking that relation as constitutive.

Secondly, the same two authors have started to explicitly expand on the normative side of their work such that it now offers some practical criteria for judging how well (or badly) we collectively deal with such things qua issues. To retrospectively caricature somewhat, the job of actor network theory (ANT) – for which Latour in particular is best known – was to (re)distribute the activity of the world thereby expanding in general what might count in our narrations. The more recent work in STS in which I am interested here, meanwhile, has become more concerned with investigating the specific ways in which the social is produced. This is reflected both by an increasing concern to define the different 'modes', 'regimes', 'styles', or 'logics' (for example Law, 1994; Stengers, 2004; Latour, 1999, 2003a; Fraser et al., 2005; Barry, 2005; Mol, 2006) through which the world emerges, and a new willingness to distinguish between the better and worse ways in which we collectively make things, decisions, and societies.

The idea of the paper as a conversation or encounter between a particular case study (involving the monarch) and a particular conceptual approach (involving Stengers and Latour) also informs the structure of the piece. It proceeds in three steps addressing (i) the notion of progress, (ii) its contestation, and (iii) possible alternatives. At each stage, first a theoretical discussion and then a illustration of practical consequences is offered. As the paper progresses it will hopefully become increasingly obvious how these ostensibly separate treatments are informing each other both in terms of the theory illuminating the practice but also – and crucially – vice versa.

2. Making progress in theory

In our supposedly 'late' or 'post' modern times, it has become fashionable to suppose that 'progress' is one of those grand narratives that 'we' do not believe in anymore. By way of contrast, I will begin this exploration of the current state of the relationship between science and democracy by suggesting that rumours of progress' demise have been greatly exaggerated. In fact, I want to follow Isabelle Stengers in arguing that it remains the case today that 'whether we speak of science or society, progress is the dominant image' (Stengers, 2000, p. 152). According to her analysis,

> 'it is what allows us to structure history, to separate the essential from the anecdotal, to make narration or signification communicate. For us, progress truly constitutes a measure of the march of time and the identifying mark that authorizes the person who speaks to judge. It also authorizes us to select, in a given situation, which narratives are illusory and which are truthful. Progress selects between what is worth conserving and amplifying and what can, with some transitory pains, be relegated to the past. It thus authorizes us to treat the problems of the present in two radically different ways, depending on whether these problems herald the future or represent a past destined to be superseded' (2000, p. 152)

Progress, as Stengers describes it here, then, does not describe the teleologically given or evolutionary driven direction in which modern science and/or society is inevitably moving. Instead she characterises it as one of the most profoundly powerful of political strategies. Whilst this is hardly a novel observation, what the richness of her formulation allows is the specification of that strategy as involving at once a politics of time, a politics of space, and a politics of materiality.

If progress is a 'politics of time' (Osborne, 1995), it is because it figures the story of modernity as a 'distinctive form of historical temporalization […] through which the three dimensions of phenomenological or lived time (past, present, and future) are linked together within the dynamic and eccentric unity of a single historical view' (Osborne, 1995, p. ix). According to Latour, what distinguishes the progress of modernity as such 'a different time' (Latour, 1993, p.1) is that, '[t]he moderns have a peculiar propensity for understanding that time passes as if it were really abolishing the past behind it' (1993, p. 68). What emerged from such discourses of modernity is, as Doreen Massey has recently reminded us, '*one* story, which the 'advanced' countries/peoples/cultures were leading. There was only one history' (2005, p. 71 emphasis in original).

And because there was only one story, one history, Progress as a politics of time is also always already a politics of space. Specifically a politics in which what Massey calls the 'real import of spatiality, the possibility of multiple narratives' is denied in advance. As she puts it, the 'regulation of the world into a single trajectory, via the temporal convening of space, was, and still often is, a way of refusing to address the essential multiplicity of the spatial' (2005, p. 71). I will return in more detail later in the paper to how 'the

challenge of space is addressed by an imagination of time' (2005, p. 71), but first I want to complete my brief sketch of the distinctive features of the figure of Progress by proposing that what we can now see is a specific spatiotemporal imagination is best understood in very material terms.

In this I am following Latour. The much touted 'progress' of the modern age, he argues, is not the progress of modern humans. Their history, he writes, remains 'contingent, agitated by sound and fury' (2005, p. 71). Instead, it is the progress of modern objects and the 'total revolutions' they are supposed to bring which is the key. Hence:

> 'the history of the moderns will be punctuated owing to the emergence of nonhumans – the Pythagorean theorem, heliocentrism, the laws of gravity, the steam engine, Lavoiser's chemistry, Pasteur's vaccination, the atomic bomb, the computer – and on each occasion time will be reckoned as starting from these miraculous beginnings, secularising each incarnation in the history of transcendent sciences. People are going to distinguish the time 'BC' and 'AC' with respect to computers as they do they years 'before Christ' and 'after Christ' (2005, p. 71)

Into Osborne's sentence 'Modernity is a form of historical time which valorises the new as the product of a constantly self-negating temporal dynamic' (1995, p. xii), we should, perhaps, add the words 'space-' before 'time' and 'object' after 'new'.

To summarise, then, we might consider Progress as a specific style of 'socializing nonhumans' (Latour, 2004), a way of bringing new things into the collective. This style is technologically determinist in at least two senses. First, because it both offers and justifies a particular view of 'technology transfer' whereby a novel entity produced in a laboratory or other site of scientific production is presumed to cross the boundary into an undifferentiated social where it causes permanent and predictable changes in people's lives according to the properties by which it is defined. And technologically determinist second, because it tends to equate technical innovation with innovation per se (see Barry, 2001 for an exploration of the implications of this point) and thus measure the forward momentum of the collective by the speed at which it can generate new things. All told, although I defined it earlier after Stengers as a political strategy, Progress is possibly best described as 'anti-political' in the sense that Andrew Barry has used that term to refer to moves that close down the space for contestation, dissensus, and multiplicity (2001, p. 207). Progress simply does not leave any room for any-thing else. Any other trajectories, any other versions of becoming.

3. Making progress in practice

The soil microorganism *Bacillus thuringiensis* (hereafter Bt) has been described as the 'probably the single most important insecticide ever discovered' (Benbrook and Hansen, 1997). Although pretty much ubiquitous under the surface for millions of years, Bt only began its 'social life' in earnest at the beginning of the last century when it was isolated by a Japanese scientist. In the years that followed, as evidence emerged of how this insecticidal action worked and could be manipulated, the various subspecies of Bt began to be used as what is now known as a biopesticide. Because of the way that it leaves no poisonous residue, degrades rapidly in sunlight, and can be used to target certain pests without having a detrimental effect on mammals, birds or most non-target insect species and micro-organisms, it became one of the few pesticides that organic farmers are permitted to apply to their crops.

Then, in the mid-1980s, the socialisation of Bt took a significant turn. After the strand of DNA that codes for the protein that gives it is toxicity was isolated, Bt re-entered the laboratory. The race was on to produce a commercially viable use for what was described as 'the first useful gene' (Charles, 2001, p. 41) as far as the genetic modification of crops was concerned. Unwittingly Bt had become part of the project – embodied in biotechnology – to transform biology into what Stengers calls a 'theoretico-experimental science' (2000) along the lines of classical physics. This mode of science, she argues, organises the relation between knowledges, witnesses, and objects in such a way that what emerges is 'the invention of the power to confer on things the power of conferring on the experimenter the power to speak in their name' (2000, p. 89). In other words, by its ability to 'mobilise' (2000, p. 114) both humans and nonhumans alike, theoretico-experimental science positions itself as telling the truth of the world.

Here, it was the aforementioned Bt gene that was mobilised in an attempt to produce crops that would bypass the need for an external application of pesticide by expressing the genetically introduced protein through their leaves. The language of one entomologist who worked for Monsanto at the time is revealing: 'It was simply there for the taking', she says (Marrone quoted in Charles, 2001, p. 42). As Daniel Charles puts it in his account of the twists and turns that led to the production of commercially viable GM Bt crops (Charles, 2001, Chapter 4), this was 'too perfect a target for the fledgling biotechnology industry to ignore […] It was a simple gene that promised immediate and dramatic effects' (Charles, 2001, p. 42).

Whilst all this activity in the laboratory was going on, the regulatory landscape outside was also changing rapidly. The self-imposed and self-policed climate of responsibility and restraint on the part of scientists working with recombinant DNA that had been established in the US through the Berg Committee and the follow-up Asilomar conference in the mid-1970s, was now long past. It was now up to the national authorities to decide how best to deal with the novel organisms which they were well aware were already in the pipeline and would soon be requiring of a regulatory judgement. A critical juncture was reached in 1989 when a report produced by the National Research Council concluded that 'the *product* of genetic modification and selection constitutes the primary basis for decisions […], and not

the *process* by which the product was obtained' (quoted in Jasanoff, 2005, p. 53 emphasis in original). As Jasanoff comments, 'the message was unambiguous […f]or policy purposes, biotechnology was henceforth to be regarded as a supplier of a familiar class of products requiring familiar types of review – not as a unique technological process threatening society with uncertain or incalculable harm' (Jasanoff, 2005, p. 53).

What familiar types of review meant for a familiar class of products meant in terms of the GM Bt crops for which applications for commercial cultivation were made in the early 1990s, was regulation by the US Environmental Protection Agency (hereafter EPA) as a biopesticide. The EPA's risk assessment for Bt plants concentrated on two types of potential dangers. The first was the possibility of the development of insect resistance to Bt. A particular issue for organic farmers whose reliance on (non-GM) Bt as one of the few approved insecticides has already been noted, the intricacies of the ensuing debate are well covered elsewhere (especially Levidow (1999)). Of greater relevance here is the second area of concern assessed by the EPA, namely the effect on non-target insects. Here the EPA's own description of the work that they carried out is worth quoting at length:

> 'Prior to registration of the first Bt plant-incorporated protectants in 1995, EPA conducted ecological risk assessments for all Bt Cry proteins expressed in potato, corn, and cotton. EPA evaluated studies of potential effects on a wide variety of non-target organisms that might be exposed to the Bt protein, e.g., birds, fish, honeybees, ladybugs, parasitic wasps, lacewings, springtails, aquatic invertebrates and earthworms. Such non-target organisms are important to a healthy ecosystem, especially the predatory, parasitic, and pollinating insects. These risk assessments demonstrated that Bt Cry proteins expressed in transgenic plants do not exhibit detrimental effects to non-target organisms in populations exposed to the levels of Cry protein found in plant tissue. While EPA was aware of potential adverse effects on many species of Lepidoptera from Cry1 proteins, the Agency did not believe that non-target Lepidoptera would be exposed to sufficient amounts of Bt protein to cause an unreasonable deleterious effect, nor that Bt crops would threaten the long-term survival of a substantial number of individuals in the populations of these species. At that time, even though EPA knew that *Bacillus thuringiensis* var. kurstaki was toxic to Lepidoptera, EPA also concluded that threatened or endangered species of butterflies and moths would not be at risk because they would not be exposed to Bt Cry1protein in Bt crops.' (EPA, 2001, IIC32)

The significance of this last detail will become more clear later in the paper, but to conclude this section, a couple of general points about the context of the EPA's evaluation of GM Bt crops are worth emphasising. The first is, as Jasanoff has noted, that it took place just as 'the US discourse of regulating agricultural biotechnology began to equate risk assessment with scientific assessment. Public officials asserted that the only way to manage the threats of biotechnology was through risk assessment based on 'sound science'' (2005, p. 107). The idea that the commercialisation of GM crops might involve other sorts of risks than very narrowly defined threats of harm to human health or 'the environment' were becoming inadmissible. The state had decided that the best way to deal with the sorts of things produced by 'innovation science' was more science (what Jasanoff has termed 'regulatory science' (1990)). Secondly, this move can be seen in a broader historical context of the 'demonstration practices' (Jasanoff, 2005, p. 263) by which facts and things 'acquire credibility in the public eye' (Jasanoff, 2005, p. 263). As Jasanoff summarises, '[t]he tendency in the United States has been to conduct substantial sociotechnical experiments whose apparent success not only validates the immediate venture they stand for but bolsters the overall narrative of technological optimism' (Jasanoff, 2005, p. 263). The commercialisation of Bt crops was simply another example of this strategy and to begin with it seemed to work well.

Bt corn, for example, was sold as the answer to the answer to the 'ravages' (advertising material) of the European Corn Borer moth, whose larvae 'devastated' (advertising material again) around 7% of the Midwestern US corn crop each year (including 20% of some fields). Farmers were told by promotional literatures that Bt corn would 'simplify' their lives by 'purifying the environment'. Eventually licensed by the EPA in 1995, these corporate promises of a 'revolution in agriculture' were initially matched by a revolutionary take up. By 1999, Bt corn had captured a 20% share by plantings of the entire US corn market.

4. Contesting progress in theory

As both Nigel Thrift (1996) and Bruno Latour (1993, 1999a,b) have noted, anyone who tries to explain that (technological) revolutions attempt to abolish the past but cannot do so, is taken for a reactionary and treated accordingly. Such is the politics of time in action. This situation can be explained by the fact that, in the modern worldview, the only alternative to progress is 'decadence' (Latour, 1993). Both, of course, have the same origin (Latour, 1993, p. 72). That is why there exist as many instances of the 'modernization' of the world being represented in terms of the imagery of decline as the path to a shiny, happy future. The 'antimoderns', as Latour calls them, accept modern temporality wholesale: the only distinction is one of sign. The arrow of time, then, traces the arc of progress for the moderns, that of decadence for the antimoderns. The former embrace the future, the latter crave the past. For both, modernity is 'permanent transition' (Osborne, 1995, p. 14).

Interestingly, however, it may be the heretics who refuse both options that get the last laugh. By generating more

and more 'exceptions' to the 'rule' of the arrow of history, the moderns' very Constitution, by encouraging a proliferation of quasi-objects, acts to explode the very forms of temporality on which it is based. Is agricultural biotechnology, for example, as old as farming or a new as gene sequencing? Fortunately, in light of this situation, '[w]e are not attached forever to this temporality that allows us to understand neither our past nor our future' (Osborne, 1995, p. 74).

We might, for example (and it is only one example), experiment with thinking in terms of 'slowing down'. According to Stengers,

> 'slowing down is truly an anti-capitalist idea, since the force of capitalism is an abstract motion forward, the ongoing invention of new abstractions and new definitions of what is a *resource*, what is to be exploited, and what profits can be made. Capitalism is terribly inventive and one of its conditions is that no one can take the time to seriously ask about the consequences of what it invents, beyond profit-making. It is always a matter of speed, being faster than others, claiming the right to be fast […] Also capitalism is a process of mobilisation […] You know all the *mots d'ordre* about nobody being able to arrest progress, which are used against everybody who wants to wonder about consequences. It is interesting to just imagine what would happen if we did slow down mobilisation.' (Stengers with Zournazi, 2002, pp. 250–251 emphasis in the original)

Stengers' imagining is echoed both in the debates in political theory about speed and democracy (for example Wolin, 1997; Shapiro, 2002; Connolly, 2003; Mackenzie, 2002) and the best expressions of the emergent structure of feeling that is interested in slowing all kinds of things down for example, (slow) food, (slow) cities, (slow) knowledge, (slow) living: see Honoré (2004, for a popular review). Not least in the fact that, in this work, the point of 'unhastening' (Pels, 2003) is not to simply reject progress (that would be the antimodern move), but to redefine it. Indeed, for Stengers, 'slowing down is the condition for what I still call 'progress'' (Stengers with Zournazi, 2002, p. 252):

> 'From that point of view, I would emphatically say that I am not post-modern. What I mean by this is that the idea that we have to leave the ideas of progress behind is too easy a solution, much to easy […] We have to work in our own tradition, our own way of feeling, and not renounce progress – 'Sorry, we were wrong'. We cannot leave the game, because the whole world is now poisoned by our games. But we should be cautious with progress, utterly disentangle it from mobilisation, when you quietly destroy what you define as an obstacle to progress […A]s soon as you slow down […] many, many things become interesting.' (Stengers with Zournazi, 2002, p. 252–253)

I think we can usefully take Stengers talk here of things becoming interesting when we slow down quite literally. Because it is precisely all those other things, other stories, other trajectories, other becomings (Massey, 2005, p. 12) that were defined as not counting in the name of progress, which it becomes possible to pay a little more attention to once we are not concentrating solely on the one revolutionary object, the next big thing. Slowing down, then, is not a matter of turning back time. Rather it serves to bring back space, or rather the 'challenge of space' posed by Massey earlier. Being cautiously progressive (or progressively cautious) in Stengers' sense is thus about finding a way forward that is both adequate and appropriate to a world full of life and lives, a 'pluralistic cosmos' (Connolly, 2005, Chapter 3 after; James, 1996, also; Stengers with Zournazi, 2002, p. 260; Bingham, 2006). Such a way forward would have to be less concerned with the question of 'succession' and more with that of 'coexistence' (Latour, 1999b), less a trail blazing pushing back of the frontier, and more a set of navigational skills such as those described by the philosopher Michel Serres:

> '*Procedural*: this term has its origins in *procedo*, the act of walking, or rather moving forwards, step by step. This also means to advance among the particularity of sites and conditions. Can one define a way of thinking based on such a model? Is it not precisely what proper philosophy denounces as empiricism? Not even that, for at the end of its journey, empiricism intends to rejoin the universal it did not posit at the beginning. We are dealing here with something quite different - that is, taking seriously the particularities of the sites, the unpredictability of circumstances, the uneven patterns of the landscape and the hazardous nature of becoming.' (Hénaff, 1997, p. 72 summarising Serres, 1995)

Both Stengers and Latour find inspiration for conceptualising this 'hazardous nature of becoming' in the sociotechnical imbroglios that today so often accompany the introduction of things heralded as 'revolutionary'. In particular they are interested in what Michel Callon (2003) has called the 'concerned groups' that emerge around the 'matters of concern' which are increasingly replacing 'matters of fact' (Latour, 2004a). These are groups who *do* want to wonder about consequences (to return to an earlier quote from Stengers), publics called into being by the possibility that things might have of indirect and unintended outcomes (Dewey, 1927). What is of interest to Latour, Stengers, and others here is precisely that they do not seek a return to the past any more than they bemoan the loss of a simple future. Rather, they demonstrate the fact (and sometimes demonstrate about the fact) that this mirror image opposition does not work anymore, insisting on a recognition that in a full world things are not so simple. A realisation that going forward today can only mean 'stepping into an even more entangled future' (Latour, 1999, p. 290).

5. Contesting progress in practice

In 1998, Dr. John Losey, an entomologist at Cornell University, was studying whether the weeds in Bt cornfields could serve as an alternate host for the European corn borer, the insect Bt toxin killed. During this research, Losey noticed the large amount of milkweed in and around the cornfields. He wondered whether monarch larvae would eat any pollen that had drifted onto their sole source of nutrition and, if so, whether it would harm them. To find out, Losey and his colleagues conducted a simple laboratory experiment in which he misted milkweed leaves with water and sprinkled corn pollen from two different types of corn (one GM, one unmodified) onto the leaves at a density that visually mimicked the pollen density he had observed in the field. They then placed five three-day-old Monarch larvae on each milkweed leaf, and tested and observed their feeding habits and survival rates over the next four days. After that period, 44% of the larvae feeding on the milkweed dusted with Bt corn pollen were dead (compared to 100% survival on the controls), whilst those that survived ate significantly less than those exposed to the conventional hybrid pollen. Following peer review, a write up of the experiment appeared in the 'Scientific Correspondence' section of the March 1999 issue of *Nature* under the title 'Transgenic Pollen Harms Monarch Larvae' (Losey et al., 1999, p. 214)

Losey has since declared that 'I knew there would be a lot of interest in the results of this paper because it involved Bt corn and monarch butterflies, two things of interest to the general population' (quoted in Pew Initiative, 2003, p. 8). He was right. If there was any other trajectory – literal or metaphorical – which could compete with the hold that the story of Progress had on the US psyche, it was that of the monarch. The unofficial 'national insect', its enormous popularity was due in part to its charismatic (for an insect) good looks and size, but mostly to what has been called its 'intelligence' (Deming, 1997). For it is this intelligence which makes possible what has been called by the World Conservation Union (IUCN), 'the most striking and spectacular butterfly phenomenon on earth' (Wells et al., 1983, p. 463), the annual migration of up to 3600 km made by millions of North American monarchs back to precisely the same area of high altitude forests in central Mexico from where their ancestors four generations removed had set off the previous spring.

The exact mechanism that determines how the monarchs are able to make their remarkable journey with such unerring accuracy remains something of a mystery. We do, though, after forty years, the effort of thousands of volunteers, around half a million tagged monarchs, and a lot of on the ground leg work by Fred Urquart and his team, now know exactly where in Mexico all the millions of monarchs overwinter (a tiny area of oyamel forest high in Michoacan state, Grace, 1997). We also now know, thanks to the formalisation of citizen science initiatives such as the Monarch Larva Monitoring Project, Monarch Watch, and Journey North much more about how many monarchs make the trip to and from these overwintering grounds each year and the precise route they take (Howard and David, 2004). Further, thanks to some experimental set-ups ranging from outdoor cage releases (Perez and Taylor, 2004) to rather more down to earth ways of 'chasing monarchs' (Pyle, 1999), we now have a much better sense of whether the butterflies navigate by sun compass, get their bearings from the Earth's magnetic field, or orientate themselves by mountain ranges and river valleys (Solensky, 2004).

What is significant here about such mappings of the complexities of the monarchs' intelligence, is that they have taken place not in the lab but out in the world. By necessity, knowledge about how the monarch has 'learned to be affected' by, with, and through its environment (Hinchliffe et al., 2005; Thrift, 2004), has been generated by what Stengers terms the 'field sciences'. Working in this mode,

> 'the biologist loses the power to judge and must learn to recount. We here enter a problematic proper to the field sciences, which distinguishes them from laboratory sciences. One finds at work in the 'terrain' – in the depths of the ocean, in the museums where collected fossils are examined, in the forest where samples are harvested – as many sophisticated instruments as there are in the experimental laboratory, as much invention as the meaning of a measure. But one does not find experimental apparatuses in the Galilean sense, giving the scientist the power to stage his own question, that is to say, to purify a phenomenon and give it the power to bear witness to this subject; the instruments of the naturalist, or the field scientist, give him the possibility to collect indices that will guide him in his attempt to reconstitute a concrete situation, to identify relations, not to represent a phenomenon like a function furnished with its independent variables.' (Stengers, 2000, pp. 140–141).

Because they do not 'permit the construction of a point of view from which all cases would come back to the same' (Stengers, 2000, p. 140), these monarch field sciences do not offer an apparently time- and place-less 'authority' (Stengers, 2000, p. 126). As such they might be considered less 'vulnerable to power' (Stengers, 2000, p. 126) than the theoretico-experimental version of biology that helped produce Bt corn. We should be careful not to be reductionist or idealistic here, and certainly must not forget that there is nothing necessarily 'innocent' about fieldwork (see, for example; Massey, 2003). It is, nonetheless, useful to think through the differences between a world made 'available' through the process and practices of 'mobilization' (both Stengers, 2000, p. 116), and the 'problematic space' or 'problematic landscape' (Stengers, 2000, p. 64, 65) generated by paying close attention to the world as it is. Which is full of uncertainties as Stengers explains:

> 'Irreducible uncertainty is the mark of the field sciences. In effect, the terrain does not authorize its representatives to make it exist other than where it is. […] Field scientists are indeed more annoying than the allies who are interested in power, because they are interested in precisely what power, when it addresses itself to the theoretico-experimental sciences, makes one forget 'in the name of science" (Stengers, 2000, pp. 144–145)

What John Losey and his colleagues (working and observing in the field before they came back to the lab), 'annoyingly' suggested was that the biotechnology industry might have forgotten in the name of Progress that a significant proportion of the migrating monarch population would in any given year pass through precisely those areas of the North American corn belt where product genetically engineered to be toxic to certain Lepidoptera was being planted in ever increasing quantities. Certainly the EPA's conclusion in their risk assessment 'that threatened or endangered species of butterflies and moths would not be at risk because they would not be exposed to Bt Cry1protein in Bt crops' (EPA, 2001, IIC31) would start to look a little less convincing given that North American migration of the monarch had been classified as a 'threatened phenomenon' by the IUCN.

According to the EPA, however (although this has been disputed), they had indeed 'considered the potential toxicity of Bt-maize to Monarch butterflies' and concluded that 'Bt-maize poses an extremely low risk'. Such a conclusion 'rested on an expectation that there would be relatively few milkweed plants (Monarch food source) near or in maize fields and on an expectation that the amounts of MON810 pollen which might land on adjacent milkweed plants would be below toxic levels' (CEQ/OSTP, 2001, p. 25). Losey, though, had not pretended to bring definitive 'proof'. 'It [his experiment] simply raised the possibility of risk' as Margaret Mellon of the Union of Concerned Scientists put it (quoted in Pew Initiative, 2003, p. 9) But in so doing, he and his colleagues had become 'engaged in, and contribute[d] to, disrupting the political-economic calculuses' of progress (Stengers, 2000, p. 144), like all those the field scientists 'who try to model the 'greenhouse effect,' the consequences of deforestation, the effects of pollution' (Stengers, 2000, p. 144). Mellon again: 'Losey's finding undercut a vision of biotech as wholly safe and without problems' (quoted in Pew Initiative, 2003, p. 9).

In other words, by 'making public' (Latour and Weibel, 2005) the fact that the trajectory of Bt crops might adversely cross the path of another, the field (scientist) had raised an 'awkward question' (Stengers, 2000), an 'objection' (Latour, 2004). An awkward question about whether the biotechnology industry behind Bt had overestimated the relevance and underestimated the risk (Stengers, 1997, Chapter 1) of their innovation once it was extended out of the lab and into the field (by assuming that just because it worked safely in the former it would in the latter). An objection to the assumption that this new thing called Bt corn would simply 'replace' what had gone before rather than being added (Latour, 2003) and having to find its place (Mol, 1993) alongside all the other trajectories (of which the monarch was only one amongst many) that make up a very full world (Massey, 2005; Callon, 1998). Had, by assuming that Bt corn would behave the same everywhere and the environment would behave as it was told, the biotech corporations employed a 'strategy' that 'aimed to mask a change of milieu or signification, that is, to pass from a problematic of linkage to a chain of unification'? A strategy that Stengers urges us to treat as '*antidemocratic, that is to say irrational*' (all Stengers, 2000, p. 158, emphasis in original)?

Following the publication of Losey et al.'s paper in *Nature* in the spring of 1999, the explicit connection between science and power that Stengers makes in this quote was made in and by the public too. Almost immediately following publication, headlines such as 'Gene Spliced Corn Imperils Butterflies' (*The San Francisco Chronicle*) were all over the US. The *New York Times* put a picture of the Monarch on its front page and declared it the 'Bambi of the Insect World', whilst on National Public Radio, the butterfly went one better and became the 'Elvis of Insects'.

The aforementioned popularity of the monarch meant that it did not take long for awkward scientific questions to become awkward political questions, scientific objections to become political objections. Greenpeace called for an immediate ban on the planting of Bt corn, whilst volunteers dressed up on Capitol Hill as monarch butterflies which would fall down 'dead' when touched by the terrifying Bt corn-human hybrid. Similar scenes were enacted in greater numbers later in the year at the protests outside the WTO ministerial (where this paper started). On the streets of Seattle, Bt corn finally became an 'emblem of modernity' (Fischer, 1994; Bingham, 2005), but not quite in the way that the biotechnology industry had planned. Intended to represent – embody even – the modern age in a rather different way, the new plant ended up symbolising its discontents and raising questions about the modern way of dealing with (nonhuman) things. In a few short years, in other words, Bt corn had moved from being involved in a demonstration of progress to a demonstration of entanglement.

6. Progressing cautiously in theory

To recap, according to Latour and Stengers, making things (or decisions) in the name of Progress can result in what they call 'badly constructed propositions' (Latour, 1997, p. xiv). Because their production is guided by the imperative of speed, too often the risk is not taken to properly test, let alone ensure, that scientific or technical innovations are 'well articulated' (Latour, 1999a, pp. 142–144) with the other things that they will share the world with. As the complexity of our inventions leaves us more and more implicated in the world (not less and less as was the modern

dream), the aforementioned 'sociotechnical experiments' (Latour and Weibel, 2005, p. 263) are increasingly becoming truly 'collective experiments' (Latour, 1998). Experiments, that is to say, on the entire fabric of the collectives of which we are part (Latour, 2003, p. 77).

What is required, in this situation, according to Latour, is the establishment of a full-fledged 'philosophy of Research' (Latour, 1998, p. 208). This would both recognise that 'the laboratory has extended its walls to the whole planet […] the difference between natural history – outdoor science – and lab science [or field science and theoretico-experimental science] has slowly eroded' (Latour, 2003, p. 77), and seek to exploit the fact that there are now instruments and expertise 'everywhere' (Latour, 2003, p. 77). Instruments and expertise that are capable of reporting back on the collective experiments to which publics have so often been unwittingly enrolled. The motto here is 'no experimentation without representation', an exhortation which leads us directly to one of Latour's most famous notions, the 'Parliament of Things' (for example, 1993). Famous, but often misunderstood because the image tends to bring to mind a vision so strange – a chamber filled with all the objects and organisms of the planet – that it is easily and quickly dismissed as both a fantastical and farcical suggestion.

But, of course, this is not the proposal that Latour is offering at all. What he wants filling the space in question are not the 'things themselves', but 'matters of concern' (2004). Yes, such matters are material, but it those (humans) whom have become concerned by them who will doing the talking (and other forms of representing). A Parliament of Things is nothing more (although nothing less) than a parliament of controversies. Latour is thus both generalising and formalising lessons learned about how sociotechnical imbroglios are already being debated by the aforementioned 'concerned groups' (Callon, 2003) in various 'hybrid fora' (Callon, 2003) that they have helped invent. What this implies is that, to put the Parliament of Things into practice, we do not perhaps after all, 'have to invent ourselves as radically different from what we are, for we are already very different from what we believe ourselves to be' (Stengers, 2000, p. 165). Thus '[t]he Parliament of Things does not belong to the future, like a utopia that would have to be realised – it is not 'realizable'. It belongs to the present as a vector of becoming or an 'experiment of thought,' that is, as a tool of diagnosis, creation, and resistance' (Stengers, 2000, p. 155).

Perhaps the greatest challenge of this 'experiment of thought' is working out how best to (i) bring together representatives of all those concerned by a given matter such that they (ii) agree on a set of ground rules for engagement (see Latour and Weibel, 2005 for some practical suggestions). For if done well, it will be this activity of assemblage that will serve both to institutionalise the principle of slowing down introduced earlier (Stengers, 2000, p. 154; Latour, 2004:240), and thus act as the condition of possibility for what Latour has recently termed a 'due process for things' (Latour, 2004, p. 240). Briefly (see Latour, 2004, Chapter 3 for a fuller exposition), this style of 'exploration of the common world' (Latour, 2004, p. 109) involves distinguishing two forms of power and holding to four requirements.

Latour describes the first of the forms of power as 'the power to take into account' (Latour, 2004, p. 102). It is tasked with determining 'How many are we?' in a given situation (Latour, 2004, p. 109), when that 'we', as Donna Haraway (1997) has famously and pithily reminded us, is 'not all us'. Done well, this requires both a cultivation of the quality of 'perplexity' (that is to say, 'you shall not simplify the number of propositions to be taken into account in the discussion' (Latour, 2004, p. 109)), and a full and fair 'consultation' (ensuring that 'the number of voices the participate in the articulation of propositions in not arbitrarily short-circuited'). The second power is the 'power to arrange in rank order'. Here the goal is to produce an answer to the question 'Can we live together?'. This, in turn requires firstly the practice of 'hierarchization' ('[y]ou shall discuss the compatibility of new propositions with those which are already instituted, in such a way as to maintain them in all in a common world that will give them their legitimate place'). In other words, what is the relative importance of one thing (for example 'the health of the American economy' Latour, 2004, p. 107) compared to another (for example, 'the health of the world's climate' Latour, 2004, p. 107)? Then, finally, comes closure or 'institution', such that 'once the propositions have been instituted, you shall no longer question their presence at the heart of collective life' (all quotes Latour, 2004, p. 109).

Except, such closure will not be final at all because a third power – that to follow up (Latour, 2004, pp. 200–209) – will seek to ensure that the collective keeps on re-presenting itself, keeps on slowly, experimentally and, yes, progressively (re)composing itself. Unlike in the modernist settlement '[i]t need not claim that the things that it does not know at time t are nonexistent, irrational, and definitively outdated, but only that they are provisionally excluded beings on the path towards appeal, and that it will find these beings *in any event on its way to* $t+1$, since it will never be rid of them' (Latour, 2004, p. 195, emphasis in original). Moving forward by 'learning' (Latour, 2004, pp. 194–200), then, and learning by moving forward.

7. Progressing cautiously in practice

During the summer of 1999, the US biotech industry tried and failed to clear up all the 'confusion' about Bt corn and monarch butterflies. First they attempted to dismiss the significance of Losey and his colleagues by declaring their experiment was not 'realistic'. However, corporations deploying an argument long used against them by environmentalists (Jasanoff, 2005, p. 109) was considered a bit rich by the public, and served only to fan the flames of an already 'hot situation' (Callon, 1998). Then, a symposium at which the results of some field studies commissioned

by the corporations was being presented descended into chaos, when a blatant attempt to 'spin' the results was revealed.

Finally, stung by having been accused of providing only the 'illusion of care' (Bratspies, 2002, p. 297), the EPA stepped in. All too aware that the five-year limited registrations that it had originally granted Bt corn products were due to run out in 2001, the agency issued a 'data call-in' in late 1999 for studies related to monarchs and Bt. What this meant was that, in order to continue to sell Bt corn, manufacturers would need to submit data about the toxicity of Bt corn pollen, the level to which monarch caterpillars would be exposed to Bt corn pollen, and the potential impact of such exposures on monarch populations. Bearing in mind what had already happened, it was seen as vital that the data collected was 'sound and accepted'. A plan was thus devised which involved a broad-based panel setting the agenda, the US Department of Agriculture's (USDA) Agricultural Research Service (ARS) running the research, and a peer review publication process.

By bringing together the two sorts of biologists (crudely geneticists and ecologists) who had been fighting over the consequences of GM crops for years in the US (Jasanoff, 2005, Chapter 2), things finally got interesting. Interesting because, after convening would-be theoretico-experimental scientists and field scientists, representatives of the purified laboratory and the uncertain terrain respectively, the things themselves were finally allowed to be interesting. Some genuinely risky experiments (in Stengers (1997, Chapter 1), positive sense of risk) were set up that genuinely allowed some objections on part of all of the participants, some redefinition of the previously taken for granted. Three sets of findings stand out in this sense.

Firstly, it turned out that – as a direct result of a lack of consultation – the original risk assessment made by the EPA in 1995, when it began licensing Bt crops for commercial use, was based on an erroneous assumption, at least as regards the monarch. In its initial evaluation, as we have already noted, the agency considered the effects of Bt corn on non-target Lepidoptera and concluded that, while existing data on the bioactivity of the Bt toxin suggested that such organisms could be affected by coming into contact with material expressing it, most moths and butterflies such as the monarch would not encounter sufficient quantities of Bt to become significantly impaired. Specifically it was presumed that milkweed did not grow close enough to Bt corn for monarchs to be at risk. It was this presumption that turned out to be significantly problematic to say the least. Effectively asking not only 'How many are we?' (in Latour's sense) but also 'Exactly when and where are we?' the study led by Karen Oberhauser (see Oberhauser et al., 2001) determined that milkweed grow relatively commonly in fields planted with Bt corn. Further, female monarchs lay their eggs on milkweed plants in and around these agricultural habitats at rates comparable to elsewhere and at times which would mean that there would be considerable temporal overlap between the times of year that monarch larvae would be feeding and the time that Bt corn would be shedding pollen.

A second set of studies indicated that the sorts of experiments that could begin to answer the question of whether 'we' can 'live together', had never actually been done up until this point. In fact, it emerged that even for the non-target species which it had been assumed would (unlike the monarch) come into contact with Bt corn, lack of good data on these organisms had meant that risk assessments were conducted using indirect measurements and extrapolations from existing models (Murphy and Krimsky, 2003). According to some, even this sort of data might have been wholly inappropriate because it was produced by testing procedures designed for conventional pesticides, conventionally applied, not genetically-modified plants expressing novel proteins (EcoStrat, 2000, p. 3).

Finally, the ARS-sponsored studies demonstrated what the scientific problematisers and political protestors had suspected all along. Making things in the name of progress had indeed resulted in some 'badly constructed propositions' having made the journey from lab to field. Specifically this turned out to be the case in the case of Bt event 176, the 'Knockout' corn mentioned earlier. Whereas the overall findings of the PNAS-published studies indicated that in the cases of three out of the four Bt toxins being tested, it would require in excess of 1000 pollen grains per cm^2 of leaf to produce significant effects of mortality on monarch larvae, in the case of event 176, only 10 pollen grains per square centimetre would be potentially toxic (Sears et al., 2001). In what was later described as a 'lucky break' by Margaret Mellon of the Union of Concerned Scientists, because Event 176 expressed Bt in the wrong tissues (significantly more strongly in the pollen than the stalk) it had not become popular with farmers as it was not as effective as the other varieties. The fact remained however, that Novartis had received 'permission to plant a lot of this in the cornfield' (Mellon quoted in Pew Initiative, 2003, p. 17).

Following this attempt at producing a due process for Bt crops, on October 16, 2001, the EPA reauthorized the registrations of the other Bt corn products still on the market. Only Event 176 was deemed to pose any unacceptable hazard to monarch larvae and a commitment from Novartis was made that this variety would be phased out. While further data on effects on monarchs of long term exposure to Bt corn pollen was requested, some of the scientists involved in the PNAS studies felt that re-registration should have been delayed until more information on the anther issue was available, or at least include more formal opportunities for 'following up' than a blanket extra five years would allow (for example Obrycki et al., 2001; Rissler and Mellon, 2001). Despite these reservations, most of those involved came away feeling that the process they had participated in, with its multiple meetings and multi-stakeholder steering committee, was a 'model' one for 'resolving scientific controversies' (Pew Initiative, 2003, p. 18). One described it as a

'blueprint for how to do research in the public interest', and a representative from Monarch Watch judged that 'the process was fair. Almost all our questions were addressed, and many more'. Despite some qualms about how definitively the results had been used to assert 'lack of harm', even Margaret Mellon of the Union of Concerned Scientists who had sat on the steering committee agreed:

> 'This was a model way to go about getting information on whether or not a risk exists. It brought scientists, environmental and government folks together with industry, found a pot of money, set a research agenda, got proposals, funded the research and got it done before [EPA] made a decision about renewal. This was a really important process that should be followed routinely by the government as it makes decisions about GM products.' (quoted in Pew Initiative, 2003, p. 19)

8. Conclusion: is another world possible?

In some ways, looking back on the Bt corn-monarch butterfly controversy with the benefit of five years hindsight, it is easy to be depressed. Less by the hows and whys of the mechanism by which it was eventually 'resolved', or even by the fact of the EPA's decision to re-register genetically modified Bt crops for another five years (although both of these are perhaps deserving of challenge). No, more because of what happened next. Or rather what did not happen, because what did not happen was any attempt to reflect on the whole mess and especially successes and failures of the assembly that had been convened to deal with it. Not much evidence of Latour's 'learning curve' (2004, p. 194) here. The actual ending which I cut off the quote from Margaret Mellon that concluded the previous section is 'This was a really important process that should be followed routinely by the government as it makes decisions about GM products – and its not'. And she should know, for two years later she was having to make the same arguments all over again:

> 'The monarch story illustrates serious weaknesses in the US regulatory system. The kinds of studies that were published in PNAS should be done *before* products are released, not after. Yet, there has been no interest in adopting the monarch research model in subsequent EPA risk assessments. The recent application for the approval of a new Bt-corn variety directed against rootworms, for example, was not accompanied by research done in accordance with an agenda set by a multi-stakeholder group. EPA's risk assessment, which was heavily criticised, was done, like many others, under strong pressure to quickly approve products. Until risk assessment procedures improve, the public will not have confidence that another monarch-like threat will be detected before it is too late.' (Mellon and Rissler, 2003, p. 6).

It makes one – or at least me – wonder what our collective prospects are if we cannot successfully institute a forum of relatively limited hybridity (there were, after all, only scientists present even if those scientists were themselves diverse), one that uses technologies of only relatively limited humility (the bases, after all, on which to judge GM were still pretty tightly framed) (see Callon (2003) again on hybrid fora and Jasanoff (2003) on technologies of humility).

However, inspired as well as troubled by the events I have been describing (as well as work such as Zournazi, 2002; Anderson, 2006; Solnit, 2005), what I have attempted to do for the most part in this paper is to offer a take which is at least a little more hopeful. Hopeful about the movement of which Seattle was only one moment because 'they have already succeeded in an important way – nothing has changed but the very description of the situation has changed, and this is the event […] The interstices of change are opening up […] People are starting to think again' (Stengers with Zournazi, 2002, pp. 253–254). And they are thinking, like Rebecca Solnit, about the 'struggle to redemocratize the world, or the corner of it from which a given struggle is mounted' (2005, p. 64). Or thinking, like Arundhati Roy about 'the politics of slowing things down' (2002, p. 191).

What I have tried to think, in turn, is how to take Solnit's and Roy's words literally or, rather, materially. Firstly I have attempted to think about the world that we might struggle to democratise as being not only human in constitution. About how the field scientists and street protestors of the case study served to democratise the world not only in the sense that they extended ideas of what might count beyond the human, but also let things count in more than one way. Together they demanded that the fact that there are multiple 'legitimate representatives of things' should be 'actively taken into account' (Stengers, 2000, p. 158), (and for evidence that this really is a matter of concern for some scientists too, see pieces such as those by Hails (2004), and Davies and Wolf-Phillips (2006)). And then, secondly, I have suggested that it really is *things* – material things (or at least some of the new ones) – that need to be slowed down. Which led me to argue that the our collective ways of going forward are inextricably linked with how we deal with things, and then to contrast the modern style of Progress (characterised by a single story, being Science led, reasoning from properties, an obsession with speed, and the bypass of democracy) with a nonmodern style of proceeding cautiously (defined by multiple trajectories, being Research-led, an interest in consequences, moving slowly, and respect for due process).

All of which means that I have risked ending up being far too optimistic. But, at a time when there is still a small chance to define the terms of 'coexistence' on which decisions on which we can live with GM crops in Europe, hopefully it is helpful to take a normative rather than a simply descriptive position on whether something really is happening. As Latour puts it, 'To be sure, social scientists are not

demiurges, nor do they occupy a vanguard position, but it is also their duty […] to offer alternatives to earlier versions of the social link' (2003, p. 46).

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