Shaking the Tree, Making a Rhizome: Towards a nomadic geophilosophy of science education

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Abstract
This essay enacts a philosophy of science education inspired by Gilles Deleuze and Félix Guattari’s figurations of rhizomatic and nomadic thought. It imagines rhizomes shaking the tree of modern Western science and science education by destabilising arborescent conceptions of knowledge as hierarchically articulated branches of a central stem or trunk rooted in firm foundations, and explores how becoming nomadic might liberate science educators from the sedentary judgmental positions that serve as the nodal points of Western academic science education theorising. This is demonstrated by commencing two rhizomatic textual assemblages that generate questions, provocations and challenges to dominant discourses and assumptions of contemporary science education. The first of these addresses cultural representations of Sir Isaac Newton and the second makes multiple, hybrid connections among the parasites, mosquitoes, humans, technologies and socio-technical relations signified by malaria.

Keywords: Deleuze, rhizomatic, nomadic, philosophy of science education

Souma yergon, sou nou yergon, we are shaking the tree
—Peter Gabriel & Youssou N’Dour, ‘Shaking the Tree’ (1989)

…rhizomes are anomalous becomings produced by the formation of transversal alliances between different and coexisting terms within an open system.

In this essay I imagine (and perform to the best of my ability) a philosophy of science education that Gilles Deleuze and Félix Guattari’s (1987) figurations of rhizomatic and nomadic thought have helped me to make more intelligible (to myself and, I hope, to others). I imagine rhizomes ‘shaking the tree’ of modern Western science and science education by destabilising arborescent conceptions of knowledge as hierarchically articulated branches of a central stem or trunk rooted in firm foundations. I will provide several examples of the materials from which we can make such rhizomes. They are readily to hand, and can be found among heterogeneous assemblages of arts, artefacts, disciplines, technologies, projects, practices, theories and social strategies that I interpret as questioning and challenging the monocultural understandings of science reproduced by many science education programs and professors. These assemblages include not only academic discourses/practices – such as...
feminist, queer, multicultural, sociological, antiracist, and postcolonialist cultural studies and/or science studies – but also the products and effects of popular arts and arts criticism.  

Peter Gabriel and Youssou N'Dour’s song, ‘Shaking the Tree’, is in several ways emblematic of my project. It is a call to change and enhance lives composed in a spirit that complements Deleuze and Guattari’s (1994) practical ‘geophilosophy’ (p. 95), which seeks to describe the relations between particular spatial configurations and locations and the philosophical formations that arise therein. Both Gabriel and N’Dour compose and perform songs about taking action to do something about particular problems in the world, and Deleuze (1994) believes that concepts ‘should intervene to resolve local situations’ (p. xx). ‘Shaking the Tree’ is a North-South collaboration (Gabriel is British, N’Dour is Senegalese) between two men who celebrate and affirm the women’s movement in Africa, where patriarchal traditions and gender discrimination remain pervasive. Thus, as a popular song, ‘Shaking the Tree’ represents marginalised knowledges in form as well as content – both popular media/culture and non-Western knowings tend to be ignored or devalued within many forms of Western science education. These exclusions contribute to what Sandra Harding (1993) calls an increasingly visible form of ‘scientific illiteracy’, namely, ‘the Eurocentrism or androcentrism of many scientists, policymakers, and other highly educated citizens that severely limits public understanding of science as a fully social process’ (p. 1); she continues:

In particular, there are few aspects of the ‘best’ science educations that enable anyone to grasp how nature-as-an-object-of-knowledge is always cultural… These elite science educations rarely expose students to systematic analyses of the social origins, traditions, meanings, practices, institutions, technologies, uses, and consequences of the natural sciences that ensure the fully historical character of the results of scientific research. (p. 1)

I suggest that the limited exposure to which Harding refers results, in part, from concentrating students’ attention on two main ways of representing science, namely, documentary media (especially the science textbook and its equivalents in other media) and the ‘theatre’ of school laboratory work (see Gough, 1993b, 1998b). Representations of science in the arts and popular media – and the wide variety of contributions that they make (or might make) to ‘public understanding of science as a fully social process’ – tend to be given much less attention. But I argue that contemporary SF – an acronym that designates

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4 I therefore intend the word ‘studies’ to convey not only the conventional academic sense of pursuing some ‘branch’ of knowledge but also to suggest the various meanings of the noun ‘study’ in the arts, such as a sketch made as a preliminary experiment for a picture or part of it, or a musical composition designed to develop skill in a particular instrumental technique.

5 I recognise that ‘marginalised knowledges’ might be interpreted to be an arborescent concept but would argue that representing some knowledges as ‘marginalised’ or ‘subjugated’ serves a useful referential function within an arborescent sign system. As Claire Colebrook (2002) points out, Deleuze and Guattari use binary oppositions – such as the distinction between rhizome and tree – to create pluralisms: ‘You begin with the distinction between rhizomatic and arborescent only to see that all distinctions and hierarchies are active creations, which are in turn capable of further distinctions and articulations’ (p. xxviii).

6 This is not to say that science educators and science education researchers ignore the effects of the arts and popular media on public understandings of science but, rather, that their attention to the range and variety of these effects is somewhat limited. For example, Stephen Norris, Linda Phillips and Connie Korpan (2003) point out that although research on reading science media reports extends back at least four decades, science educators have only recently begun to recognise their value in teaching and assessing scientific literacy; these authors also draw attention to ‘the relatively small corpus of work that has been completed in this area’ (p. 124). As I have demonstrated elsewhere (Gough, 1993b, 2001), many of the texts that purport
much more than ‘science fiction’ – provides many of the most convincing and publicly accessible
demonstrations of ‘how nature-as-an-object-of-knowledge is always cultural’. Andrew Ross (1996) alludes to this capacity of SF to illuminate the social and cultural meanings and consequences of scientific research when he writes: ‘Outside of Jurassic Park, I have yet to see a critique of Chaos Theory that fully exposes its own kinship with New Right biologism, underpinned by the flexible economic regimes of post-Fordist economics’ (p. 114).

In his Preface to Difference and Repetition Deleuze (1994) asserts that a text in philosophy ‘should be in part… a kind of science fiction’ (p. xx) in the sense of writing ‘at the frontiers of our knowledge, at the border which separates our knowledge from our ignorance and transforms the one into the other’ (p. xxi). Much of my previous research and writing on science education has been concerned with demonstrating the possibilities of ‘synthetically growing a post-human curriculum’ – to quote John Weaver’s (1999) interpretation of my work – by expanding and diversifying the cultural materials and tools that science educators deploy in their curriculum practices. Here I will explore some of the immanent but hitherto unexplicated implications of this work and demonstrate how Deleuzean concepts might generate transformative possibilities for theorising science education. Like Laurel Richardson (2001), ‘I write in order to learn something that I did not

to ‘teach science fact through science fiction’ (e.g. DeSalle & Lindley, 1997, Duback, Moshier & Boss, 1988, 1994) portray popular media as sites of fantasy or of scientific ‘misconceptions’. Thus, a common use of popular media in science education is to encourage students to identify these ‘misconceptions’. For example, Duback et al (1988, 1994) devote two whole books to exposing ‘pseudoscience’ in more than fifty movies. More recently, in a special issue of ENC Focus on the theme of ‘Becoming literate in mathematics and science’, Frank Baker (2001) writes: ‘Stereotypes and misconceptions are frequently generated by television and movie producers. Classroom teachers can take advantage of students’ interest in popular movies to help them analyze the misconceptions’ (n.p). Such readings constitute very narrow interpretations of popular media and implicitly devalue their educative potential by suggesting that their representations of science are in some way deficient unless they illustrate conventional textbook science ‘correctly’. This obscures the ways in which particular works of art and popular media function as critical and creative probes of issues in science, technology and society that their creators and consumers see as problematic.

As Donna Haraway (1989) explains, since the late 1960s the signifier SF has designated ‘a complex emerging narrative field in which the boundaries between science fiction (conventionally, sf) and fantasy became highly permeable in confusing ways, commercially and linguistically’; thus, SF refers to ‘an increasingly heterodox array of writing, reading, and marketing practices indicated by a proliferation of “sf” phrases: speculative fiction, science fiction, science fantasy, speculative futures, speculative fabulation’ (p. 5). Electronic games and web-based media and activities have added to the complexity and heterodoxy of this array. In addition, many of the interrogations of technoscience produced by visual, installation and performance artists that once might have been localised in a small number of galleries or exhibition spaces now reach a much broader audience via the websites that almost invariably accompany such exhibitions. See, for example, Gene(sis): Contemporary Art Explores Human Genomics at www.gene-sis.net <12 September 2004>.

‘New Right biologism’ (like social Darwinism before it) is the selective and strategic deployment of biological ideas in the pursuit of conservative political and economic goals. Thus, free-market economists privilege selected interpretations of chaos and complexity theories in order to ‘naturalise’ the desirability of global economic deregulation and oppose national development models that seek to internally regulate and articulate the agricultural and industrial sectors of a nation’s economy. Instead of building national economies from networks of interlocking primary and secondary industrial assembly lines, post-Fordism promotes a global market in which efficiencies are achieved through, for example, farm concentration and specialisation.

I have drawn particular attention to the significance for science education of contemporary cultural trajectories in popular media and global (eco)politics (see, for example, Gough, 1993a, 1998a, 2001, 2002, 2004b). See also the Study Guide for Science Education and Contemporary Culture (a unit in Deakin University’s Master of Education program) at www.deakin.edu.au/education/units/ess712/ <20 September 2004>.
know before I wrote it’ (p. 35), and so this text too is ‘a kind of science fiction’ that rewrites my philosophy of science education as geophilosophy.

For example, I have previously argued for adapting to the natural sciences a proposal that Richard Rorty (1979) makes in respect of the social sciences: ‘If we get rid of traditional notions of “objectivity” and “scientific method” we shall be able to see the social sciences as continuous with literature – as interpreting other people to us, and thus enlarging and deepening our sense of community’ (p. 203). I argued that seeing the natural sciences also as ‘continuous with literature’ means, to paraphrase Rorty, seeing both science and literature as interpreting the earth to us and thus ‘enlarging and deepening our sense of community’ with the earth. The consequences for science education would then best be understood in terms of storytelling – of abandoning what Harding (1986) calls ‘the longing for “one true story” that has been the psychic motor for Western science’ (p. 193). Rather, we should deliberately treat our science education stories as metafictions – self-conscious artefacts that invite deconstruction and scepticism (Gough, 1993a, p. 622).

I initially drew my support for this argument from scholars who work at the intersections of literary criticism and science studies. For example, David Porush (1991) argues persuasively that in the world of complex systems revealed to us by postmodernist science – protein folding in cell nuclei, task switching in ant colonies, the nonlinear dynamics of the earth’s atmosphere, far-from-equilibrium chemical reactions, etc. – ‘reality exists at a level of human experience that literary tools are best, and historically most practiced, at describing’ and that ‘by science’s own terms, literary discourse must be understood as a superior form of describing what we know’ (p. 77). Such arguments are consistent with those offered by scholars whose work is identified with cultural studies of science (e.g. Donna Haraway, 1994, Sandra Harding, 1994, Joseph Rouse, 1993), the discursive production of science (e.g. Charles Bazerman, 1988, 1999), and sociological studies of scientific knowledge (e.g. Harry Collins & Trevor Pinch, 1998, Bruno Latour, 1987, 1988, 1993, 1999, Bruno Latour & Steve Woolgar, 1979, Steven Shapin, 1994, Steve Woolgar, 1988). Science education researchers who have drawn on these areas of inquiry include Jay Lemke (1992), who queries the defensibility of the ‘simulations and simulacra of science’ that students encounter in conventional school science courses (see also Jay Lemke, 1990, 2001). Similarly focusing on language, Bonnie Spanier (1992) provides a persuasive rationale for using writing activities in science education that critique the discourse and content of science textbooks and representations of science in popular media to ‘raise their awareness about… societally generated distortions in the sciences’ (p. 199). Researchers who have paid particular attention to representations of science in popular media/culture include Peter Appelbaum (1995, 2000, see also Appelbaum & Clark, 2001) and Matthew Weinstein (1998a, 1998b, 2001a, 2001b).

Although I agree that literary and artistic modes of representation might be more defensible for many purposes in science education than the supposedly more ‘objective’ accounts of professional scientists and textbook authors, I now want to go beyond debating the merits and demerits of competing representationalist philosophies. In this previous work I moved away from the fixity and centeredness of a conventional scientist’s (or mainstream literary scholar’s) point of view, but I still worked within the limits of grounded positions, albeit positions found as I moved (in Rorty’s terms) from one temporary standpoint to another along various continua between literature and science.10

Thus, in this essay I explore what it means to be becoming nomadic in theorising science education, to liberate thinking about science education from the sedentary points of view and judgmental positions that function as the nodal points of Western academic science education discourse. What happens when we encourage random, proliferating and decentred

10 As journals such as Configurations (published by Johns Hopkins University Press for the Society of Literature, Science, and the Arts) demonstrate, these are increasingly well-trodden paths.
connections to produce rhizomatic ‘lines of flight’ that mesh, transform and overlay one another? As Patricia O’Riley (2003) writes, ‘Rhizomes affirm what is excluded from western thought and reintroduce reality as dynamic, heterogeneous, and nondichotomous’ (p. 27), and this is precisely what I will attempt to demonstrate here by making (or at least commencing) a rhizome, a textual assemblage that I hope will generate questions, provocations and challenges to some of the dominant discourses and assumptions of contemporary science education.

**Newton’s Head (with Apple)**

Sir Isaac Newton (1642-1727) is probably most well-known for his laws of gravitation, which explain the motion of the planets around the sun. According to some historians, his ideas about gravity arose after an apple fell on his head. We’ll probably never know if this is true.


I have just quoted forty-seven of approximately 300 words about Newton in a textbook used by my son in his year 8 school science education program. They come from a double-page spread headed ‘Who is the greatest?’ which focuses on the following questions: ‘Who is the greatest scientist of all time? Is it Curie, Einstein, Newton or Pasteur? Or is it one of the people who saved millions of lives by discovering X-rays, penicillin or vaccination?’ In these two pages Lofts and Evergreen (2000) present mini-biographies of the four scientists they name but make no further reference to the unnamed ‘people who saved millions of lives’. Two paragraphs on Newton have the sub-heading: ‘Did that apple really fall on his head?’ This question is repeated in the caption of an accompanying cartoon that caricatures the scientist in a pose that recalls Rodin’s ‘Thinker’ (albeit with clothes), sitting in closed-eyed reverie under a tree from which a ripe apple is about to fall. A ‘thought bubble’ reveals the anthropomorphic apple’s intentions: ‘Heh, heh, I can’t miss from here’ (see Figure 1).

![Figure 1: ‘Did that apple really fall on his head?’ Illustration from Science Quest 2 (Lofts and Evergreen, 2002, p. 286; © John Wiley & Sons Australia/Paul Lennon)](image)

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11 As noted above, rhizomes can be made with whatever materials come to hand (cf. bricolage), and I have made no special effort to find examples of science education texts that suit my critical purposes. Each of the science textbooks to which I refer here has been used recently (or is currently in use) by either my son or daughter in one of their school science programs.
Lofts and Evergreen (2000) represent Newton’s work as a foundational, heroic victory narrative: *The Principia* ‘launched modern science’ (p. 279) and ‘Much of the scientific knowledge that has been acquired since the seventeenth century is built upon Newton’s discoveries’ during an ‘amazing two-year period’ (p. 286). According to their account, Newton almost single-handedly transformed academic and public understandings of science and unified mathematics and science: ‘Up to this time, science had been equated with natural philosophy… Now scientists and the public were confronted with the fact that science must also be quantitative (measurable)’ (p. 279; bold in original). Despite their uncertainty about ‘that apple’, Lofts and Evergreen appear to have no doubts about the English scientist’s crucial role in completing Copernicus’s and Galileo’s unfinished business – he ‘confirmed that the sun was at the centre of the solar system’ – and are confident that they know where Newton’s head was at in his final moments: ‘Newton died in 1727 knowing that he had finally convinced most astronomers that the Earth was not the centre of the solar system or the universe’ (p. 121). Perhaps this might also have been an appropriate place to add: ‘We’ll probably never know if this is true’.

To paraphrase Harding (as quoted above), there are few aspects of Lofts and Evergreen’s (2000) account that might enable a reader to grasp how nature-as-an-object-of-knowledge is always cultural. They portray Newton as an individual genius, historicised only by incorporating events, dates, names, and places into a series of (mostly unqualified) positive statements: ‘Isaac Newton was sent to Cambridge University at the age of 18. When the university closed down in 1665 as a result of the Great Plague, young Isaac went home for two years. There he developed his laws of gravitation and his three laws of motion’ (p. 286). But, as Haraway (1989) observes: ‘No one can constitute meanings by wishing them into existence;… meanings… include particular structurings of objects of knowledge’, where knowledge is understood as ‘that which can be known in a particular time and place’ (p. 111; emphasis in original). Nevertheless, questioning the agency of ‘that apple’ in producing the particular structurings of objects of knowledge that Newton could assemble in England between 1665 and 1667 creates an opportunity to go beyond the text, because raising this possibility opens the door to considerations of what other entities, strategies and arrangements might have been mobilised. Like the ‘Pasteur’ of Latour’s (1988) *The Pasteurization of France*, it is possible to understand ‘Newton’ as an actor/actant network for which Newton the person speaks – an effect rather than a prime mover.

My interpretation of Lofts and Evergreen’s representation of Newton is one among many that might be possible and I offer it in the spirit of generative (rather than destructive) critique. More than forty years has passed since Joseph Schwab (1963) characterised the narrative style of school science textbooks as a ‘rhetoric of conclusions’ (p. 39);13 most publishers still constrain authors to conform to this generic expectation and it might be unrealistic to expect them to do otherwise. Thus, for example, I did not draw attention to ‘the anthropomorphic apple’ simply because (from one of my subject positions as a sometime biologist) I reject anthropomorphism – this would be a silly position to take on a cartoon designed to attract children’s attention. Rather, I see this example of anthropomorphism as an attribution of agency to an object that invites a very different interpretation of Newton’s achievements from those presented in the text. Similarly, writing ‘We’ll probably never know if this is true’, in reference to ‘that apple’ implicitly (and perhaps unintentionally) invites

12 Haraway’s (1989) emphasis here on ‘particular structurings of objects of knowledge’ echoes Deleuze and Guattari’s (1994) geophilosophical assertion that ‘the link between what we can say and what we can see at a given time and place is fixed by discursive regularities rather than by a fixed schema’ (p. 68).

13 Schwab (1963) argued for teaching science as a ‘narrative of inquiry’ which situates ‘the conclusions of science in the framework of the way they arise and are tested’ (p. 39).
readers to repeat it in reference to the many other historical ‘facts’ that the text presents without such problematisation.

However, if we cannot expect a junior high school science education textbook to present a range of cultural meanings of ‘Newton’, then I suggest that we should look for them elsewhere.

Newton’s Body (without Organs)

We perceive and live the world as though it were composed of organised bodies. Our notion of man, for example, privileges certain organs: the brain that thinks, the eye that judges and the phallus that holds social power. But we also necessarily presuppose some disorganised ‘life’ or ‘ground’ from which different bodies emerge… The body without organs is the undifferentiated that we imagine underlies the differentiated or organised bodies of life.

— Claire Colebrook, Understanding Deleuze (2002), p. xxi

When I first saw Salvador Dali’s sculpture, Homage to Newton (see Figure 2), I laughed out loud. Here was a material representation of Newton as Deleuze and Guattari’s (1987) ‘body without organs’ (p. 151) – a one meter tall bronze statue without eyes, brain or heart, but nevertheless retaining ‘the phallus that holds social power’.

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The curator’s notes on *Homage to Newton* in this exhibition struck me as particularly insightful:

In this sculpture, Dali commends Newton for his discovery of the law of gravity, an event that occurred when an apple fell from a tree onto Newton’s head. The line represents the fall of the apple. The apple itself has been transformed into a sphere of metal, losing its impermanence as well as its capacity for regeneration. Dali implies that the living being, Sir Isaac Newton, has become a mere name in science, completely stripped of his personality and individuality, and instead is now used like a label. To depict this, Dali introduced two large holes into the figure: one shows the absence of Newton’s vital organs, while the other displays the lack of brain. What remains is only the symbolic hardness of the metal statue.

The excerpts I quote above from *Science Quest 2* demonstrate that Newton has indeed ‘become a mere name’ in some science education textbooks, a convenient label for the conceptual personification of Eurocentric science. In some other textbooks, such as *Science 4* (Malcolm Parsons, 1996), barely all that remains is ‘symbolic hardness’: ‘force is measured in **newton (N)**’ (p. 150; bold in original).\(^\text{15}\)

In 1980 Dali produced a limited edition of *Homage to Newton* miniatures (approx. 35cm tall), and a five meter version unveiled in 1986 overlooks a Dali-designed square in Madrid. A three meter version cast in 1985 is located in the United Overseas Bank Plaza in Singapore, but differs in one important respect from all of the others: a second ball, perhaps representing a heart, is suspended in the open thoracic cavity. The plaque attached to the plinth on which this version rests offers a very different interpretation of the sculpture from the one quoted above:

In the 17th century, Sir Isaac Newton discovered the law of gravity. Legend tells us that origin of this most important and fundamental physical law was initiated by the falling of an apple, represented in the present work by the ball falling from the right hand. Salvador Dali, one of the most important surrealist artists, takes the liberty to go even further in paying homage to Newton by opening up the torso of the figure and suspending the heart to indicate ‘open-heartedness’. The open head represents an ‘open-mind’. These are two necessary qualities for the discovery of important natural laws as well as for success of all human endeavours.\(^\text{16}\)

Peter Schoppert (2004) writes of this interpretation: ‘Dali’s project of liberating art from language, of using the power and violence of the most dramatic religious imagery, to access the power of the subconscious, all these attempts have been bowdlerized here’ (p. 11). Schoppert sees this sanitisation of Dali’s work as being consistent with an overall approach to labelling both abstract and non-abstract public art in Singapore: ‘the label devises... a meaning that is as concrete as possible, and which bolsters state narratives to boot’ (p. 10).

He adds that this desire to turn an abstract or surreal work into ‘a more easily comprehended statement of certain values’ has now gone so far in Singapore ‘that even the most realistic of artworks are accompanied by descriptive and interpretive texts’ resulting in ‘a stunning kind of obviousness’ (p. 11).

Although Schoppert’s analysis might be too simplistic, it nevertheless generates more complicated questions for inquiry and speculation in science education. For example: In what ways might the Singapore label on *Homage to Newton* bolster state narratives? How does the label function as ‘a more easily comprehended statement of certain values’ than other

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\(^\text{15}\) Apart from a cross-reference from a glossary-cum-index, this is the only mention of ‘newton’ in this textbook, although N appears on several other pages in formulae and test questions.

possible interpretations? Which values might the label’s author(s) want to be ‘easily comprehended’? Such questions arise from contested (and contestable) interpretations of public artworks (and reports of their reception and critique) that provide opportunities to engage students in analyses of the social meanings of scientific research. This example is by no means esoteric: images of, and references to, Singapore’s *Homage to Newton* appear in many newsgroups, blogs and photo galleries posted on the internet by backpackers and others for whom Dali’s sculpture provides a photo opportunity or a stimulus to reflection.\(^{17}\)

Further rhizomatic connections abound. For example, the text of the Singapore plaque is faithfully reproduced — without any explanation for its presence — on the website of PhiTech, a Dutch corporation that specialises in information technology solutions for applied physics research. However, the text in this instance accompanies a photograph of a miniature *Homage to Newton*, which has no ‘heart’.\(^{18}\) In yet another instance of *Homage to Newton’s* appropriation and deployment, a photograph of the 1969 casting decorates the cover of an International Baccalaureate (IB) information booklet produced by the International School Brunei. The accompanying text states: ‘Man [sic] has the ability not only to explore space outside himself but to relate his discoveries to his own inner spaces of thought and feeling. Here the sciences, philosophy and the arts may meet and fructify one another’.\(^{19}\)

Of course, I am not suggesting that conventional textbook treatments of Newton should necessarily be displaced or supplemented by multiple exegeses of Dali’s *Homage to Newton*. What should be apparent, however, is that such treatments produce different meanings if we encourage their connections with a multiplicity of other cultural materials. That is, we can begin to transform a ‘rhetoric of conclusions’ (exemplified here by a textbook account of Newton’s life and work) into a more rhizomatic ‘narrative of inquiry’ by becoming open to the lines of flight that other cultural work invites and enables (exemplified here by the textual flows within which Dali’s sculpture produces many different meanings in many different places).

Reading the narratives of science textbooks within the heterogenous spaces created by the production, reception and critique of artworks of any kind can be understood as a variation on the approach Haraway (1989) takes in *Primate Visions*, wherein she ‘reads’ primatology as science fiction, and vice versa:

Placing the narratives of scientific fact within the heterogeneous space of SF produces a transformed field. The transformed field sets up resonances among all of its regions and components. No region or component is ‘reduced’ to any other, but reading and writing practices respond to each other across a structured space. Speculative fiction has different tensions when its field also contains the inscription practices that constitute scientific fact. The sciences have complex histories in the constitution of imaginative worlds and of actual bodies in modern and postmodern ‘first world’ cultures (p. 5).

I depart from Haraway by imagining the ‘transformed field’ I produce as a nomadic space rather than a ‘structured space’. However, the final sentence in the quotation above opens a connection to the second example of making a rhizome that I will perform here, because it also connects to ‘Shaking the Tree’. The sciences not only have complex histories in the constitution of imagined worlds and actual bodies in modern and postmodern ‘first world’ cultures, but also in ‘third world’ cultures — and the silences about such histories and


\(^{18}\) www.phitech.nl/dali.htm <12 September 2004>. The text and photograph are linked directly to the PhiTech homepage at www.phitech.nl.

geographies in both science education textbooks and ‘first world’ science journalism constitutes another aspect of scientific illiteracy to which a geophilosophy of science education must attend.

**Mosquito Rhizomatics**

We are writing this book as a rhizome. It is composed of plateaus… Each morning we would wake up, and each of us would ask himself what plateau he was going to tackle, writing five lines here, ten lines there. We had hallucinatory experiences, we watched lines leave one plateau and proceed to another like columns of tiny ants.


[Rhizomes] implicate rather than replicate; they propagate, displace, join, circle back, fold. Emphasizing the materiality of desire, rhizomes like crabgrass, ants, wolf packs, and children, de- and reterritorialize space.


Ants have already inspired me to make a rhizome for this journal (Gough, 2004c) so now I will allow mosquitoes to suggest connections, lines of flight and opportunities for deterritorialisation. I commenced these ‘mosquito rhizomatics’ in July 2004 when a number of initially separate threads of meaning – a research article in *Public Understanding of Science*, a *Time* magazine cover story, recollections of an SF novel and of various studies in the sociology of scientific knowledge – coincided, coalesced, and eventually began to take shape as an object of inquiry.

The *Public Understanding of Science* article that caught my attention was Stephen Norris, Linda Phillips and Connie Korpan’s (2003) empirical-analytic study of university students’ interpretations of scientific media reports, which followed an earlier (and similarly designed) study of high school science students by two of these authors (Norris & Phillips, 1994). Both studies sought to measure certain aspects of the students’ interpretations of the meanings of five media reports, with particular reference to the degree of certainty with which various statements were expressed, the scientific status of statements (e.g., cause, observation, method) and the role of statements in each report’s chain of reasoning (e.g., justifications for what ought to be done, evidence for other statements made in the report). According to the measurement instruments devised by these researchers, both high school and university students had difficulties with all aspects of the task, displaying a certainty bias in their responses to questions regarding truth status, confusing cause and correlation, and also confusing statements reporting evidence with statements reporting justifications. Although Norris, Phillips and Korpan (2003) admit that they designed their research to assess the interpretive abilities of high school students (rather than to ‘explain’ them), they nevertheless speculated that: ‘The performance of these students suggests that the science curriculum had not prepared them well to interpret media reports of scientific research’ (p. 125). The authors attempted to address this limitation in their study of university students by obtaining additional data, such as participants’ self-assessments of their background knowledge and interests and the reading difficulty they ascribed to each report. Within the analytic framework of a correlational study, these self-assessments ‘explained’ virtually none of the variance in the interpretive performances of the university students who, ‘in general, had an inflated view of their ability to understand the five media reports’ (p. 123). Norris, Phillips and Korpan (2003) conclude:

Generally, science textbooks used in high school and early university do not provide information on why researchers do their research, on the histories of research endeavors, on the motivation underlying particular studies, on how scientific questions arise out of...
the literature or anomalous events, or on the texture and structure of the language used in science. By contrast, scientific media reports often include the history and background to studies, information on the motivation for the reported research, and a variety of textured and structured language. In short, there is a mismatch. If media reports of science are to serve as an effective source of life-long scientific learning and support for public deliberation on science-related social issues, then much change is needed in high school and university science instruction to make this dream a reality. Otherwise, highly educated individuals having, as most of them do, little education specifically in science will help to run the major systems of our society without the benefit of being able to interpret and evaluate simple media reports of the latest scientific developments upon which those systems crucially depend (p. 141).

Norris, Phillips and Korpan’s (2003) characterisations of the differences between science textbooks and scientific media reports converge with my own and others’ qualitative studies of these types of textual materials (see, for example, Sharon Dunwoody, 1993, Gough, 1993b). But asserting that these differences constitute a ‘mismatch’ begs the question of why these distinct genres of science/education text should ‘match’ at all, given that science textbooks and scientific media reports serve different purposes. I suspect that what Norris, Phillips and Korpan might be suggesting here is that science instruction in high schools and universities equips students to interpret science textbooks but not scientific media reports, which therefore diminishes the potential effectiveness of the latter as resources for life-long scientific learning and for more increased public understanding of science and science-related social issues. However, positioning scientific media reports as some sort of desirable Other to science textbooks leaves unanswered the question of whether either type of text addresses the Eurocentrism and/or androcentrism to which Harding (1993) refers.

Shortly after reading Norris, Phillips and Korpan’s (2003) article, I also read ‘Death by Mosquito’, a cover story in *Time* magazine (Christine Gorman, 2004). The story begins by pointing out that malaria sickened 300 million people in 2003 and killed 3 million, most of them under age 5. In the same period AIDS killed just over 3 million people. ‘What makes the malaria deaths particularly tragic’, Gorman writes, ‘is that malaria, unlike AIDS, can be cured’. She asks: ‘Why isn’t that happening?’ Some selected excerpts from her story follow:

Countries in sub-Saharan Africa have suffered the brunt of this renewed assault, but nations in temperate zones, including the U.S., are not immune…

Doctors have long suspected that the malaria problem was getting worse, but the most searing proof has come to light in just the past year. Researchers believe the average number of cases of malaria per year in Africa has quadrupled since the 1980s. A study in the journal Lancet last June reported that the death rate due to malaria has at least doubled among children in eastern and southern Africa; some rural areas have seen a heartbreaking 11-fold jump in mortality…

Recognition of malaria’s toll on the global economy is growing. Economist Jeffrey Sachs, director of Columbia University’s Earth Institute, estimates that countries hit hardest by the most severe form of malaria have annual economic growth rates 1.3 percentage points lower than those in which malaria is not a serious problem. Sachs points out that the economies of Greece, Portugal and Spain expanded rapidly only after malaria was eradicated in those countries in the 1950s. In other words, fighting malaria is good for business – as many companies with overseas operations have long understood…

To better understand why malaria has become such a threat and what can be done to stop the disease, it helps to know a little biology.

I compared the ‘little biology’ provided by the *Time* article with the single page on malaria in Victoria’s current year 12 biology textbook, *Nature of Biology Book 2* (Judith Kinnear &
Marjory Martin, 2000), which devotes one of its sixteen chapters to ‘Disease-Causing Organisms’. The two texts exemplify the generic differences to which Norris, Phillips and Korpan (2003) draw attention, with the Time article providing more information on the history of research on malaria and on the social, political and economic motivations for current research efforts. In most other respects, both sources tell a very familiar story: malaria is caused by protozoan parasites and is spread among humans by mosquitoes. The Nature of Biology account provides little more than a brief description of the parasite’s lifecycle and brief biological explanations for the symptoms of mosquito bites (itchy swellings) and malaria (chills and fevers) and concludes with the following paragraph:

Although drugs are available for the treatment of malaria, a complete cure is difficult. This is because the parasite can remain dormant for many years in the liver before becoming active again. Different drugs are used against the different stages of the malarial parasite. Malaria is still one of the most serious infections in the world and is particularly common in some tropical and sub-tropical areas. The Anopheles mosquito, the main carrier of malaria, is common in these areas. Australians travelling to such areas are advised to take anti-malarial drugs both before, during and after visiting the area although this does not guarantee prevention of infection (Kinnear & Martin, 2000, p. 209).

Other than advising Australian travellers to take precautions against malaria, Kinnear and Martin say nothing about what makes it ‘one of the most serious infections in the world’ – nowhere do they mention that malaria can be fatal, or that it bears comparison with AIDS, tuberculosis and dysentery in currently being among the world’s deadliest diseases. Not only do they tacitly diminish malaria’s effects but also, to paraphrase Harding (1993) once again, there is little in Kinnear and Martin’s account that might enable readers to understand at least some of malaria’s cultural determinants. The Time article provides explanations for the increased vulnerability of pregnant women and young children, and for variations in human resistance to the disease. Time also addresses issues on which Nature of Biology is completely silent, such as how malaria parasites have become increasingly drug-resistant, why controlling anopheles mosquitoes in tropical regions is so difficult, and why the most effective pharmaceutical responses currently available are beyond the financial resources of the poorest nations of the world, particularly those in Africa. Admittedly, Time’s treatment of malaria is more than twice as long as that found in Nature of Biology, but Kinnear and Martin could still have made different choices about what to include in (and exclude from) their account. For example, is alerting Australians to the risks of malarial infection if they travel to certain areas really more important than alerting them to the massive human tragedy of millions dying of malaria in the West’s tourist destinations and, moreover, that this is a tragedy that Western nations have the resources to ameliorate?

However, neither Time nor Nature of Biology provide readers with any alternatives to understanding malaria within what David Turnbull (2000) calls ‘the knowledge space of Western laboratory science’ wherein ‘malaria is made to appear as a natural entity in the world, …embedded in a conceptual framework which portrays the discovery and elucidation of its causes as occurring within the gradual unfolding of an emanant scientific logic, which will culminate in a physicochemical solution to the malaria problem’ (p. 162). To step outside this logic requires, in Deleuze’s terms, an act of deterritorialisation which, as Kaustuv Roy (2003) describes it, is ‘a movement by which we leave the territory, or move away from spaces regulated by dominant systems of signification that keep us confined to old patterns, in order to make new connections’ (p. 21; italics in original). Roy (2003) continues:

To proceed in this manner of deterritorializing, we make small ruptures in our everyday habits of thought and start minor dissident flows and not grand ‘signifying breaks,’ for
grand gestures start their own totalising movement, and are easily captured. Instead, small ruptures are often imperceptible, and allow flows that are not easily detected or captured by majoritarian discourses (p. 31).

I am disposed to produce such ‘small ruptures’ and ‘minor dissident flows’ by reading questions for inquiry in science education within an intertextual field that includes SF. In this instance, as I read the *Time and Nature of Biology* texts, I also recalled reading *The Calcutta Chromosome: A Novel of Fevers, Delirium, and Discovery*, a mystery thriller in the SF sub-genre of alternative history by Amitav Ghosh (1997). Like most works of SF, Ghosh’s novel offers a semiotic space that is *not*, to recall Roy’s words, ‘regulated by dominant systems of signification’, and that therefore invites readers to think beyond the sign regimes of Western laboratory science. Ghosh’s novel becomes another filament in my mosquito-led rhizome by offering a speculative counterscience of malaria that connects with (but does not replicate) the ‘real’ history of Western medicine’s explorations of the disease. For example, one of the key protagonists in Ghosh’s alternative history is Ronald Ross, whose work on the lifecycle of the plasmodium parasite for the British Army’s Indian Medical Service in late nineteenth century Calcutta eventually brought him a Nobel prize (although, as fictionalised by Ghosh, Ross is a much less heroic character than the one that official histories provide). *The Calcutta Chromosome*’s action takes place in three temporal frames (the late 1890s, the mid-1990s and a very near future) and in locations that range from India to the Americas. Characters, places and events are connected by the mosquito, a vector that easily crosses boundaries between human and animal, rich and poor, here and there, and (with the parasite it transmits) also blurs the border between then and now.

Whereas *Time and Nature of Biology* occlude malaria’s complex heterogeneity, Ghosh’s novel dramatically foregrounds the ways in which outbreaks of malaria in particular places and times are manifestations of numerous complex interactions among parasites, mosquitoes, humans and various social, political (often military), administrative, economic, agricultural, ecological and technological processes. Although some of the interactions Ghosh depicts might be figments of his imagination, malaria’s irreducible multiplicity is substantiated not only by malariologists (see Turnbull 2000, pp. 162-165) but also by scholars in other disciplines. For example, political historian Timothy Mitchell (2002) demonstrates that a terrible outbreak of malaria in Egypt during the 1940s cannot be understood as a predictable unitary event but as the effect of a series of complicated interconnections involving war, disease and agriculture:

> War in the Mediterranean diverted attention from an epidemic arriving from the south, brought by mosquitoes, that took advantage of wartime traffic. The insect also moved with the aid of the prewar irrigation projects and the ecological transformations those brought about. The irrigation works made water available for industrial crops, but left agriculture dependent upon artificial fertilizers. The ammonium nitrate used on the soil was diverted for the needs of war. Deprived of fertilizer, the fields produced less food, so the parasite carried by the mosquito found its human hosts malnourished and killed them at a rate of hundreds a day… The connections between a war, an epidemic and a famine depended upon connections between rivers, dams, fertilizers, [and] food webs… What seems remarkable is the way the properties of these various elements interacted. They were not just separate historical events affecting one another at the social level. The linkages among them were hydraulic, chemical, military, political, etiological, and mechanical (p. 27).

In the light of such examples, is it easy to see why sociologists of science such as David Turnbull (1989) see malaria as a political disease ‘resulting from the dominance of the Third World by the colonial and mercantile interests of the West’ (p. 287). Indeed, the development
of tropical medicine as a specialisation within Western medical science can itself be understood as a response by colonial administrators to the devastating effects of malaria and other tropical diseases on imperial demands for resources and labour. For example, Latour (1988) quotes a French colonial official who complained in 1908: ‘Fever and dysentery are the “generals” that defend hot countries against our incursions and prevent us from replacing the aborigines that we have to make use of’ (p. 141).

Diane Nelson (2003) has recently drawn on Ghosh’s novel – and other works in social and postcolonialist studies of science, technology and medicine – to explore Paul Rabinow’s (1989) proposition that Europe’s colonies were ‘laboratories of modernity’ (p. 289). Although Latour’s (1987, 1988) work is an obvious and acknowledged influence on Nelson’s analysis, the introduction to her essay evokes rhizomatic connectivity as much as actor-networks:

Ghosh imagines the science of malaria, a disease dependent on multiple connections, enmeshed in the logics of a colonial counterculture. In turn, I argue that the hybrid form of social science fiction may be the most adequate way to think about the delirious products and unlikely networks of these colonial laboratories. Malaria as a disease figures largely there, an emblem of the simultaneously faithful and fickle nature of postcolonial connectivity (p. 246).

Similarly, I argue that deliberately seeking and/or making multiple, hybrid connections between the texts of science education, scientific media reports, social studies and histories of science, SF and SF criticism (as I have demonstrated here with respect to the assemblage of parasites, mosquitoes, humans, technologies and socio-technical relations that malaria signifies) enables generative lines of flight from the defined territories of Western science and science education.

**Losing the Way: Becoming a Nomadic Subject in Science Education**

History is always written from the sedentary point of view and in the name of a unitary State apparatus, at least a possible one, even when the topic is nomads. What is lacking is a Nomadology, the opposite of a history.

…nomads have no history; they only have a geography.


Ronald Bogue (2004) argues that Deleuze and Guattari’s binary opposition of nomadic and sedentary is a ‘de jure distinction of pure differences in nature’, that is, the nomadic and the sedentary are ‘pure tendencies that are real, yet that are experienced only in various mixed states. They are qualitatively different tendencies co-present across diverse social and cultural formations’ (p. 173). Bogue adds:

Deleuze and Guattari’s nomadic thought is inherently unstable in that its use of binary oppositions is intended to be generative and mutative, but it is not therefore to be pursued in a haphazard and careless fashion… yet their effort is not to fix categories and demarcate permanent essences, but to make something pass between the terms of a binary opposition, and thereby to foster a thought that brings into existence something new. In this regard, the categories of pure differences in nature are themselves generative forces of differentiation, which through their mutual opposition function to displace and transform one another (p. 178; italics in original).

Western science and science education also tend to be written from a sedentary point of view and I have thus tried to demonstrate the generativity of performing a nomadic subjectivity. Like Rosi Braidotti (2002), I understand that ‘the nomadic subject is a myth, or a political
fiction, that allows me to think through and move across established categories and levels of experience’ and that choosing to ‘become nomad’ is ‘a move against the settled and conventional nature of theoretical and especially philosophical thinking’ (n.p.). However, I emphasise that my disposition to ‘wander’ away from the semiotic spaces of science education textbooks and scientific media reports, and to experiment with making passages to hitherto disconnected systems of signification, is neither ‘haphazard’ nor ‘careless’ but a deliberate effort to unsettle boundary distinctions and presuppositions.

John Zilcosky (2004) notes that some poststructuralist and postcolonialist theorists see merit not only in wandering but also in getting lost: ‘losing one’s way – literally and philosophically – leads to a deterritorialization of knowledge: literary wandering subverts… and resists the systematisation of the world’ (p. 229). However, I agree with Zilcosky that such claims might be disingenuous, that ‘lostness presupposes a state of being found’ (p. 240). I prefer to imagine nomadic wandering in the discursive fields of science education not as ‘losing one’s way’ but as losing the way – as losing any sense that just one ‘way’ could ever be prefixed and privileged by the definite article. Like rhizomes, nomads have no desire to follow one path.

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References


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