Carnival in Space and Time: Shared Metaphors of Change in 'Post Neo-Darwinian' Evolutionary Theory and Feminist Science Fiction

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This thesis is presented in fulfilment of the requirements for the degree of Doctor of Philosophy

English and Cultural Studies
School of Social and Cultural Studies
The University of Western Australia

2008

THE UNIVERSITY OF
WESTERN AUSTRALIA

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Abstract

This thesis argues that representations of social and biological change in science fiction texts very frequently (possibly always) mirror current and past theories of evolution. Using Bakhtinian carnival, various feminist science theorists and ecofeminism, the thesis offers a critique of evolutionary theories as both scientific narratives and culturally inscripted stories of origins and change. A significant contention is that the politics of domination evident in Darwinist mutation/selectionism and neo-Darwinist genocentrism can be contextualised and modified by multidisciplinary stories such as epigenesis, punctuated equilibrium, panbiogeography, serial endosymbiosis theory, planetary homeostasis, and prebiotics. Identified in the thesis as 'post neo-Darwinian', these specific science narratives present multiple mechanisms of organic and inorganic change. They suggest that stories of interrelationship and cooperation (organism to organism/organism to environment/environment to organism) are at least as important as those that support hierarchy and competition. When these post neo-Darwinist stories are mapped onto individual feminist science fiction novels by Joanna Russ, Joan Slonczewski and James Tiptree Jr. (Alice Sheldon), the two different forms of story telling can be seen to have similar investments in mutable bodies, distributed agency, non-human subjectivities, the interactivity of organisms and environments, and interdisciplinary accounts of the world. In this thesis post neo-Darwinian evolutionary science and feminist science fiction texts read as both carnival and ecofeminist. Their shared metaphors of change are transgressive, subversive, ironic and – at times – farcical as they oscillate between the potentially frightening chaos of carnival and the potentially hopeful chaos of an ecofeminist synthesis.

Acknowledgements

This thesis has been a significant intellectual, physical and personal journey for me and I am profoundly grateful for the support I have received from many quarters. My two long suffering sons, Rhys and Zac, long ago realised the computer was more of a sibling than a piece of technology. They achieved their adulthood during my period of postgraduate study and I dedicate all the work I have ever done to them. The most patient and generous people in my academic life to thank would be my supervisor, Associate Professor Van Ikin, and co-supervisor, Associate Professor Jane Long. Van Ikin supervised me through two postgraduate degrees and has dealt with my creative work, my academic work, some odd hybrid productions and a mountain of official forms we have needed to fill in and sign over the years. To say he has gone above and beyond the call of duty is an understatement and I would like to thank him and acknowledge his tremendous efforts on my behalf. Pam D' Rozario kept me on track through what I can only describe as a very challenging 'rite of passage' for which I am deeply grateful. Without her I would not have succeeded in this effort. I would also like to thank those that have had a 'hands on' part in the production of the document. Helen Merrick has been a great reader and given invaluable advice on much of the thesis. Algis Kuliukas read and commented on the aquatic ape chapter, and Christina Haq of the UWA Graduate Studies School also gave me important feedback on my writing. Rachel Shave helped with the Joanna Russ chapter and Christopher Lang was an enthusiastic proofreader, putting back into perspective the sections that threatened to destroy my peace of mind in the final months.

The next group of people I need to thank are a big group of people that have actually accomplished the challenging job of keeping me alive during the production of the thesis. To the staff at the dialysis centre in Melville, WA, I owe a very deep debt of gratitude. John, Euphemia, Hoon, Jenny, Christina and many, many other wonderful and dedicated nurses do a difficult job and are an inspiration. My fellow dialysers and their families whom I take with me on my journey in my heart – Stephen, Michael, Rochelle, Jeff, several Richards, two Lawrences, the inimicable Joyce, many others and dear, dear Quan, with whom I had many silly and intelligent conversations about *Buffy* in that dire place. I am eternally grateful to my first renal specialist Dr Rangan Gopala at Fremantle, one of the kindest men I have met, who refused to see me as an environmental catastrophe and told me I was worth at least as much water as the average lawn, and my current renal specialist Paolo Ferrari, who is also terribly kind, and has fantastic political initiative as well. There are simply no words to adequately thank my friend Helen Pike who donated one of her kidneys to me during this process. I just want her to know her superhuman gift enabled me to realise some important projects and freed me to move out into the world again and appreciate even the most difficult days I have had since. Of course, things were not straightforward following my transplant so I would also like to thank Dr. Bu Yeap, endocrinologist, Dr Redfern and Dr Siah at the Oncology Department of Royal Perth Hospital and a number of excellent but anonymous surgeons, nurses and anaesthetists! As a rule of thumb, I would say that doing a thesis on dialysis or chemotherapy is to be avoided; however, if it is necessary then have good friends. Mine helped me keep perspective and kept me company through some hard times. Thank you Ella Scott, who has been absolutely solid, Helen Merrick, Stewart Woods, Helen Pike, Liana Christensen, the other WWW group members, and Lezli-An Barrett. Also a big thankyou to musicians Eric, Megan and Chris who helped me dance myself into a bit of happiness every Friday night during my treatments and recovery.

Other ways in which I have been helped have kept me close to the project and enabled me to enrich it. The WA science fiction community have always been very supportive of my efforts and my editor at Harper Collins, Stephanie Smith, always encouraged me to do this writing even when it meant I did not produce much fiction work. ArtsWA and UWA provided funding for me to attend the 'Taking Nature Seriously' conference in Oregon for the presentation of the paper 'Imagining Alternative Pathways of Biological Change and Co-existence'. I would also like to acknowledge, with thanks, the Dean's Postgraduate Award in 2003 that enabled me to have spend six months as artist in residence at SymbioticA, the Science/Art collective run through the School of Anatomy and Human Biology at UWA. There I met scientists who both challenged me and reassured me with respect to my understandings of science, particularly Stuart Bunt, Jan Meyer and Miranda Grounds. At SymbioticA I was also given the opportunity to liaise with artists working on science/art projects and am particularly grateful for the friendship and interests of Cynthia Verspaget and Nina Sellers. This kind of work gave me a very enriched appreciation of the genre I study and write in. In 2004, I received a Creative Development Fellowship from ArtsWA that provided funds for me to be a Research Fellow at SymbioticA for a full year. I would like to thank Oron Catts, director of SymbioticA, for the opportunities offered and Ricky Arnold at ArtsWA for supporting the project. In 2006 I received a Foundation Bursary from the Perth branch of the Australian Federation of University Women to assist completing the doctorate, and more recently a completion scholarship from the Graduate School at UWA. These two scholarships enabled me to turn my attention to the dissertation and to be free of teaching for a short time. For this I am very appreciative.

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INTRODUCTION

This thesis, *Carnival in Space and Time: Shared Metaphors of Change in Post neo-Darwinist Evolution and Feminist Science Fiction*, looks at multidisciplinary stories of biological change in science and traces similar structural metaphors of change in three feminist science fiction (sf) texts. The title expresses postmodern humour and irony, mixing puns, clichés and theoretical jingoism. 'Carnival in space and time', with respect to evolution, conjures up the many appearances and disappearances of odd and wonderful life forms through the countless aeons and the myriad ecologies of a heaving, restless planet. 'Carnival in space and time' also makes an appeal to major science fictional tropes. 'Space' is usually assumed to be 'outer space', an infinite area ripe for the imagining of other possible worlds. 'Time' connects to a significant linear trope that the genre capitalises on to produce alternate histories or a sense of future scenarios that removes sf from realist or modern fiction. Thus the open-endedness of the 'space and time' of the title offer a physical and imaginative multidimensionality in which to experience a 'carnival' of physical form, social and cultural expression, and the interaction of science, scientific theory, literary criticism and creativity.

'Carnival' is a central idea in this thesis, as it can be read in the loose, popular sense that refers to any parade, collection or celebration of difference, yet it can also indicate a theoretical tool for reading subversion and the breakdown of authorised sociopolitical, cultural and bodily boundaries. Carnival is almost an automatic marker for feminist sf, which regularly challenges patriarchal authorities, subverts social and cultural processes of class, gender and race, and celebrates viral, technological, organic and inorganic bodily difference and irregularity. The significance of carnival when applied to science in this thesis is, however, a little different. The carnival of the title can visually and intellectually encompass the material subjects/objects of evolution and evolutionary theory, and include organisms that range in size and complexity from the non-nucleated prokaryotic cell to the entire homeostasing planet, yet carnival in science is a disconcerting process when it comes to subversion and/or challenges to authority.

Historically, scientific interest in bodies relies on a particular kind of distance or objectification. Science expects order within and without bodies: bodies are generalised to fit into a coherent system of classification, they are mapped via certain basic patterns, types and families, they function in predictable, normative ways, and they are fixed by image, label and measurement. In carnival terms, this is the classical, monumental, closed body of science establishing its dominance over the open,

secreting, irregular, responsive body of both the natural and imaginative worlds. Some jokes and irregularities are allowed in science – Henry Gee tells stories of the fossil, Hallucigenia, a complete puzzle to those who studied it until they worked out that it had been interpreted upside down.[1] While Acanthostega, an early tetrapod fish, defied attempts to enthrone it as the adventurous ancestor of land dwelling animals. Out of water, the fully aquatic *Acanthostega* would have died, its tiny front legs sticking out at right angles and utterly unfitted for the task of lifting its body.[2] However, the carnival body in science, while it can be amusing in its grotesqueness, is generally consistent with Mary Russo's portrait of the abject body, repressed by the classical body and consolidating the cultural control of the bourgeoisie and its values through its 'difference'.[3]

Evolutionary science and theory are the points where those predominantly classical, closed representations of the body in science are inevitably challenged. In enlightenment science with its modernist apparatus, the body is a fixed study, but in twenty-first century evolution it is more likely to be a fluid, changing body in constant movement, flux and relationship, difficult to fix, and influenced by complex internal systems and external systems that impinge upon it. Like the carnival body it is more open and global, and the separations between multiple organismic fields, individual organisms, collective organisms such as species, and organisms and environments becomes more elusive. In some respects the carnival and evolution in the title of the thesis are tied together and have the same topos of experience/study. Bakhtin says of the carnival body that it is an 'endless chain of bodily life [that] retains the parts in which one link joins the other, in which the life of one body is born from the death of the preceding older one....It stresses elements common to the entire cosmos: earth, water, fire, air; it is directly related to the sun, to the stars....It reflects the cosmic hierarchy. This body can merge with various natural phenomena, with mountains, rivers, seas, islands and continents'.[4] This is a definition that suggests deep time, connectivity between organisms in a heredity pathway, epigenetic forces acting on bodies from environments, and perpetual connections between organisms and ecologies.

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1 Henry Gee, *Deep Time: Cladistics, the Revolution in Evolution* (London: Fourth Estate, 2000), 76-9.
2 Ibid, 56-57.
3 Mary Russo, *The Female Grotesque: Risk, Excess and Modernity* (New York: Routledge, 1994), 8-9. All subsequent page references will be to this edition.
4 Mikhail Bakhtin, *Rabelais and His World*, trans. Helen Iswolsky (Bloomington: Indiana University Press, 1984), 318.

The open and inclusive nature of carnival also allows the generic and theoretical complications of this thesis with its appreciation of subversiveness, its combined critical and creative approach, its irregular structures and linkages, and its 'merry polyvocality' of science and fictional narratives. While the multiple narrative presentation of science and feminist sf texts in this thesis owes much to Donna Haraway's biopolitical model of story telling in science, Bakhtin's carnival theory is also used in its strict theoretical incarnation to open up and reveal disquieting ambiguities in academic authority and discourses, and problematic constructions of subjects within various scientific disciplines. Although for Bakhtin carnival is a place where *all* cultural roles, expressed and repressed, official and unofficial, are shown to be multivalent, Mary Russo's feminist extensions of his carnival theory allow for a more focused political reading of the inversions, parodies, transgressions and reversals found in the many stories from both the science and fiction fields considered in this thesis. Compared in this way, on a structural level, the two different forms of multiple and partial story telling – evolutionary narratives and feminist sf narratives – reveal similar investments in bodies, agency, in the interactivity of organism and environment, and in interdisciplinary thinking. A politic, therefore, begins to emerge through the 'space and time' of the title and the multiple instabilities of the two carnivalised genres of evolutionary science and feminist sf with their shared metaphoricity.

This politics of change depends on two constructions in this thesis: the proposed territory of 'post neo-Darwinism', and the deliberate mapping of ecofeminist values across the subversive and undisciplined carnival readings of bodies and culture in evolutionary theory and the carnival readings of feminist sf texts.

At this point in time, there is no such thing as 'post neo-Darwinism'. The term has been coined ironically for this thesis from current theoretical jingoism. However, as well as being ironic, it is also a hopeful and serious term, consciously attempting to incorporate the extensive scope of current challenges to Darwinist and neo-Darwinist evolutionary theory, and denoting the problems of historical and cultural transitions to new understandings. 'Post neo-Darwinism', like other often controversial 'posts' – postmodernism, post structuralism, post colonialism, post feminism, post human and so on – tries to hold within it a concurrent multiplicity of meaning and possibility, while simultaneously expressing a deeply problematic split in ways of thinking about the world. 'Posts' seem to find their genesis in broad-based, exploratory resistances to universalising narratives but they are rarely historically or theoretically definitive

regarding actual lines of separation between movements, ideas, thinkers or time periods. As dialogues multiply in breadth and intensity, these 'posts' form broad demarcations on issues, but they fail to represent clearly identifiable points on cultural continuums of thought and practice; rather, they loosely indicate times and places of contention, separation and changeover, possibly even of 'epistemic rupture'.

An academic neologism, my term 'post neo-Darwinism' claims for itself a separateness from the traditional orthodoxies of both Darwinism and neo-Darwinism, while reflecting, through its etymological kinship with other theoretical 'posts', the on going power of Darwinism and neo-Darwinism. Colonialism has not disappeared, neither has feminism; however, the grounds of these discourses are shifting in 'seismic sections'.[5] Thus acceptance of a lingering inheritance of struggle is bound up in the permission 'post' words give to thinkers that allow them to explore a theoretical space with boundaries that act *as if* the ongoing power struggles within the discourse have been resolved. That is, the possibilities of new stories, new configurations of ideas, new directions and even new unities can be imagined in a (currently largely theoretical) 'space and time'. That the culture has adopted these many 'posts' and refrained from formulating alternative words to define new movements is also of significance. With no fresh terms clearly limiting the new spaces that follow perceived separation from major historical movements and ideas, there is the suggestion of anarchy. And anarchic spaces suggest carnival with its subversions of prevailing authorities, its inclusion and celebration of multiple voices and bodies and its ongoing search for sign 'posts'. The sign 'posts' may answer some of our demands for new stories to explain the problems besetting biology through cultural discussion.[6] However, the 'post-neo-Darwinist' position created for the specific needs of this thesis tries to show due care for both existing and newly conceived paradigms, recognising the difficulty for any proposed approach of being robust enough to hold all contemporary debate in the area.

The second strategy employed in this thesis to map the politicised carnival expression of post neo-Darwinist evolutionary stories and feminist sf stories is to read carnival through ecofeminism. Ecofeminism is a complicated theoretical project that

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5 Lisa Nakamura, *Prospects for a Materialistic Informatics: An Interview with Donna Haraway*, http://www.electronicbookreview.com/v3/servlet/ebr?command=view_essay&essay_id=nakamuraaltx (accessed September 30, 2003).

6 Lynn Margulis, 'Big Trouble in Biology: Physiological Autopoeiesis versus Mechanistic neo-Darwinism', in *Slanted Truths* eds. Lynn Margulis and Dorian Sagan (New York: Springer Verlag, 1997), 265-282.

draws attention to politically invested divisions between nature and culture, between culturally inscribed human, animal, 'others', and between textual bodies of difference. Examples of current theorists using this approach referred to in this thesis are Donna Haraway and Karen Barad, who respectively use the cyborg and sf literature and 'multi-agential posthuman performativity', and overlap with ecofeminist theory. While not usually considered ecofeminist, their writings critique representation in science and destabilise nature/culture dualisms. Haraway, along with other ecofeminist theorists such as Patrick Murphy, also speak directly to the importance of systems of agency and ecofeminism, particularly in literature and in feminist sf.[7] While both feminist sf and post neo-Darwinian stories challenge boundaries and rewrite subjectivity and agency, ecofeminism as it is interpreted in this thesis identifies certain commonalities in the different narratives and guides the political reading of post neo-Darwinism and feminist sf texts in the identification of their shared metaphors of change. Ecofeminism in this thesis is used to explore physical bodies, physical difference and sociocultural subversiveness, but it also acts as the impetus to move away from the implicit dangers and excesses of carnival toward a more hopeful politic. This hopeful politic is one of reconstructing a biological and cultural relationship that is not contained by the classical body of monumental modernism and bourgeois constraint, nor is it seduced by the violence and potential abjection of carnival. Rather, the two theories of carnival and ecofeminism map across each other forming a complementarity in the critiques of science in this thesis and in the analyses of the creative writing.

Writing responses to multiple narratives of evolutionary theory, writing specific case studies of feminist sf texts, writing the complex arguments of this thesis, and being a writer of sf myself, I write into and through a web of community and personal engagements with theory, genre and eco/feminist politics to understand the critical

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7 Carolyn Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution* (New York: Harper Collins, 1980); Donna Haraway, *Simians, Cyborgs and Women: The Reinvention of Nature* (London: Free Association Books, 1991); Donna Haraway, *Primate Visions: Gender, Race, and Nature in the World of Modern Science* (London, New York: Verso, 1992); Karen Barad, 'Posthuman Performativity: Toward an Understanding of How Matter Comes to Matter', *Signs: Journal of Women in Culture and Society* 28, no. 3 (2003); Karen Barad, 'Performing Culture/Performing Nature: Using the Piezpelectric Crystal of Ultrasound Technologies as a Transducer Between Science Studies and Queer Theories', in *Digital Anatomies*, ed. Christina Lammar (Vienna: Turia and Kant, 2001); Karen Barad, 'Reconceiving Scientific Literacy as Agential Literacy, or Learning How to Intra-act Responsibly Within the World', in *Doing Culture + Science*, ed. Roddy and Sharon Traweek Reid (New York: Routledge, 2000); Patrick D. Murphy, *Literature, Nature and Other: Ecofeminist Critiques* (New York: State University of New York Press, 1995); Patrick D. Murphy, 'Ground, Pivot, Motion: Dialogics, and Literary Practice', *Hypatia* 6, no. 1 (Spring) (1991); Patrick D. Murphy, 'Ecofeminism and Postmodernism: Agency, Transformation, and Future Possibilities,' *NWSA Journal* 9, no. 3 (1997).

commonalities of these fields. This dissertation reflects this process. Such a manifold engagement across branches of knowledge and expression is often seen as a positive feminist methodology, an acknowledged expression of transdisciplinarity, and as a manifestation of dialogic, carnivalistic and ecofeminist praxis. Katie King, looking at the 'ecologies of production' of feminisms, supports new, active ways of thinking that 'come into being from acts of translation across fields of power',[8] while Bob Hodge argues that transdisciplinarity in the 'New Humanities' promiscuously mingles disciplinarities, and disciplinarity with non-disciplinarity.[9] He suggests feminist enquiry has been particularly productive in the 'New Humanities' interrogation of disciplinary imperatives of orientation and politics and, for him, the transdisciplinary formations challenge the boundaries of disciplinarity more strenuously than multidisciplinary or interdisciplinary work. That scope and focus change in chapters and sections of this dissertation, sometimes telling the larger stories of evolution and feminist sf writing and sometimes telling smaller stories which seem to have a larger or almost allegorical significance, evidences ecofeminist and dialogic praxis. Patrick Murphy describes this shift between general critiques of power and the specifics of story:

> Repeatedly her [Dale Bauer's] literary analysis telescopes out from the aesthetic text to larger questions of cultural community and political and ideological power under patriarchy. But that is not surprising, since anyone employing dialogics as a method must find herself constantly shuttling back and forth between text and context, discourse and community, and personal and political.[10]

Murphy distinguishes between writers who simply use dialogism as source material and those who embrace it as method. Connections made within this thesis involve a similar 'telescoping' to that which he mentions in Bauer's writing. Further connection between praxis and theory is found in the composite nature of this dissertation, because as a composite work, it is an example of what Hodge calls 'monstrous knowledge: a 'seamed' creation, an 'unstable patch-work of premises and fields, an incoherent and shifting map whose present status is not agreed on, much less its future'.[11]

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8 Katie King, 'Productive Agencies of Feminist Theory: The Work it Does', *Feminist Theory* 2, no. 1 (2001), 95.
9 Bob Hodge, 'Monstrous Knowledge: Doing PhDs in the New Humanities', *The Australian Universities Review* 38, no. 2 (1995), 37.
10 Murphy, 'Ground, Pivot, Motion: Dialogics, and Literary Practice', 147.
11 Hodge, 'Monstrous Knowledge: Doing PhDs in the New Humanities', 37.

Hodge's commentary inevitably conjures up images of Frankenstein's creature, an image that is used a number of times in this thesis to suggest and critique new disciplinary unities. Shelley's novel is known to be significant in the history of sf, but it is also key in Holquist's analysis of Bakhtinian carnival, as an example of how 'otherness' is always at work in the heart of any genre[12] and how genre is made up of 'story inside framed story'.[13] The thesis follows obvious seams between science stories and fictional stories, but also insists on identifying multidimensional contestations, resistances, ambiguities and contradictions that have not previously been considered in evolutionary science. This leads to the work in the following chapters being treated as nested narratives, with the emphases shifting between story telling in science and science in story telling, and the 'whole' proposing a shared, culturally based metanarrative of change.

Following the Introduction, the first section of the thesis is concerned with "Genre". Chapter One, 'Genre: Narratives of Change', explores the composite monster as foundational to both sf and carnival. Genre is often discussed philosophically with respect to its purity and contradictions, but its constitutive processes are varied and form a long list of cultural processes and material manifestation. This chapter considers the history of sf through physical production from science romance novels, early magazines, and art work; its dialogic production within the sf community of fans, writers, critics and readers; the way the academy appropriates the genre and attempts prescriptive understandings of it; and the content of the literature which usually emphasises science and/or technology. Of central significance to this thesis is the use of science in identifying what texts belong or do not belong in the genre. This thesis argues that science is essential to understanding sf, but that the only science that can be claimed to consistently constitute the genre is evolutionary science – the science of change. Extending Brian Aldiss' argument that evolution was a central driver in *Frankenstein*, the primal text of the sf genre,[14] this dissertation argues that evolution is necessary to understand all sf texts, and particularly feminist sf texts. That is, the science of change is essential to understanding the literature of change.

The next section of the thesis is concerned with "Evolutionary Narratives". Chapter Two focuses on the conflicted early development of Darwinism, its ongoing ambiguous relationship with religion, and current scientific resistances to Darwinism,

12 Michael Holquist, *Dialogism: Bakhtin and his World* (London and New York: Routledge, 1994), 89.
13 Ibid, 97.
14 Brian Aldiss, *Trillion Year Spree: the History of Science Fiction* (London: Paladin Grafton Books, 1988).

particularly the theory of punctuated equilibrium. Surprisingly, reciprocal borrowings are common between the two discourses of religion and evolution, and are a source of discomfort for a number of scientists. This chapter also showcases general scientific reservations to Darwinism in terms of disciplinary specifics and looks at punctuated equilibrium as a post neo-Darwinist theory, one with specifically feminist loadings. Punctuated equilibrium scientifically challenges Darwinian gradualism, arguing that the speed of change is sometimes precipitate. Punctuated equilibrium accords with current global experiences of cultural change and is certainly a common metaphor in sf texts, feminist and otherwise. This chapter reveals Darwinism, usually considered the core narrative of modern evolutionary theory, as problematic and destabilised.

Chapter Three continues the "Evolutionary Narratives" by following familiar stories of neo-Darwinism and socio-biology produced from the 1950s through the narrowing of the evolutionary model to the new synthesis. This model was built on Mendelian genetics, population mathematics, random mutation, and adaptation, and argued for individual selectionism as the primary creative force in the production of species. Reinforced by molecular biology, neo-Darwinism has become a deterministic creed driven by conservative gender and race politics. While reductionist evolutionary ideas cannot be ignored, the intention here is not to produce a field overview of debates that has already been covered by other feminist critics, or to get mired in feminist argumentation with sociobiology. Instead, the material in this chapter presents reflections on the popular power of these foundational stories and their particular authors. The challenges to neo-Darwinism and socio-biology come from examining the constitution of scientific authority in the area and the implications and problems of extending genocentrism into interdisciplinary stories driven by nostalgic politics. This chapter confronts powerful stories of genetic reductionism and explores their links to dominant knowledge and to manifest social power, thus contextualising the 'other' evolutionary stories in this thesis, and their sociocultural potential.

Where Darwinism, punctuated equilibrium and neo-Darwinism are carnivalesque because of ambiguities, oppositional extremities and internal contradictions in the presentations of science practice and scientific authority, Chapter Four continues the "Evolutionary Narratives" by considering an openly carnival story that humorously centralises grotesque bodies, conventional science, subversive science and subversive politics. This theory is the Aquatic Ape Theory (AAT), the only feminist theory of human evolution. In faithfully following methodologies from socio-biology and neo-Darwinism the AAT undoes them. Not a predominantly academic story, the AAT is

transdisciplinary in the most challenging way, existing as a 'potentially explosive density near some arbitrary margin that destabilises the basic core-plus-periphery structure of the prior disciplines'.[15] It is yet another 'seamed' story, one of many within this seamed thesis, a larger narrative that eclectically borrows knowledge to construct, in both the academic sense and the imaginative, creative story-telling sense, a pre-hominid forced to depend on a marine or estuarine environment at some time in its prehistory. The focus of this evolutionary tale is the survival of beleagured females and their offspring rather than the success of the hunter. The AAT argues that many of the differences that mark the human animal, such as bipedality, hairlessness, big brains and speech, are considered as having developed in response to the needs of that dependent and vulnerable group. This is a conflicted story that has met with general scientific derision, but has also had some unexpected wins in fields like biochemistry and paleontology. Part of its seamed character is its combination of conservative neo-Darwinian methodology and popular ethology supported by multidisciplinary science stories, some of which are based on geology, virology, and current molecular biology and are not currently read as feminist.

The bricolage chapter that proposes 'post neo-Darwinism' as a composite, ecofeminist reading of evolution covers a number of disciplines that have investments in evolutionary narratives. Chapter Five concludes the "Evolutionary Narratives" by discussing prebiotics, serial endosymbiosis theory, neo-Lamarckianism and non-Mendelian heredity, panbiogeography, the constraints of morphology, homology and convergent evolution, the neutral theory and Gaia. Except for Gaia, these are not theories that have been particularly examined for their feminist or ecofeminist potential to date. So the central argument of this chapter is that, while individually some of these scientific ideas might present as feminist friendly, it is as a collective that they have eco/feminist weight. Taken together, they mount a strong challenge to Darwinian and neo-Darwinian authority, and they carnivalise evolutionary science with their multiple organic and inorganic foci, their appreciation of the many fields operating in and around organisms, their embracing of a range of different perceptions and mechanisms of biological change, and their acceptance of multiple agency in scientific stories of change. Quite specific parallels can be seen between this wide screen picture of evolution and Bakhtinian carnival theory, as the sheer enormity, complexity and bounty of the natural environment is explored. In Rabelaisian stories, the earth is a giver of bounty and a devouring place, a consuming, defecating, aging, and birthing

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15 Hodge, 'Monstrous Knowledge: Doing PhDs in the New Humanities', 37.

body. In scientific stories that move beyond mechanistic stories of nature and reductionism, it is a homeorrhetic entity that is eternally responsive to active geology and chemistry, the multiagentiality of organism and ecosystem, and to the vast processes of extinction and emergence.

Ecofeminism, as it is mapped onto the carnivalised narratives of evolution in Chapters Two to Five, is alert to potential strategic unities and a 'different' consciousness which has the potential to both rehabilitate existing ideas and analyses, and to formulate fresh, inclusive stories to complement hierarchical systems of domination politics in biology and natural history. Ecofeminism offers a global approach, though currently it has no singular definition due to its extensive cooption into many areas of academic and environmental theory and practice. In this thesis, the models followed in examining science again owe much to Barad and Haraway.

Barad borrows from Haraway's cyborg argument of the agency of objects as 'material-semiotic actors'in the world, and her theories of 'situated knowledges', knowledges produced and compromised by social construction that have real material expression and consequence.[16] Barad's system of multi-agential, posthumanist performativity – a system of knowing that 'incorporates important material and discursive, social and scientific, human and nonhuman and natural and cultural factors'[17] is intuitively and literally applied through this thesis and forms a theoretical sinew reinforcing the potentials for an 'ethic of knowledge' in the carnival space.[18] On the other hand, Haraway's hybridity and story telling approaches to science, which have been crucial to navigating evolutionary thinking in this thesis, have also modelled a vital and strong ecofeminist politic and 'imploded' disciplinary boundaries to allow for the second major shift in the thesis toward popular culture texts and the mapping of evolutionary science onto feminist science fiction.[19] Haraway herself uses feminist sf

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16 Donna Haraway, 'A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century' and 'Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective', in Haraway, *Simians, Cyborgs and Women: The Reinvention of Nature* , 149-182 and 183-202; Karen Barad, 'Meeting the Universe Halfway: Realism and Social Constructivism without Contradiction', in *Feminism, Science and the Philosophy of Science*, ed. L.H and J. Nelson (London: Kluwer Academic Publishers, 1996), 161-94; Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham: Duke University Press, 2007).

17 Barad, 'Posthuman Performativity: Toward an Understanding of How Matter Comes to Matter', 808.

18 Barad, 'Meeting the Universe Halfway: Realism and Social Constructivism without Contradiction', 183.

19 Donna Haraway, 'A Game of Cat's Cradle: Science Studies, Feminist Theory, Cultural Studies', *Configurations: A Journal of Literature and Science* 1 (1994), 60-61 for an extensive list of interventions through popular and academic culture: 'Feminist, multicultural, anitiracist technoscience projects include, for example, popular cultural production (film, TV, video, print

as an example of a flourishing survivor of those 'dense imploded zones'. She addresses it directly as a politically hopeful genre, as do a number of other ecofeminist theorists.[20] This thesis also argues feminist sf as a hopeful, engaged genre, positing it as carnivalised, but also contending that it is frequently driven by an ecofeminist politic and that it represents and reflects on 'post neo-Darwinist' evolutionary constructions of biological and sociocultural change.

The treatment of feminist sf in this thesis takes the form of three chapters that are literary 'case studies' of novels. The novels are considered with respect to the extended definition of the sf genre as it is discussed in Chapter One. Two of the case studies have already been published in a journal and the third will form a chapter in an edited collection on Joanna Russ to be published in 2009. These chapters are written as formal papers, utilising the disciplinary specific understandings of evolutionary theory in the earlier section of the thesis.

These "Case Studies" - Chapters Six, Seven and Eight - examine feminist sf texts for structural configurations of scientific metaphors. The novels considered are *Up the Walls of the World* by James Tiptree Jr., *The Children Star* by Joan Slonczewski, and *We Who are About to ...* by Joanna Russ.[21] Within a critical context of carnival, these texts reject or ironise randomly adaptive, competitive, genocentric explanations of

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fiction, advertising, music, jokes, theatre, computer games), diverse practices for apprehending and refiguring the ethnospecific categories of nature and culture, professional studies of technoscience (philosophy, anthropology, history, sociology, semiology), community organizing, labor practices and struggles, policy work at many levels, health politics, media interventions, environmental activism, technical design, engineering, and every sort of scientific research. These practices regularly do not respect boundaries between and among sacred categories, such as nature and society or human and non-human. But boundary crossing in itself is not very interesting for feminist, multicultural, antiracist technoscience projects. Technoscience provokes an interest in zones of implosion, more than in boundaries, crossed or not.'

20 Haraway, *Simians, Cyborgs and Women: The Reinvention of Nature* and Haraway, *Primate Visions: Gender, Race, and Nature in the World of Modern Science*. In *Primate Visions* Haraway reads Octavia Butler's fiction as primatology. Also see Stacy Alaimo, 'Cyborg and Ecofeminist Interventions', *Feminist Studies* 20, no. 1 (1994) and Murphy, 'Ecofeminism and Postmodernism: Agency, Transformation, and Future Possibilities'. Alaimo sees sf as a forum for working out issues with science and technology, while Murphy sees feminist sf writers as offering 'eutopian' visions in literature that seek to deal with and transform genre and nature writing.

21 See Tess Williams, 'The Tiptree Carnival', *Foundation: the International Review of Science Fiction* 33, no. 90 (2004); Tess Williams, 'Imagining Alternative Pathways of Biological Change and Co-existence', *Foundation: the International Review of Science Fiction* 35, no. 98 (2006); Tess Williams, 'Castaway: Carnival and Sociobiological Satire in *We Who Are about to ...*', in *On Joanna Russ*, ed. Farah Mendelsohn (Middletown, CT: Wesleyan University Press, forthcoming). See also Tess Williams, 'Embodying Change: (R)Evolutionary Theories of an Alien Synthesis', in *SciFi in the Mind's Eye: Reading Science through Science Fiction*, ed. Margret Grebowicz (Chicago: Open Court, 2007). This last reference is a single chapter case study of the four *Alien* films as carnival texts, expressive of a similar shared evolutionary metaphoricity.

biological and social change and promulgate social and biological change as multi-level, composite and complex.

Together the literary narratives and the evolutionary narratives that are mapped onto them can be interpreted as a decentred and unstable ecofeminist story domain. Multiple agency is key to this transdisciplinary production, a multiple agency that refuses the Cartesian organism/environment cut, subverts representations of social and scientific authority, and actively engages with a system of discursive materiality that includes both the fantastic bodies of nature and the human imagination.

GENRE

Chapter One
Genre: Narratives of Change

And suppose for a moment that it were impossible not to mix genres. What if there were, lodged within the heart of the law itself, a law of impurity or a principle of contamination? And suppose the condition for the possibility of the law were the a priori of a counter-law, an axiom of impossibility that would confound its sense, order and reason.

Jacques Derrida 'The Law of Genre'[1]

The older generic categories do not, for all that, die out, but persist in the half-life of the subliterary genres of mass culture, transformed into the drugstore and airport paperback lines of gothics, mysteries, romances, best-sellers, and popular biographies where they await the resurrection of their immemorial, archetypal resonance at the hands of a Frye or a Bloch.

Frederick Jameson 'The Political Unconscious'[2]

Introduction

The meaning of the term 'genre' is historically and hierarchically slippery and, as Derrida points out in the epigraph to this chapter, it is a paradoxical concept: the heart of genre being the impossibility of making culturally complex bodies of work cleave to clearly formulated rules which compartmentalise texts into stable groups. However, while acknowledging that genre is philosophically problematic, there is still a great deal left to say about historical, literary and community notions of genre, their broad and specific constitutive processes, and the varied political and cultural agendas that are used to dictate the necessities and the forms of genre. Some approaches to genre present very narrow and prescriptive fields, while others offer more overarching perceptions that situate texts relative to other bodies of writing. Unable to impart a stability of universal consensus, the various understandings of genre reveal layered and sometimes ambiguous and/or conflicted understandings. The first chapter of this thesis sifts through some different ideas on genre using science fiction, feminist sf and evolutionary narratives as cases in point to demonstrate different constitutive processes in genre and to illustrate that the interrelationship of genres is also significant in the production and reception of genre.

Genre creation and reception, in this chapter, are viewed more as a web, an entanglement of the physical and the discursive, than as a hierarchical or even firm ordering process. Sf, and feminist sf, sit at the heart of a series of limiting affects and

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1 Jacques Derrida, 'The Law of Genre,' *Glyph* 7, Spring (1980), 57.
2 Fredric Jameson, *The Political Unconscious: Narrative as a Socially Symbolic Act* (London: Methuen, 1981), 107.

connections that range across the materiality of publishing and marketing, community understandings of shared conventions (particularly within the sf community of fans, writers and readers), academic critiques, specialised reading practices, and sf's particular associations with science/technology. Any one of these contingent materialities or practices provides valid insights into what is meant by the term science fiction, but one of the main tasks of this thesis is to expand upon and redefine the role of science in the production of sf literature, and particularly of feminist sf literature.

Thomas O. Beebee argues that genre is a labile construction. The novel for him is a hybrid construction of multiple discourses. Addressed together in forms he calls 'use values', Beebee argues that these multiple discourses reveal ideology.[3] Beebee's process has something in common with Bakhtin's notion of speech genres and heteroglossia in the novel. Beebee believes comparative understanding of various discourses within genre is an effective way of penetrating the instabilities of genre and producing critique. He sees this approach as more effective than description, prescription or Derrida's ultimate contradiction. Beebee argues that, while often only one genre appears to be foregrounded in a particular text, every work inevitably involves more than one genre. Examining intersecting genres through the work offers a sort of 'refraction' process where different periods, cultures or modes can illuminate ideology through their connection and values.[4] The two main genres selected for the case studies in this thesis are 'post' neo-Darwinian evolution stories and feminist sf, both discourses that tell stories of biological and social change. These different 'genres' are then contextualised further within carnival theory, feminist science studies and ecofeminism. Carnival is used as a decentring theory that identifies the undoing of traditional patriarchal authority through subversion and an emphasis on the grotesque, while feminist science studies and ecofeminism, although in some senses also similarly 'unravelling' to patriarchal politics, are seen as theories that also suggest or anticipate possible new unities in the understandings of creative, discursive and material multiplicities.

Carnival as a critical theory is largely grounded in Mikhail Bakhtin's work and goes beyond the instability inherent in specific genres to consider larger framing cultures and the physical world as similarly unstable. Carnival disrupts what is usually perceived as 'natural' and 'normal' with inversion, parody, transgression and reversal. For Bakhtin, carnival is a place where all cultural roles and modes, expressed and

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3 Thomas O. Beebee, *The Ideology of Genre: A Comparative Study of Generic Instability* (University Park: Penn State Press, 1994), 14-19.
4 Ibid.

repressed, official and unofficial, are shown to exist and be multivalent. Although I primarily use carnival to demonstrate both the contradictory values of mainstream evolutionary theory and its many marginalised stories, this theoretical approach can be supported by reference to Thomas O. Beebee's idea of 'use value' and the 'refractive' actions of stories within stories. Embedded metaphors of social and physical change within feminist science fiction texts are mapped by reference to multidisciplinary Darwinian, neo-Darwinian and 'post neo-Darwinian' scientific evolutionary narratives. This intersection is constructed as dialogical, culturally complex, and politicised. Compared in this structural way, the different story forms of 'post neo-Darwinism' and feminist sf story telling demonstrate similar investments in bodily difference, in subverting existing authorities and in exploring new notions of multiple agency. As has already been noted in the introduction, this is not a neat linear form of story telling but what Murphy refers to as an 'emancipatory strategy', that will offer critique and reveal the political potential (through the literature) of scientific pluralism.[5]

Murphy distinguishes between writers who use dialogism as source material and those who embrace it as method. The politics of relationship drive both this thesis and this chapter, thus connections are made within and between the various narrative levels of scientific and fictional change, but they are not necessarily familiar or consistent connections. Bodies, physical environments, culture, discourse and language alter in a carnival of (deep) time and (planetary) space, but they still nourish the central story of shared metaphors of change and eco/feminist politics in the two different genres of 'post neo-Darwinist' evolutionary theory and feminist sf.

Genesis: historical material specificity and genre

Having a particular hold in the study of literature, the term genre has frequently been used to try to separate one form of creative written/verbal expression from another in the broadest sense and, from very early times, it has also been used to rank writings and verbal expressions against each other through the privileging of certain forms.[6] This prescriptive and value-laden inheritance compounded with the recent burgeoning of popular texts in western culture has made the whole contemporary notion of genre complex. The repudiation of traditional prescriptive or descriptive literary models, together with the advent of structuralism, linguistically based post-structuralism, the rise of postmodern theory, which examines 'transgressed boundaries, multiple

5 Murphy, 'Ground, Pivot, Motion: Dialogics, and Literary Practice', 148.
6 Robert Baldick, Betty Radice and C.A. Jones, eds, *Classical Literary Criticism: Aristotle, Horace, Longinus*, trans. T.S. Dorsch (London: Penguin Books, 1974).

discourses and discontinuous structures',[7] and recent proliferations of interdisciplinary critical and writing practices have complicated the term even further. Boundary debates have come to take different forms, often dependant upon the writer's, reader's and critic's particular disciplinary perspective, the period in which, about which and from which they write, and the agenda they have for promoting or criticising the notion of genre in the first place. The result is that some critics, readers and writers seek to firm up divisions between forms of writing as they see value in mapping particular kinds of cultural expressions, or identifying their own work within a specific area of consideration, while others seek to dismantle genre as they argue it perpetuates ideological or artistic distortions.

Beyond this broad picture, however, literary genre is shaped in sometimes unexpected but fundamental ways by technological modes of production and distribution, and the politics of publishing and marketing. James Gunn summarises the changing face of nineteenth century technology, and its effects on genre production, against the background of a 'growing middle class and a newly literate working class':

> New processes for the printing of newspapers and magazines had made them cheap enough to produce and sell in large quantities: the invention of the rotary printing press in 1846, the linotype and pulp paper in 1884, the halftone engraving in 1886, and such methods of distribution as the railroad, the automobile, the truck, and a nationwide distribution system, as well as the introduction of general advertising to help pay the bills.
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> The first general mass magazine containing fiction was published in England in 1891. It was soon followed by others in Great Britain and in the United States....In 1896, the mass magazines would be joined by the pulp magazines, consisting entirely of fiction, and they, in turn would give birth to the category pulps – the detective, the western, the love story, and finally, in 1926, the science fiction magazine.[8]

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7 Ralph Cohen, 'Do Postmodern Genres Exist?' in *Postmodern Genres* ed. Marjorie Perloff (Norman: University of Oklahoma Press, 1988), 11. Cohen's essay discusses the oppositionality of prescriptive theories and open theories of genre: 'These critics assume that a genre theory of the novel is committed to backgrounding literary artifice, to demanding coherence, unity and linear continuity. But though such an assumption may apply to some generic theories, there are others that are perfectly compatible with multiple discourses, with narratives of discontinuity, with transgressed boundaries.'

8 James Gunn, ed., *The Road to Science Fiction: from Gilgamesh to Wells* (New York: Mentor, 1977), 345-346.

From such beginnings, Darko Suvin claims British sf grew into a 'paraliterature', happily published by most of the country's major publishing companies as books, or at least as slim volumes.[9] America, on the other hand, had a different experience. In the 1890s, mass media publications contained many adventure stories, some of which have been identified as precedents for sf in particular.[10] Their covers 'bristled with all manner of fantastic iron tanks, parasolled flying machines, robots puffing steam and "electric turtles"',[11] foreshadowing the fascination with technology displayed by many of the science fiction magazine covers that were to follow only a few decades later.

This bears mentioning because the British and American traditions appealed to different classes, and American sf separated out from 'literature' at an early juncture and still maintains a certain separateness, while many early British authors (Wells, Orwell, Lewis, Wyndham) were clearly recognised as mainstream literary writers. In America, technologies of distribution that helped form and promote early sf were followed by editorial and publishing decisions that further shaped, firmed and regulated the genre. Stories by writers like Jules Verne, H.G. Wells and Edgar Rice Burroughs were frequently presented in sf magazines in the first half of the twentieth century. As both stables of magazines and writers continued to extend, a pattern was followed of identifying a 'classic' story and reprinting it. Other genres, like aviation and war, western frontier, mystery, sports and so on, fell away or changed writers and appeals significantly. Science fiction, however, still sees a number of its major early writers being continuously reprinted and the garish covers on science fiction magazines and paperback novels have only begun changing very recently.

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9 Charles Elkins and Darko Suvin, 'Preliminary Reflections on Teaching Science Fiction Critically'. *Science Fiction Studies* 6, no. 19 (1979), 20-31. The thesis of 'paraliterature' is that the democratisation of literature was denounced in Britain which led to the production of 'popular' or 'mass' fiction. See also Darko Suvin, *Victorian Science Fiction in the UK: The Discourses of Knowledge and Power* (Boston: G.K.Hall, 1983).

10 Lester Del Rey, *The World of Science Fiction: 1926-1976 The History of a Subculture* (New York: Ballantine Books, 1979), 15-17. Del Rey contends that Edgar Allan Poe stories, like 'The Unparalleled Adventure of one Hans Pfaal' (1835), joined with lesser known pieces like Fitz James O'Brien's 'The Diamond Lens' (1858) and Ray Cummin's 'The Girl in the Golden Atom' (1919), then came together with the late 19th Century romances of Jules Verne to create a precursor for the genre. Brian Stableford, on the other hand, in *The Cambridge Companion to Science Fiction* ed. Edward James and Farah Mendlesohn (Cambridge: University Press, 2003), 20, also adds stories from writers as diverse as Nathaniel Hawthorn, Edward Everett Hale, and Frank R. Stockton.

11 Tony Goodstone, ed., *The Pulps: Fifty Years of American Pop Culture* (New York: Chelsea House Publishers, 1970), xi.

Through stories from authors, editors, fans and commentators, Helen Merrick speaks to the publication experience of the sub-genre of feminist sf in her thesis.[12] Merrick says that much of what works against the sub-genre of feminist sf is what makes sf identifiable as the parent genre in the market place. She also says, 'Publishers have always had a substantial impact over the production, circulation and even content of texts', and they can decide 'what texts are actually available to (which) readers'.[13] Decreased print runs and a short shelf life in the larger bookstore chains since the 1970s have militated against new authors becoming established (and possibly redirecting the genre), while traditional authors such as Heinlein, Asimov and Clarke are taught and reprinted year after year. Independent bookshops try to support new and/or specialist writers but it is difficult for them to make an impact on sales numbers. The relationship between the publishers and the big bookshop chains, based on fast turnover and market positioning, leads to a direct form of censorship from the publishers concerning genre 'publishability' and self-censorship among writers who worry about the acceptability of their work in relation to what is commonly understood by publishers and booksellers to constitute a genre.

Publishing decisions can be both very specific and very revealing with regard to constructions of genre, but as genre is often naturalised it can take an exception to reveal the rules. Merrick discusses Octavia Butler's difficulties as a black, feminist, sf writer. Butler took *Parable of the Sower* (1994) and *Blood Child and Other Stories* (1995) away from dedicated sf imprints to the independent literary press Four Walls Eight Windows because she felt she was not situated well in the genre market. Although she actively embraces sf, the small press successfully positioned her as 'speculative fiction', identifying her with the magic realism of Toni Morrison's *Beloved* and Toni Cade Bambara's *The Salt Eaters*.[14] Clearly, part of the problem Butler encounters when publishing as a feminist sf writer is an underdeveloped critical vocabulary on race and genre in the literary community, but also she runs aground on certain publishing and genre expectations that she fails to meet. Sf has long been considered a genre written by and for adolescent white males. Women had difficulties achieving a consistent presence in the genre as writers, readers and fans until the

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12 Helen Merrick, 'Feminist/Science/Fictions: A Case Study of Feminist Cultural Production in Critical and Popular Communities' (PhD, University of Western Australia, 1998).
13 Ibid, 253.
14 Ibid, 266.

1960s, and African American women were practically invisible.[15] They were so invisible that the African American protagonist of Butler's *Xenogenesis* trilogy, Lilith, was represented on the cover of the first edition as a white woman. The reasons for this would be complex, including not only institutionalised invisibility of black characters and a failure to read and promote colour in the narrative, but also the continuity of certain genre 'stories' or markers. Nalo Hopkinson, another black feminist sf writer, gives a further insight on this in an interview:

> In December 2001 my publisher released a collection of my short stories. When they showed me the cover that they wanted to use, I was very pleased, because it's gorgeous work. It shows a young black woman dressed in a loose white dress and head wrap that hints that she's going to some kind of Orisha ceremony. She's standing at night among the tall canes of a tropical sugar cane field. She's carrying a lit candle, and beside her at head height is a snake twined around one of the canes. After a few days of exulting over the cover, though, it struck me; most of the stories in the collection are set in Toronto! I had hoped it would have a cover that was sort of Michael Ray Charles meets cyberpunk. I pointed the Toronto settings out to my editor, and she said she realized that, but that my readers were used to the kind of cover image she had chosen and to the occasional dissonance between it and my content. It's odd.[16]

Here Hopkinson speaks to a significant political inertia that operates within and around genre and publication. She gets the black woman on the cover that Butler failed to get, but the appeal of the exotic stereotype won out over a faithful representation of what was largely urban content in the book. In the same interview, Hopkinson also recognises imbalances that perpetuate genre expectations in the industry itself: she says, until more black people are visible as editors, publishers, design people, marketing people, graphic novelists, comic book artists and so on, black people will continue to be invisible in stories. Hopkinson is not being utopian when she says this; she is calling for what Haraway terms a 'materialist refiguration' of genre. Genre is not

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15 Justine Larbalestier, *The Battle of the Sexes in Science Fiction* (Middletown, CT: Wesleyan University Press, 2002); Sarah Lefanu, *In the Chinks of the World Machine: Feminism and SF* (London: The Women's Press, 1988); and Merrick, 'Feminist/Science/Fictions: A Case Study of Feminist Cultural Production in Critical and Popular Communities'. These texts offer comprehensive discussions of women in sf.

16 Alondra Nelson, 'Making the Impossible Possible: An Interview with Nalo Hopkinson', *Social Text* 20, no. 2 (2002), 100.

conceptual. It has phenomenological practices at the roots in its production and continuity. Thus literary categories may be discussed in many different ways, as they will be from this point in this chapter, but they are always underpinned by materialist sociocultural practices that are inflected with gender, race, ethnicity and (of particular importance to both scientific evolutionary stories and speculative feminist fiction) anthropocentrism.

Evolution: (mostly) girl talk

In the same interview quoted in the previous section, Alondro Nelson asks Nalo Hopkinson about defining her work as 'speculative fiction' as opposed to science fiction. Hopkinson replies, 'I don't know that I prefer speculative fiction (spec-fic) as a description. If I've said that, it would depend on who asked me the question and why'.[17]

Genre awareness is complex. Sf writers are usually part of a specific speech community that has extended knowledge of the conventions, history, discourses and disputes of the genre. The original community was generated from the letter pages of Hugo Gernsback's American 'scientifiction' publication *Amazing Stories* in 1926. Contributors to the letters pages contacted each other via the letters page and discussed shared interests. As different media developed and the work of sf became more wide ranging, sub-genres and special interest groups developed and claimed special territories, so the sf community came to be composed of many groups with different foci – space opera, comic books, gaming, star trek, cyberpunk and utopian fiction to name a very few – a carnivalesque intersection of voices, subjects and texts.

It has been recognised that a specialised knowledge of the genre exists within this community; however, the sf community represents a loose affiliation of shared interests not a unified set of values. The sf community is, and always has been, a community divided by events and personalities, and the histories of editors, magazines, artists, individual writers and fans have been extremely significant in both forming and informing the tastes and understandings of more recent writers, readers, artists and critics within the sf community. Also, although there is an unofficially recognised and mutable 'canon' of texts in this large and complicated genre, it is essential that the genre not be perceived as monologic on the level of the sf community, because nothing could be further from the truth.

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17 Ibid, 99.

Examples of the polyvocality and nuanced discussions of the sf community and genre can again be located through the sub-genre of feminist science fiction. Sarah Lefanu, Justine Larbalestier and Helen Merrick all record histories of women and/or feminism and sf in some respect.[18] In *In the Chinks of the World Machine: Feminism and SF* (1988), Lefanu is primarily interested in the literature and responds as a literary critic, but she contextualises feminist sf through historical periods and broad, recognisable sf themes and identities. Her case studies of women writers consider their individual sexual politics via their personal development but also, on occasion, with regard to the part they play in the sf community. Alice B. Sheldon's biographical story, for example, is a particularly rich one and involves deception and confrontation with readers, fans and other writers. For nearly a decade Sheldon wrote under the pseudonym James Tiptree Jr. and the 'outing' of James Tiptree Jr. as a woman caused a re-evaluation of all the literature that had been published under that name and any commentary about it. Tiptree's 'career' is extremely revealing with regard to representations of gender and gendered attitudes, and how they are integral to the shaping of the genre.[19]

Larbalestier's *The Battle of the Sexes in Science Fiction* is largely historical. It follows shifts such as the one where sf fictions affirm traditional gender roles of masuline superiority and feminine submission, such as Wallace G. West's 'The Last Man' (1929), Nelson S. Bond's 'The Priestess Who Rebelled' (1939), and Edmund Cooper's *Who Needs Men?*(1972), through satirical gender stories such as Frederik Pohl and Cyril Kornbluth's *Search the Sky* (1954), Bruce McAllister's 'Ecce Femina!' (1972), James Tiptree Jr.'s 'Mama Come Home' (1968), to Russ's 'When it Changed' (1972), a story that generated a whole post-masculine-world trope for feminist utopian writing.[20] Fictional texts are thus shown *not* to be manufactured for a static category of genre, but to be part of a dialogic process of genre formation. Larbalestier further demonstrates that tension around gender exists within the genre at other community sites, notably in letters in magazines and fanzines, forums and the construction and bestowal of awards, she also notes that science is another area of contested value in sf writing, but she does not pursue it.

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18 Lefanu, *In the Chinks of the World Machine: Feminism and SF* , Larbalestier, *The Battle of the Sexes in Science Fiction*, and Merrick, 'Feminist/Science/Fictions: A Case Study of Feminist Cultural Production in Critical and Popular Communities'.
19 Julie Phillips, *James Tiptree, Jr.: The Double Life of Alice B. Sheldon* (New York: St Martins Press, 2006).
20 Larbalestier, *The Battle of the Sexes in Science Fiction.*

In her thesis, Helen Merrick does look at that connection, arguing that feminist science studies is directly relevant to feminist sf. She invites extended heteroglossic and interdisciplinary readings of the genre of feminist sf, looking also at feminist literary criticism and its contribution to new perspectives on this form of writing. Feminist sf may well be a sub-genre of that body of writing loosely identified as sf, but its worldview stretches beyond a handful of books found on independent bookstore shelves.[21] Merrick's thesis allows a glimpse of 'secondary feminist identities' that stand in the shadows behind those on which we usually focus.[22] Although they can be examined in this limited context, feminist science fiction stories are not just isolated challenges to mainstream sf, which in its turn challenges mainstream literature. Rather they are connected to a larger social machinery that is interrogating and challenging culture and gender representation in other major discourses too. Thus Bakhtinian models of dialogia, heteroglossia and carnival prove useful in the study of feminist sf (texts and genre), accommodating the writing and the processes of its production and reception within the cultural community and the 'otherness' of its content, with both an embracing historicity and specificity.

Any consideration of sf and the sub-genre feminist sf inevitably reveals a multiplicity of contributing voices and different ways to construct the genre. Acknowledging the whole continuum of critical, readerly, writerly and even editorial perspectives that inevitably contribute to any parameters or process of understanding of the genre – both in general and in particular – is sometimes difficult. Who holds authoritative knowledge, when do they hold it, why do they hold it and how do they hold it are key questions. Writers? Fans? Theorists? Writers are often critics, critics are often fans, fans are often writers too.[23] In a community like this, does *anyone* hold authoritative knowledge? And if they do, what shape does it take? In many ways, sf is a real example of carnival as the field is constructed in a significantly non-hierarchical fashion and draws on multiple identities, and cultural, historical and social discourses such as literary criticism, fandom and critiques of science in an extraordinarily eclectic way. The publishing industry feeds a conservative representation of the genre, but subversions via gender and race are frequent and significant destabilising elements.

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21 Merrick, 'Feminist/Science/Fictions: A Case Study of Feminist Cultural Production in Critical and Popular Communities'.
22 Sandra Harding, 'Who Knows? Identities and Feminist and Epistemologies', in *(En)Gendering Knowledge: Feminists in Academe*, eds. Joan E. Hartman and Ellen Messer Davidow (Knoxville: The University of Tennessee Press, 1991), 100-120.
23 Helen Merrick and Tess Williams, eds. *Women of Other Worlds: Excursions through Science Fiction and Feminism* (Perth: University of Western Australia Press, 1999).

Evolution: (mostly) boy talk

In 'Do Post-modern Genres exist?' Ralph Cohen sums up the critical dilemma of postmodernism's attempts to annex sf as a 'poster genre':[24]

> Post-modern critics have sought to do without a genre theory. Terms like 'text' and 'ecriture' deliberately avoid generic classifications. And the reasons for this are efforts to abolish the hierarchies that genres introduce, to avoid the assumed fixity of genres and the social as well as the literary authority such limits exert, to reject the social and subjective elements in classification.[25]

He goes on to argue that some theorists find it useful to build 'families' of texts, noting certain continuities in those texts. His conclusions are that any true escape from genre is impossible. Cohen views with scepticism the non-generic space that postmodernism supposedly supports, claiming essays on post-modern, post-generic texts are themselves products of and examples of linear narratives which work on reader persuasion. Cohen's position is not original, as Heidegger, Derrida and Bakhtin, in their philosophies of literature, have already suggested ultimate contradictions in the construction of genres in their writings. Their difference is one of focus. Derrida suggests that at the heart of the law of genre is paradox which means that the law cannot ultimately function as a law. Any given text will always break any law of genre. Heidegger contends that an intuitive understanding of genre necessarily predates an intellectual understanding of genre; that is, to interpret genre we must understand it prior to interpreting it. And Bakhtin assumes, like Cohen, that any text trying to escape genre will simply create a further expression of genre.

The paradoxical problem of genre is the problem of the hermeneutic circle, the problem of having to know a form before being able to describe it and, therefore, inevitably addressing it from a position of prior knowledge of the form. While the problem of the hermeneutic circle does indeed exist, and the application of genre is challenged by this 'chicken and egg' argument of which comes first, the text or the rules, genre as a constitutive function cannot be dismissed. Examining the difficult relationship between literal and conceptual productions of text, and the complexities of

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24 For a broader overview of postmodernist writers on sf see Veronica Hollinger, 'Contemporary Trends in Science Fiction Criticism, 1980-1999,' *Science Fiction Studies* 26, no. 78 (1999), 232-262.

25 Ralph Cohen, 'Do Postmodern Genres Exist?' 13.

reception of text, conflicted as they sometimes are, is a significant critical struggle and ultimately affects all the stories we tell, not just literary stories.

The last section looked at genre as constituted primarily by the community of people who read and/or write sf, are maybe familiar with its history and contribute in some way to its perception, reception and content. However, the academy is a part of a different community that also directly addresses sf. Within literary studies there have always been advocates of sf, though much of the effort of theorists has been restricted by the necessity of approaching a popular genre from a focus on mainstream literature. This has produced some apologist critiques, as noted by Roger Luckhurst,[26] but also some serious structural analysis.

Darko Suvin devised standards for identifying sf narrative, as opposed to prescribing it by its content. His ideas of cognitive estrangement and the narrative dominance of fictional 'novum' guide many other late twentieth century criticisms in the genre. In a particularly famous quote Suvin says, 'SF is a literary genre whose necessary and sufficient conditions are the presence and interaction of estrangement and cognition, and whose main formal device is an imaginative framework alternative to the author's empirical environment'.[27] This demands a non-mimetic, or non-realist world that diverges from the writer's (or reader's) own world, and one that demands an intellectual engagement with the 'novum', the novelty or innovation in the text. The novum has to have a 'cognitive logic'; that is, the novelty has to work in the fictional world in a manner understood in western culture to be rational.

Suvin has been central in this field and many other critics borrow - at least in some part - from him for their own analysis of the genre. Like Suvin, Robert Conquest also includes reader and writer as part of the process of constructing genre, though he defines sf as anomalous which implies his thinking is still dependent on the normative structures applied to mainstream literature.[28] John Griffiths predicates the structure of the genre on an empirical method of observation, but his critical method of

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26 Roger Luckhurst, 'Border Policing: Postmodernism and SF', *Science Fiction Studies* 18 (1991), 362. Luckhurst analyses postmodern theoretical approaches to sf and identifies a certain level of excitement with the genre in postmodernity, but sees the theory then as having placed an expectation upon the genre to advance beyond its 'prepubescent technotwit satisfactions' to a place where 'shamefaced' sf must drag itself into step with mainstream, even if it is a 'belatedly, derivatively, and ...degraded form'.

27 Darko Suvin, *Metamorphosis of SF: On the Poetics and History of a Literary Genre* (Cambridge, Mass.: Yale University Press, 1979), 7-8.

28 Robert Conquest, 'SF and Literature', in *SF: A Collection of Critical Essays*, ed. Mark Rose (New Jersey: Prentice Hall, 1976), 30-45.

investigating a text, or group of texts, could chase analysis back into prescription.[29] The asking of 'original' and 'revealing' critical questions on genre, which Griffiths advocates, is tricky when existing preconceptions of genre must prompt any line of enquiry; however, he does promote comparative studies of writers, periods, tropes and ideologies, thus moving towards heteroglossia and dialogia. And, although Robert Scholes maintains the polarity between mimetic and fantastic fiction, his definition of science fabulation clearly rewords Suvin. Scholes says, 'Fabulation, then, is fiction that offers us a world clearly and radically discontinuous from the one we know, yet returns to confront that known world in some cognitive way'.[30] Philip K. Dick also focuses on the integrated construct of cognitive estrangement and the novum lying at the heart of the sf story.

> We have a fictitious world; that is the first step: it is a society that does not in fact exist, but is predicated on our known society; that is, our known society acts as a jumping-off point for it; the society advances out of our own in some way, perhaps orthogonally, as with the alternate world story or novel. It is our world dislocated by some kind of mental effort on the part of the author, our world transformed into that which it is not or not yet. This world must differ from the given in at least one way, and this one way must be sufficient to give rise to events that could not occur in our society – or in any known society present or past. There must be a coherent idea involved in this dislocation; that is, the dislocation must be a conceptual one, not merely a trivial or bizarre one – this is the essence of science fiction, the conceptual dislocation within the society so that as a result a new society is generated in the author's mind, transferred to paper, and from paper it occurs as a convulsive shock in the reader's mind, the shock of dysrecognition. He knows that it is not his actual world that he is reading about.[31]

Related to perceptions of the genre as cognitive estrangement and 'dysrecognition' is Samuel Delany's identification of the specialised reading processes the genre requires. Reading processes do not define a genre with precision, but they are certainly part of

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29 John Griffiths, *Three Tomorrows: American, British and Soviet Science Fiction* (London: Macmillan, 1980), 33-55.
30 Robert Scholes, 'The Roots of Science Fiction', in *Science Fiction: A Collection of Critical Essays*, ed. Mark Rose (Englewood Cliffs, New Jersey: Prentice Hall, 1976), 47.
31 Philip K. Dick, *The Collected Stories of Philip K. Dick: Vol.1: The Short Happy Life of the Brown Oxford* (New York: Citadel Press, 1990), xiii.

the historical specificity of the genre and absolutely integral to the dialogic experience of genre. Delany talks about the challenge the genre poses to naturalism and how difficult this can be to negotiate. This is an audience-centred identification of genre that complements Suvin's ideas, but raises further questions about cultural constructions of genre:

> [T]here are those people who *won't* read science fiction, and there are also people who really *can't* read it, and are to be distinguished from people who just *won't* read it. I know I've come across more and more people who've actually tried to read science fiction and can't make it make sense. When I actually worked with some people who expressed their goodwill, claiming very seriously they had tried this, and it just didn't make sense – when we began to read the thing sentence by sentence, and you worked over it with them the way you would work with a child just learning to read, I began to discover that what they couldn't do is put the *world* together. They couldn't take the little hints, the little flashes, the little throwaways that any science-fiction writer uses, to make the world coherent, and make a world out of it. They were actually having difficulty, unless there was a page of exposition. All those little hints and what-have-you which are the essence of a science-fiction story – by which the author makes the whole thing vivid and makes the whole thing glitter – they literally didn't know how these were supposed to be read. And you'd also discover that by working with them through a science-fiction story literally phrase by phrase – you know, what does, and what does 'what does this mean about the world' mean about the story – you discovered they got better at it and eventually they learned it. But it is a language; in that sense science fiction really *is* a language.[32]

According to Delany, estrangement occurs at three levels in sf writing. Firstly, the syntagmatic, where the juxtaposition of certain words jolts the reader out of previously accepted mimetic modes and forces them to 'restructure their web of signifiers'. The famous example he gives comes from a Heinlein story, where a door 'dilates' rather than opens. The second level is the estrangement experienced in terminology, where words may evoke certain images but in fact they do not represent anything that actually

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32 Charles Platt, *Dream Makers: The Uncommon People Who Write Science Fiction* (New York: Berkley, 1980), 71.

exists – Le Guin's 'ansible', for example, is a purely fictional device for instantaneous communication over parsecs of space. And the final estrangement lies in plot where the fictional effect relates directly back to Suvin's notion of cognitive dissonance, as when, for example, James Tiptree Jr. leads the reader to identifying human males as aliens from a human female viewpoint in the short story 'The Women Men Don't See'.[33]

That the three levels of estrangement occur, and occur regularly, within sf is unique, according to Delany. While sentences, or sometimes even passages, may be transposed into other genres using their particular code words (eg. replace 'blaster' with 'six gun' and 'spaceship' with 'palomino') it will not work overall because it is the persistent inmixing of the various levels of estrangement that create sf more than its individual conventions, more than its common plot tropes and more than any ideas it contains which may be restricted to the historical time and place when the text was written. Such alternative reading practices and difficulties are also mentioned by Damien Broderick in *Reading by Starlight*, a text that looks in detail to reading protocols and generic conventions.[34] This emphasis on active reading highlights the heteroglossic and carnivalistic nature of sf, situating sf almost as a 'grotesque' form of literature – transgressive writing, the form of which is sometimes so foreign to readers that they cannot recognise it. Even from the initial engagement sf must be approached as a literature of potential inversion, subversion, transgression and invention.

Suvin's reflection on sf narratives receives almost universal approbation, and it makes sense that sf in the late twentieth century is story telling in league with rational empiricism. However, the cognitive approach does minimise another important critical pathway into the sf genre.

Ursula Le Guin is the eloquent proponent of mythic/archetypal sf in both her criticism and her fiction, an author who sees the 'scientist mentality' as necessary but insufficient for performing well in the genre. Le Guin uses the cultural archive of story, Freud, Jung and Anthropology to counteract the notion that the logic of the sf genre is purely cerebral/empirical in content and response. She argues that the richness of myth in sf cannot be done away with and there is a level of engagement (as opposed to estrangement) that occurs where a character with mythic resonance 'looks back' at the

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33 Samuel Delany, *The Jewel Hinged Jaw: Notes on the Language of SF* (New York: Dragon Press, 1977), 278-284.
34 Damien Broderick, *Reading by Starlight: Postmodern Science Fiction* (London: Routledge, 1995).

reader.[35] This suggests a recognition in the writer and the reader of cultural and psychological precedent in the text. Le Guin does not stand alone in this mode of criticism, Levi-Strauss and Northrop Frye also support myth as a panstructural unity in culture and literature; however, Le Guin is isolated in formally identifying the sf genre in this way. Since structuralism, the resistance to mythic criticism lies in the supposed essentialising nature of myth.[36] Popularly and critically received notions of myth argue that it is static, repeating and closed. As sf is usually associated with innovation and change, this appears to set up an unresolvable conflict between the two modes of story telling.

As is often the case, both reading myth itself and reading myth as a contributing discourse to sf is more complicated than the essentialist label suggests, but little work has been done in the area. Tom Lombardo's lengthy internet essay argues sf has a special status in creating myth, and he uses E.E. Smith, H.G. Wells and Olaf Stapledon as examples of modern mythmakers. He follows a historiographic method and attempts a synthesis of myth (particularly its large scale story telling properties), philosophy and science, but really only manages a problematic rehash of Suvin.[37] Rosemary Jackson also tries for synthesis in genre through myth. She searches for broad, unifying principles to contain the protean differences of 'myths, legends, folk and fairy tales, utopian allegories, dream visions, surrealist texts, sf [and] horror stories' under the classification of the 'Fantastic'. She argues that all these modes of narrative form a literature of subversion and challenge the 'real' with their representations of the impossible, their violations of accepted orders, their inverted values and their replacement of authoritative truths with uncertainty.[38] Although Jackson strikes a positive, rehabilitative note for the genres of the fantastic with respect to mainstream literary prejudices, there are concerns with the over-inclusiveness of her literary meta-genre. The main problem being, while she includes sf under the auspice of fantasy, she fails to recognise its significant differences from the other genres she discusses. Although there is often an element of the allegorical in sf, there is a failure in her

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35 Ursula Le Guin, *The Language of the Night: Essays on Fantasy and Science Fiction* (London: The Women's Press, 1989), 65.
36 Joanna Russ, 'What can a Heroine do? Or Why Women can't Write,' in *To Write Like a Woman: Essays in Feminism and Science Fiction* (Bloomington: Indiana University Press, 1995), 79-93. Russ criticises myth as necessarily politically reactionary and anti-feminist due to the apparent fixity of the stories.
37 Tom Lombardo, *Science Fiction as the Mythology of the Future*, www.odysseyofthefuture.net/pdf_files/Readings/ScienceFictionLongArticleJuly2005.pdf. (Accessed 26th September, 2004)
38 Rosemary Jackson, *Fantasy: The Literature of Subversion* (London: Routledge, 1981).

coverage to account for the very different discourses which are also often coopted into sf, particularly those of overt political ideologies and science.

Taking another approach, I argue the value of myth criticism in sf, saying myth has been misrepresented as static and closed. Separating archetype from myth, the contention is that Jungian archetype *is* essentialised, but myth is not. Myth has a broader topos and is reflected, not only in literature, but in social structures and understandings. I subscribe to Joseph Campbell's argument of myth as 'womb', or a safe story script, and his idea that stories that appear predictable and safe (because they are known) can change if social, cultural or personal development renders that particular script open in some way. This is a reading of myth and sf that is actually compatible with Suvin's notion of estrangement. Estrangement, in this case, can occur on a level where a familiar story suddenly alters focus.[39] The hero, for example, is a core mythic construct of Western literature, but the hero is also present in science in discourses such as neo-Darwinist reductionist stories of 'the gene as hero' in biology, where the gene is given the qualities and aspirations of survivor, conqueror, culprit, controller, and other anthropomorphised qualities. This is a structure that can be undone by placing the organism or the environment at the centre of scientific and/or literary stories. A number of feminist sf authors are already doing this, as can be seen in the case studies of this thesis. These writers undo hyperindividualistic hero narratives to reveal science, organisms and environments as necessarily cooperative and interdependent. Rather than reading to include sf in other recognised literary genres, this approach encourages mythic readings of sf to embrace science, and to recognise that the kinds of rationality usually attributed to science are not incompatible with myth, which has a less easily isolated culture wide rationality.[40]

Evolution: nature's little helper and sf

That science is part of the nomenclature of sf implies that science is an identifying marker for texts that belong or do not belong in the genre. If only it were so simple. Commentary on sf occupies a great number of sites on the internet, and at one location alone fifty-two definitions from fans and sf writers have been collected together.[41] These definitions are listed acontextually and reflect a high degree of faith that the

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39 Tess Williams, 'Writing Creatively in Academia: Archetype Speaks to the Paradox', *Australian Journal of Communication* 24, no. 1 (1997), 94-103.
40 David Adams, 'Metaphors for Mankind: The Development of Hans Blumenberg's Anthropological Metaphorology', *Journal of the History of Ideas* 52, no. 1 (1991), 152-166.
41 Neyir Cenk Gökçe., *Definitions of Science Fiction*, http://www.panix.com/~gokce/sf_defn.html (accessed may 21, 2000).

essence of a genre can be captured in one or two sentences. Of the fifty-two definitions, nearly half of them have some mention of science and/or technology. There is, however, little elaboration in any of them as to what exactly science is, and how science and/or technology are constituted, either in the culture or in the literature. In terms of mapping a significant discourse into, or onto, another significant discourse, this is a serious oversight. In more developed considerations of the science and science fiction question, both Joanna Russ and Brian Aldiss have something more specific to offer.

Russ, in a milestone essay, 'Towards an Aesthetic of Science Fiction', positions science as central to sf, pointing out that it serves as the didactic impetus of sf literature in much the same way that Christianity served as the didactic impetus for medieval fiction. She constructs an oppositional, scientific reading to Bernard Bergonzi's demonic/angelic interpretation of H.G. Wells' *The Time Machine,* claiming Wells' vision in the book was never a traditionally religious one of good and evil, but was one of an 'iron physical law'. Russ claims entropy, or the second law of thermodynamics, is at the heart of a story portraying cultural and physical decay. She also discusses a story by Ursula K. Le Guin called 'The Masters' which 'has as its emotional centre the rediscovery of the duodecimal system'. Russ's use of Wells and Le Guin is not innocent. She situates these two powerful writers as mother and father of the genre, preparatory to an early foray in what would eventually become a larger cultural discussion about the gendering of knowledge. Allying herself with Stanislaw Lem, Darko Suvin and Samuel Delany, who also include science as a mainstay of the genre, she lays the groundwork for feminist utopias to be included as sf.

> One very important point which emerges in the work of all three critics is that standards of plausibility - as one may apply them to sf - must be derived not only from the observation of life as it is or has been lived, but also, rigorously and systematically from science. And in this context 'science' must include disciplines ranging from mathematics (which is formally empty) through the 'hard' sciences (physics, astronomy, chemistry) through the 'soft' sciences (ethology, psychology, sociology) all the way to disciplines which as yet exist only in the descriptive or speculative state (history, for example, or political theory).[42]

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42 Joanna Russ, 'Towards an Aesthetic of SF', *Science Fiction Studies* 2, Part 2, no. 6 (1975) 112.

Russ's argument is deceptive because she argues for the centrality of science in the genre, gives Wells and Le Guin as specific scientific examples of story telling, but then dilutes her apparently non-negotiable position to include branches of humanities studies, such as political theory and history, under the umbrella of science. This ambivalence highlights a dilemma in the genre that is firmly tied to issues of gender. During the 1970s, feminist utopian writings proliferated and were often structured as extensive social critiques that either failed to address, or only obliquely treated, technology and/or science.[43] Russ identified their main themes as a lack of central or formal government, a concern for ecology and the natural world, rural or at least non-urban and non-industrial settings, sexual permissiveness and a marginalisation of war and violence.[44] There is very little in the way of traditional science or technology identified on that list, yet these utopias are generally accepted as a specific historical manifestation of sf. And, while some feminist utopias did demonstrate an engagement with science and technology, such as Marge Piercy's *Woman on the Edge of Time,* which took up Shulamith Firestone's challenge and explored reproductive technology as a way of changing constructions of gender, many others - such as Sally Miller Gearhart's *Wanderground* - did not, disguising science and technology as embodied or natural. This uneasy inclusion of some feminist utopias in the sf genre, and the embracing of politics and history as 'sciences', is only the tip of the iceberg with regard to the complexities and difficulties of using science and/or technology as a defining criterion of the genre.

That same quote of Russ's also contains a second major problem. While Russ may have been deliberately working to anneal the split that was growing between 'hard' and 'soft' sciences because they reflect a gendered binary in scientific knowledge as well as in sf, she actually reinforces the division. Maths, physics and chemistry are the 'hard' sciences, or the most authoritative sciences, and have historically been presented as 'value-free' discourses, or as Donna Haraway calls them, 'parables of objectivity

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43 While more problematic than they appear, some examples of apparently non-technical, non-scientific utopias include Mary E. Bradley Lane, *Mizora: A World of Women* (1880-81); Charlotte Perkins Gilman, *Herland* (1915); Dorothy Bryant, *The Kin of Ata are Waiting for You* (1971); Sally Gearhart, *Wanderground* (1978); Sheri S. Tepper, *The Gate to Women's Country* (1988); Pamela Sargent, *The Shore of Women* (1986); and Marion Zimmer Bradley's *Darkover* series (particularly those with the free amazons), written from the 1970s into the first decade of the twenty-first century.

44 Joanna Russ, 'Recent Feminist Utopias', in her *To Write like a Woman: Essays in Feminism and Science Fiction* (Bloomington: Indiana University Press, 1995), 76.

and scientific method'.[45] Russ's solution was to shift certain select humanities studies (those predicated on more 'factual' information such as dates) closer to the paradigm of objective knowledge and then put them under the rubric of 'soft' sciences. This apparently extended a protective arm of respectability over bodies of knowledge that were known to be more fraught in terms of absolute knowledge than those driven by theorems and laws and expressed in equations. It is a realignment, however, that does not stand untouched by social and cultural critiques of science and of some of the changes in science itself.

Aldiss's inclusion of science in his first chapter on the genre in *Trillion Year Spree* is simultaneously both more specific and yet more tangential and cautious than Russ's approach. He identifies *Frankenstein* as the original sf text, and Darwinian evolutionary theory as the central scientific paradigm driving Shelley's creative work. He extrapolates from this, but he is very careful in constructing science as a contributary thread in the genre. In a key sentence, he says:

> Sf is the search for a definition of man and his status in the universe which will stand in our advanced but confused state of knowledge (science), and is characteristically cast in the Gothic or post-Gothic mold.[46]

The qualification 'confused' placed on the scientific content of the genre in this quote acknowledges an important element of the science/sf debate, one that Russ also treats. That is, what becomes of fiction when the science that has been written into it changes, when what is known or assumed to be factual is superseded or challenged by different information? Russ's answer to that question is 'nothing'. According to her, such a text simply becomes sf based on incorrect information. Michael W. McClintock, however, extends the 'nothing' argument, and points out that, if the definition of sf is dependent on accurate representations of science to exist, the genre could well become an empty set, with all its fiction inevitably being discarded as science changes.[47] Aldiss, on the other hand, deals with the issue of the dating of scientific content by the care he takes to situate *Frankenstein* historically within Shelley's physical, psychological, cultural and ideological environment. To Aldiss, Darwinian evolution is a signal scientific discourse both in the generation and the continuing nature of the sf text, as can be seen

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45 Donna Haraway, *Simians, Cyborgs and Women: The Reinvention of Nature* (London: Free Association Books, 1991), 184.
46 Brian Aldiss, *Trillion Year Spree: the History of Science Fiction* (London:Paladin,1988), 30.
47 Michael W. McClintock, 'Some Preliminaries to the Criticism of Science Fiction', *Extrapolation* 15 18 (1992), 19-23

by his titling of one of his chapters, 'The Origins of the Species', and his making statements about evolution which are not restricted to that text or that period:

> The greatest successes of sf are those which deal with man in relation to his changing surroundings and abilities: what might be loosely be called *environmental fiction.* With this in mind, I hope to show that the basic impulse of sf is as much evolutionary as technical.[48]

Other writers and critics who have, on occasion, incorporated 'change' in their definitions of the genre, include Isaac Asimov, Frederick Pohl and James Gunn.[49] However, Aldiss is unusual in specifically and persistently linking the science and theories of evolution to the genre. Of course, Aldiss is doing an historical reconstruction of the genre and is explicitly invested in Darwinism when he mentions evolution, as Darwinian precepts were inextricably welded to notions of progress and industrialisation from the middle of the nineteenth century. The difficulties with Aldiss, and the possible reason why the logic of his analysis has not been previously extended, is his historical particularity and his general acceptance of equivalence in critical parlance of Darwinism and evolution. The issue becomes then, that evolution does not begin and end with one scientist or one theory, no matter how significant his/her/its contribution to our current cultural consciousness. As Elizabeth Wilson says, any comprehensive theory will have 'a history determined by skirmishes over power and the naming of truth' and the very construction of the theory as central will inevitably promote oppositional arguments.[50] Every theory or genre is subject to the dialogic nature of cultural and linguistic process in their complexity and development.

A key contention of this thesis is then that Aldiss' ideas on the origins of the sf genre can be extended and that evolution can be identified as the central and recurring scientific discourse of sf. The argument is that sf texts are very frequently (perhaps

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48 Aldiss, *Trillion Year Spree*, 42.

49 These particular examples come from the web site previously quoted (http://www.panix.com/~gokce/sf_defn.html), which raises yet another issue with using 'potted definitions' of sf as this site quotes Isaac Asimov as saying, 'Modern sf is the only form of literature that consistently considers the nature of the changes that face us, the possible consequences, and the possible solutions.' Whereas a quote from Frederick Andrew Lerner's *Modern SF: the American Literary Community.* (New Jersey: The Scarecrow Press, 1985), 124. takes a different statement of Asimov's with a different emphasis: 'sf is that branch of literature which deals with a fictitious society, differing from our own chiefly in the nature or extent of its technological development'. When writers or critics have written prolifically, over a period of time, their views or focus can change and quoting them without context can become problematic. As Nalo Hopkinson said in her interview with Alondro Nelson, when asked if she preferred the term spec-fic to science fiction, she answered that it depended on who was asking her.

50 Elizabeth Wilson, 'Is Science Feminism's Dark Continent', *Meanjin* 51, no. 2 (1992), 79.

always) marked by current and/or past theories of evolution, which, although providing intersections for various specific fields of scientific study (paleontology, biology, genetics, embryology, ecology, molecular biology and so on), also inform various aspects of sf narratives through metaphors of change. Such a proposal permits even texts where there is an apparent rejection of technology (but significant change to social and cultural matrices) to witness to an embedded science because, in fact, evolution is the most necessary science to imagining worlds of difference. Evolutionary concepts saturate sf's tropes of colonisation and survival, the adaptation of humans to alien habitats, rapid changes in speciation, unusual genetic changes in populations, the creation of alien beings, the incorporation of technology into bodies and cultures and much more. Therefore, if science is essential to understanding the genre, it is also necessarily coupled to change. Evolutionary science – with its complex materiality and its many metaphors seems to be the most necessary scientific discourse to stories of science fiction.

Evolution: taxonomic trickery - analogy, bricolage

This study of evolution in sf does not work in a strictly analogical fashion. Analogy is a different process from those advocated by either Beebee or Bakhtin, both of whom work on historical and cultural context in genre analysis, and work with multiple structures and discourses in literature so as to reveal ideological sub-texts. An example of an analogous approach is found in David Fishelove's exploration of the historical development of literature using the framework of Darwinian evolutionary theory. His work is worth considering at some depth at this point in this chapter, because a cursory examination of subject matter may seem to link his work to this thesis, but the critical processes are completely different.[51]

Fishelove is theoretically attached to the Russian formalist school, a school which promoted deep and intensive reading of texts but, in their intensive focus, tended to isolate texts from their cultural and historical matrices and reinforced their canonical value as art without examining their modes of production and reception. This deep, uncritical attachment to theorising work in isolation is problematic with a genre such as sf. In many respects, it also seems problematic with other genres and texts. Fishelove labels individual texts as representative of 'species', then frames their historical positions as biological processes of competition. Having used this metaphor,

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51 David Fishelove, *Metaphors of Genre: The Role of Analogies in Genre Theory* (University Park, PA: Penn State University Press, 1993).

he maintains an aesthetic understanding of the texts he selects and does not examine the evolutionary or biological concept of species in his writing. The example he gives of literary 'survival of the fittest' is based on the rise and acceptance of the Miltonian 'mock-epic' at the expense of Richard Blackmore's Arthurian epic written in the same period. The line he draws between 'mock-epic' and epic is mostly one of subject. He justifies survival of the lesser artistic form by saying that the survival of a particular form is not just dependent on the period it is written in, but also on the period that follows it. Thus, according to Fishelove, Milton's depiction of Satan gained vitality, rather than lost it, in the romantic period, therefore it was a successful literary 'species'. Historically the texts are simplified. That Milton's epic was written around the time he fled the Black Death, that it is classical epic form adapted to Renaissance humanist themes, that he was embroiled in the religious turbulence of the times and became a fugitive from the newly reinstated Royalist government, and so on, has no place in Fishelove's argument. In his analogy, Milton was positively selected for his devilish 'gene' over Blackmore's less fit royalty 'gene'. Fishelove's argument literally replicates, in this example, all the worst excesses of genetic reductionism by failing to account for any other reasons why one 'form' may have been successful over another.

The difficulty with analogous thinking is that it is effective up to a certain point. For instance, in a chapter entitled 'Literary Genres as Biological Species' Fishelove does make comments of value when comparing Russian Formalism with the traditional allopatric theory of evolution:

> I was first attracted to the allopatric theory by its similarities to the formalist perspective on the issue of literary evolution. But in addition to these shared premises about the indirect path of evolution, allopatric theory contributes one interesting feature not stressed by Russian Formalism and its disciples: the concept that the new form must develop in the periphery before it 'infiltrates' the dominant area. It seems that in at least the two cases I have briefly examined- some forms of the novel and the Christian epic – this hypothesis is corroborated.

The allopatric theory and the Russian Formalist evolutionary theory both reject the smooth, linear path of evolution. Instead, the formalists presented a picture made up of constant 'struggles' and 'breaks' as summarised by Erlich: '[A] twisted path, full of

detours, of zigs and zags. Every literary trend represents a crisscrossing, a complex interplay between elements of tradition and innovation.[52]

Unfortunately, Fishelove fails to further develop the connection. Rather, he uses the two separate discourses of literature and evolution as forms of whole truth to corroborate each other. There is no 'refractive' sense of genre to generate meaning, or to give any insight into literary or evolutionary values, because Fishelove uses both discourses passively, failing to negotiate the instabilities of either scientific or literary genre or examine disputed or shared borders. In short he uses one canonical form of discourse as an affirmation of another canonical form of discourse, and fails to engage in any sort of decentring process.

The approach in this thesis to evolutionary theory is quite different from Fishelove's. This thesis does not accept Darwinism without interrogation. Rather, Darwinian ideas are presented as deeply marked with the politics of patriarchy, colonialism, environmental exploitation and eugenics and as extending themselves beyond the natural world to shape and define technology, economics and political institutions. This perspective prompts an investigation of resistances to Darwinism and neo-Darwinism, and an examination of alternative metaphors for change in biology and environments, with significant implications for notions of change in human society. The field of evolutionary theory is viewed as dialogic, polyvocal and historically contextualised - as is feminist sf. Feminist sf texts cannot be read or received in the same way as Milton's epic poem. While *Paradise Lost* would have its own ruptures and instabilities, it is a canonical work that reflects then contemporary Christian allegory, morality and politics. By contrast, feminist sf has its roots in the nineteenth century and is a specifically, postmodern polyvocal, subversive and experimental sub-genre, posing serious questions to dominant biological, technological, social and cultural stories. Thus the readings of both evolutionary stories and literature are complexified in this thesis, and reflect very different values to such analogous critical readings of both scientific and literary discourses.

Beebee's model of genre analysis forms a closer precedent for the critical methodology of this thesis, which seeks to align evolutionary theory and feminist sf, two previously unconnected discourses, and look at what they share ideologically. Central to Beebee's approach is the concept of 'use-value':

> my definition [of use-value] cannot be paraphrased for three interrelated reasons: first, because use-value implies instrumentality in

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52 Ibid, 51-52.

> a certain type of action, rather than an equation with some other thing or with an abstract notion of value: second, because use-values are shifting, rather than fixed; third, because ideology, the political unconscious, lies beyond the limits of discourse. The ideological components of our generic distinctions are no more open to paraphrase than they are to naming. That is perhaps why philosophical attempts to come to grips with genre, such as Ortega y Gasset's or Benjamin's or Derrida's end up as tautologies or metaphors or paradoxes.[53]

As an example of his own methodology, Beebee examines the will at the end of the original version of Herman Melville's *Moby Dick* and the very specific accounting processes involved in commercial whaling as recorded by Melville. Beebee contends that the meaning of Melville's text reveals 'use-values' of ethnography and law as well as heroic questing, therefore showing that the interpretation of literary genres 'depends on a recognition of their non-literary neighbours as well'.[54] However, while Beebee's methodology informs the model of analysis of genre as used in this thesis it also has the limitation of working most effectively, in his examples, at intersections of known and established discourses. In this respect a Bakhtinian understanding of genre is more serviceable for reading a shared 'metaphoricity' in distinct disciplines, and Bakhtin's carnival theory best fits this exploration of the material and discursive intersections of speculative fiction and evolutionary science.[55]

Evolution: devolution and genre

In the Bakhtinian system, texts are built from linguistic units, known as 'utterances', and can be addressed in a number of ways, none of which are ever divorced from the social and ideological context that produces them:

> Utterances and their types, that is speech genres, are the connecting mechanisms that run from the history of society to the history of language. There is not a single new phenomenon (phonetic, lexical, or

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53 Beebee, *The Ideology of Genre: A Comparative Study of Generic Instability*, 279.
54 Ibid, 251.
55 Adams, 'Metaphors for Mankind: The Development of Hans Blumenberg's Anthropological Metaphorology'. Adams summarises Blumenberg's writings and summarises Blumenberg's 'metaphorology', as developing from philosophical anthropology. Blumenberg's history is complicated and some key work is still in German, but he seems relevant to some of the ideas of this thesis in his philosophical approach, arguing humans give tangible form to their experience via metaphor and that apparently different metaphors can serve similar functions in very different contexts.

> grammatical) that can enter the system of language without having traversed the long and complicated path of generic-stylistic testing and modification.[56]

This primary genre, the utterance, is then co-opted into a 'style', which in turn leads to the construction and identification of 'secondary genres', and the utterance becomes a link in a vast and complex chain of language events. This chain is a dialogue of infinite responsivenesses, and utterances can only be demarcated by noting a change of speaking subjects. From this base, Bakhtin particularly addresses literary genres, and speech genres, that accommodate all 'styles', including 'literary, scientific, commentarial, conversational and so forth'. Of these he comments on their flexibility and plasticity, but he absolutely denies the same freedom to utterance itself, which he says is of normative significance and is mandatory.[57] For Bakhtin, secondary genres are almost infinite as they involve the constant recombination of utterances produced by constantly changing historical and social 'styles'.

This is then a sort of non-systematising system that allows the basic units to carry out their function, but recognises multiple voices or discourses within texts, including the speaker's voice, and insists on acknowledging both the synchronic and diachronic contexts of text. What is unusual about this approach is that it allows for the identification of textual moments as temporally specific but also requires any proper reading of them to be linked to previous, current and future speech events. Knowledge, broken down into utterance and rebuilt into 'styles' and then 'genres', becomes more free-floating and ever more dialogic as it builds in complexity. According to this reading of language and text, there is never a strict fit between institutions and discourses, and never an unoccupied space beyond systems. Whatever falls or shifts outside (and sometimes inside) a professional 'patois' will be coopted into other genre patterns. There is no finality to the production or reception of speech acts.[58]

Evelyn Cobley, who specifically critiques Bakhtin on genre, accepts that he makes a significant move away from theories that argue genres as 'naturalised' forms into what she refers to as a sociological poetics. In a statement that links Beebee's and Bakhtin's approach, she says: 'If genre is the site where social codes intersect with

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56 Mikhail Bakhtin, *Speech Genres and Other Late Essays*, trans. Vern W. McGee (Austin: University of Texas Press, 1986), 65.
57 Ibid, 66-79.
58 Gary Saul Morson and Caryl Emerson, *Mikhail Bakhtin: Creation of a Prosaics* (Stanford: Stanford University Press, 1990) and Holquist, *Dialogism: Bakhtin and his World.*

poetic texts, then generic features must be approached as dynamic carriers of ideological meaning and should not be reduced to static elements in a synchronic figuration'.[59] According to Cobley, Bakhtin's process represents, if not a complete rupture of the hermeneutic circle, at least a rupture in its frustratingly closed presentation of the nature of genre. While recognising genre as necessary and inevitable, Bakhtin resists closure for both the text and the world: the linguistic synchronic is always supplemented by the historical diachronic. This is an ambitious project and, as Cobley points out, Bakhtin's system is not without problems.

Cobley identifies Bakhtin as undermining Goethe's universal conception of the human mind through his insistent historicizing; however, she believes Bakhtin harks back to the idea of a universal mind through his language. In doing so, he commits that previously mentioned sin of essentialism. Cobley detects it in his work on Dostoevsky. Bakhtin refers to carnival as having its roots in the 'primordial mind', and 'Dostoevsky's uniqueness [being] invoked as a heightened expression of all human consciousness rather than as a socio-historically specific manifestation'.[60] Bakhtin's slip into prehistoric thinking and his romanticising of the author are indeed issues, as is his unexplained maintenance of the separation of literary genres from the everyday genres he is using as critique. However, Murphy and Bauer challenge the interpretation of Bakhtin as essentialist, arguing that dialogic understanding creates an unavoidable inner multivocality which is provoked by the constant participation of the 'other' (meaning *parole,* culture, place, class, race and gender) in the formation of self. Murphy and Bauer contend that dialogue and carnival necessarily militate against any idea of a unitary subject, with Murphy identifiying the self as a 'chronotopic relationship' constituted by multiple narratives.[61]

Bakhtin was working on the threshold of postmodernism. As Cobley says, he offers an unusual reorientation of genre as he decentres traditional notions of what genre is. Thus she situates him as resistant to the traditions of Heidegger and Goethe. However, what if Bakhtin is seen as anticipatory and not just as resistant? For example, Bakhtin deliberately includes science in his schema, witness the statement above in which he talks about how speech acts can be built up into styles and genres that include science. Science is also embraced in carnival:

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59 Evelyn Cobley, 'Mikhail Bakhtin's Place in Genre Theory', *Genre* XXI, Fall (1998), 326.
60 Ibid, 330.
61 Dale Bauer, 'Gender in Bakhtin's Carnival', in *Feminisms: an Anthology of Literary Theory and Criticism*, ed. Robyn R. Warhol and Diane Price Herndl (New Brunswick: Rutgers University Press, 1997), 715; Murphy, 'Ground, Pivot, Motion: Dialogics, and Literary Practice', 150-151.

> The principle of laughter and the carnival spirit on which the grotesque is based ....destroys limited seriousness and all pretense of an extratemporal meaning and unconditional value of necessity. It frees human consciousness, thought and imagination for new potentialities. For this reason great changes, even in the field of science are always preceded by a certain carnival consciousness ....[62]

The process goes deeper than the inclusion of science as discourse or 'genre', which anticipates Haraway's 'story telling' approach to narratives in different disciplines. He also foreshadows Barad and her 'multiagential posthuman performativity'. Despite philosophy of literature being an esoteric discipline at the time of his writing, there is no doubt Bakhtin wrestles with something that more closely resembles physics than art. Cobley summarises the issue: 'His approach requires that we perform a horizontal, immanent analysis of individual texts as well as a vertical examination of each text's insertion into both a history of literature and a history of social discourse'.[63] Just as Heisenberg's uncertainty principle raises the difficulty of a particle being measured *in situ* and in motion at the same time, so Bakhtin complicates the spatiotemporal identification processes of genre by insisting the text be simultaneously viewed as synchronic and diachronic. This is significant, but Bakhtin pushes the process further. Genre is contingent and destabilised, and knowledge exists outside genres and, therefore, outside systems where it regroups in infinite numbers of new genres. This anticipates, but does not specifically explore, physicist Karen Barad's recent feminist science theories on representation. Barad believes that all interactions should be transformed into 'intra-actions' as part of a posthuman project that considers there is no actual 'outside' to any phenomenon. While Barad goes beyond Bakhtin to include agency in all contingency, and matter in the reading of agency (thereby *specifically* giving voice to environmental, inanimate and alternative subjectivities),[64] links can still be found to these ideas in Bakhtin's theories. Bakhtin's atomisation of speech acts and his struggles with the reconstitutive processes of genre and his identification of the transgression and subversion of carnival offers a wide frame of subjectivity and political possibility. Bauer and Russo see him foreshadowing feminism, Murphy sees him foreshadowing ecofeminism, and I see him as foreshadowing the multiagential posthuman.

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62 Bakhtin, *Rabelais and His World*, 49.
63 Cobley, 'Mikhail Bakhtin's Place in Genre Theory', 332.
64 Barad, 'Posthuman Performativity: Toward an Understanding of How Matter Comes to Matter', 801-831.

This reading of Bakhtin as a 'pre-theorist' of politically contentious current discourse leads to an interesting intersection. Michael Holquist nominates Mary Shelley's *Frankenstein* as the poster text for carnival. As well as saying it is an important case study for the grotesque body and intertextuality, Holquist notes the novel joins individual, text and world, all bodies in the act of becoming, and all bodies insistent on connection.[65] As mentioned previously, Shelley's novel is also nominated by Brian Aldiss as the primary science fictional text in the western tradition and Aldiss' theory is the specific theory of sf being extended within this thesis. Thus, it is intriguing that carnival and speculative fiction join together in the same generative historic text, but it is not really a surprise – Holquist says carnival writing and *Frankenstein* are about the 'novel body', and the inevitably historically patched stories we tell, while Aldiss says speculative fiction and *Frankenstein* are about 'our confused state of knowledge'. The emphasis of both carnival and sf then is on the seamed body/text, rather than on the unseamed body/text. Thus carnival and sf are 'sewn' together in this crucial literary story about science and the changing body, and through the multiplicity of its narratives, evolutionary theory also presents as a connected, seamed body of work.

Bauer and McKinstry respond to the feminist potential in Bakhtin. Concerned that feminism is being coopted into the dominant male culture and recreated as monologic and oppositional, they see Bakhtin's work on language and dialogics as supporting standpoint theory, and offering the potential to 'rethink human agency and lived experience'.[66] Bakhtinian dialogics offers critical tools to assist feminism to find the lost or parodied voice of women in many texts, including major canonical works. Other aspects of his theoretical system also serve feminism. While carnival is acknowledged as a theory of fragmentation and alienation, reflecting 'a desire to subvert a highly homogenised world which has increasingly suppressed expressions of multi-voiced complexity',[67] it is also a theory of embodiment and a significant 'means for displaying otherness'.[68] Mary Russo explores this capacity of carnival to identify women's bodies as the culturally inscribed other. Her argument is that the classical, renaissance body is male, closed, self-contained and static, while women's bodies are a primary material of carnival being open, protruding, irregular and secreting. Bodies in

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65 Holquist, *Dialogism: Bakhtin and his World*, 94-106.
66 Dale Bauer and S. Jaret McKinstry, eds., *Feminism, Bakhtin and Dialogism* (New York: State University of New York, 1991), 3.
67 Cobley, 'Mikhail Bakhtin's Place in Genre Theory,' 336.
68 Holquist, *Dialogism: Bakhtin and his World*, 89.

carnival are more closely allied with women because they can be read as degraded, transgressive and subversive. While primarily supporting the feminist potential of carnival embodiment, Russo's argument can also be extended into a potential ecofeminist space:

> The grotesque body of carnival festivity was not distanced or objectified in relation to an audience. Audiences and performers were the interchangeable parts of an incomplete but imaginable wholeness. The grotesque body was exuberantly and democratically open and inclusive of all possibilities. Boundaries between individuals and society, between genders, between species, and between classes were blurred or brought into crisis in the inversions and hyperbole of carnival representations.[69]

Russo does not directly investigate ecofeminism herself, but certainly foreshadows it with the words 'an incomplete but imaginable wholeness', which conjures up visions of multiple subjectivities and new connections between bodies and environments, and speaks to blurred boundaries between species. Bakhtin lists the images used in medieval 'grotesque realism': '...the extremely fanciful, free and playful treatment of plant, animal and human forms'.[70] For Russo, carnival is bloated, irrepressible and incurably heterogenous, and taken from Bakhtin's viewpoint it is very possibly the story of the world in its incomprehensible historicity and geographic vastness. Bakhtin explains that the body without the mediation of the classic aesthetic is eternally pregnant and dying, swallowing and defecating, and so the earth is therefore the ultimate body from which everything is born and to which everything returns. It is therefore not surprising to find that Bakhtin has been adopted as a theoretical model by ecofeminist writers such as Murphy who perceive the Bakhtinian dialogic ecology and feminism as central to a new 'affirmative praxis' which will cure the 'critical maladies of enervated humanism, solipsistic scepticism, and paralytic undecidability' and bring us to a point of understanding 'multivocalities' and non-human subjectivities.[71] These theories, offering a very different perspective on Bakhtin's system of genre, are not specifically articulated by Bakhtin, but his work gives them a degree of purchase, and

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69 Russo, *The Female Grotesque*, 79.
70 Bakhtin, *Rabelais and His World*, 32.
71 Patrick D. Murphy, 'Prolegomenon for an Ecofeminist Dialogics', in *Feminism, Bakhtin and Dialogism*, ed. Bauer, 39-56; Patrick D. Murphy, 'Voicing Another Nature', in *A Dialogue of Voices: Feminist Literary Theory and Bakhtin* ed. Karen Hohne and Helen Wussow (Minneapolis: University of Minnesota Press, 1994), 59-82; and Murphy, 'Ground, Pivot, Motion: Dialogics, and Literary Practice', 146-61.

his open and inclusive system encourages a political approach in understanding complexities and extending agency.

Conclusion

To summarise the directions of this chapter, which have been complex, some address has been made to genre in general and to the constitution of the popular genre of science fiction and the sub-genre of feminist science fiction. Genre has been noted as a construction relying on technology and materiality, as much as on philosophy and precedent. Also affecting the perception and reception of genre have been community notions of genre, which are vested in history, but have also been shown to be generally dialogic and specifically (and sometimes immediately) responsive. At a remove have been the academic analyses of sf, most of which have rested in some respect on Darko Suvin's notion of cognitive estrangement and the fragile understandings of myth in science and science fiction. Then, combining both community definitions and academic approaches, is the more robust consideration of science in sf, with some examination on how science as a discourse is coopted into, not only the definition, but the active construction of the genre.

It is at this point that this thesis becomes participatory in the process of genre description/definition/constitution as it seeks to extend Aldiss' idea that evolutionary science was significant in the production of the genre's primal text, *Frankenstein*, and argues that it is core to the whole construction of the sf genre. However, the intersection of evolutionary science and sf is one of structural metaphor not of analogy, so there is a consideration of two different approaches to practical literary genre study. Fishelove is a theorist who combines literature and evolutionary theory in an unproblematic and analogous fashion, situating both literature and Darwinism as predominantly stable and monologic discourses and mapping them onto each other by way of simple equivalency. His methodology is contrasted to that of Thomas O. Beebee who works in a refractive way with the instabilities of literature, seeking out ideological content via the refractive 'use value' of different discourses in the text. Beyond Beebee is Bakhtin, who perceives any genre as dialogic and heteroglossic, permanently open and multivocal.

This thesis refers to Beebee's approach because of its consideration of science in genre literature and combines that with Bakhtin's philosophy of literature and carnival to open pathways of study from evolutionary theory into feminist science studies and feminist science fiction. These discourses, feminist speculative fiction narratives and

evolutionary narratives, are all connected and all explore change as it is worked out on social, cultural, textual and natural bodies. This approach is productive and is ratified as both 'bricolage' and Bakhtinian dialogics. Two apparently disparate fields, speculative literature and evolutionary science then join to create a carnival of subversion and invention. The carnival reveals a coherent set of problems with prevailing authorities and surprisingly similar possibilities in potential syntheses and new unities, unities that invite the coexistence of multiple and partial perspectives, and suggest new subjectivities and interdisciplinary alliances.

EVOLUTIONARY NARRATIVES

Chapter 2
Punctuating Darwin's Story

The law of the father might be a myth, but its very real potency is hard to deconstruct.

Donna Haraway[1]

The principle of laughter and the carnival spirit on which the grotesque is based destroys ... limited seriousness and all pretence of an extratemporal meaning and unconditional value of necessity. It frees human consciousness, thought, and imagination for new potentialities. For this reason great changes, even in the field of science, are always preceded by a certain carnival consciousness that prepares the way.

Mikhail Bakhtin[2]

The dinosaur egg is real, more real than any inanimate thing. The egg is the direct link to evolution, to Darwin and Jurassic Park. It's like owning a piece of the cross.

Henry Galiana[3]

Introduction

Western thinking is underpinned by a number of significant narratives that extend far beyond the areas of interest originally treated by the creators of those narratives. Darwin's theory of evolution is an example of a thesis that has become a metanarrative. Originally formulated as a focused treatise on natural history, Charles Darwin's major text, *The Origin of Species by Means of Natural Selection Or The Preservation of Favoured Races in the Struggle for Life*,[4] published in 1859, has become a seminal cultural text, underwriting discourses as varied as psychology, economics, history, politics and literature.

Useful in many fields for one hundred and fifty years, Darwinism faces particular challenges to its integrity at the beginning of the twenty-first century as it is widely interrogated on both a specialist and generalist level. The specialist and generalist fascination with questions of origins speaks of an almost universal interest in mechanisms of change and the concept of evolution and is indicative of a growing desire to clarify the past (and therefore the present) in some way. That clarification is hard to achieve in a field which encompasses scientific theory and practice ranging from the study of contemporary intracellular mechanisms of the immune system to carbon testing the preserved remains of life forms that existed nearly half a billion

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1 Haraway, *Primate Visions*, 281.
2 Bakhtin, *Rabelais and His World*, 49.
3 Virginia Morrel, 'A Dinosaur for the Mantel: Dinosaur Bones for Private Collections', *Natural History* 107 (1998), 58.
4 Charles Darwin, *The Origin of Species by Means of Natural Selection or the Preservation of the Favoured Races in the Struggle for Life* (New York: The Modern Library, 1998).

years ago. Any attempted synthesis of such disparate data is perforce either going to be quite elastic or express some sort of disciplinary bias, as has the 'modern synthesis'.[5] The history of what is understood to be evolution is also problematic. Darwinian science, for example, is complicated by the many readings and amalgamations it has gone through since its inception. Academic commentators often, explicitly or implicitly, resist the mythologising of Darwin and his theory by contextualising both the person and the ideas in the science of the time, while scientists struggle with the developing logic of evolution and applying evolutionary ideas within their own particular disciplinary field.[6] Popularly, evolution has come to mean genetics and selection, but historically it also manifests as oppositional to Christian views on creation. This is a complicated story, to say the least.

There is a strong push to identify positions in the field, and to clarify agendas,[7] but one of the arguments of this thesis is that, rather than becoming clarified, the central Darwinian dogma and its resistances have become significantly carnivalised as evolution has become subject to extensive cross disciplinary analyses, radical popularisation and the inclusion, in some form, of most natural phenomena. This carnival incorporates both a Lilliputian and Brobdignagian view of biology, society and the individual. It also provides a space where oddities and curiosities form a consistent part of the scientific spectacle, where theoretical and informational confrontation are commonplace, and boundaries are compromised as much by interpretation as information. Evolution carries other markers of carnival. Incursions of

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5 The 'modern synthesis' is usually understood to be the joining of Darwin's theory of natural selection, Mendelian genetics and Fisher's ideas of population genetics. See R.A. Fisher, *The Genetical Theory of Natural Selection* (Oxford: Clarendon, 1930). Stephen Jay Gould refers to the 'hardening' of the modern synthesis, which took place through the 1950's following works published by Ernst Mayr and Theodore Dobzhansky on the origin of the species. This hardening took the form of shutting down what had been a pluralistic perspective on evolution at the beginning of the century, to a narrowing of understanding and an overemphasis on the relationship of molecular biology and individual natural selection. See Ernst Mayr and W. Provine, *The Evolutionary Synthesis: Perspectives on the Unification of Biology* (Cambridge: Harvard University Press, 1980); Stephen Jay Gould, *The Structure of Evolutionary Theory* (Cambridge: The Belknap Press, 2002); Niles Eldredge, *Reinventing Darwin: The Great Evolutionary Debate* (Phoenix: Giant Paperback, 1995); Robert G.B. Reid, *Evolutionary Theory: The Unfinished Synthesis* (London: Croom Helm, 1985).

6 See again various texts that will be treated more specifically in the body of this chapter: Bentley Glass, Owsei Temkin, William Strauss Jr, ed., *Forerunners of Darwin: 1745-1859* (Baltimore: Johns Hopkins Press, 1959) for an early multidisciplinary history of Darwinian thought; and Mae-Wan Ho and Peter T. Saunders, ed. *Beyond Neo-Darwinism: An Introduction to the New Evolutionary Paradigm* (London: Academic Press, 1984) and Mae-Wan ho and Sidney W. Fox, ed., *Evolutionary Processes and Metaphors* (London: John Wiley & Sons, 1988) for more contemporary representations of evolutionary thinking across disciplines.

7 Niles Eldredge, *Reinventing Darwin: The Great Evolutionary Debate*; Stephen Jay Gould, *The Structure of Evolutionary Theory*; and Richard Lewontin, Steven Rose and Leon J. Kamin, *Biology as Ideology: The Doctrine of DNA* (New York: Harper Collins, 1993).

scientists and pop science writers into the field have extended and hybridised an idea that was initially a guideline confined to incremental changes in biological forms and based on animal husbandry. As with any carnivalised space, theoretical or material, evolutionary bodies (of work) express and represent changing forms, procreation is a central issue, irregular bodies generate interest in both rules and exceptions, and recombinant forms and ideas are signalled as sites of both potential growth and disorder. In all it seems very likely, as Michael Denton says, that evolutionary theory is a theory in crisis.[8] What then remains to be worked out is the shape of this crisis – and if evolutionary thinking is indeed confined to science.

Because of the shifts in scale and the large territory covered by evolutionary thought, theory and subjects there is always some fragmentation of any presentation of the subject/concept of evolution, even though it may not always appear that way. Foregrounded in this chapter are just three considerations of evolution focusing predominantly on Darwinism. The first section draws attention to the complicated relationship that Darwinism has with religion. Contrary to the popular perception that Darwinism is the polar opposite of creationism, evolution and religion have an intricate relationship that sees them in situations of mutual borrowings as well as antipathy. This section situates Darwinism as cultural discourse, as well as historical scientific discourse, and recognises Darwinism and Christianity as braided beliefs or 'cosmogenies' that intersect in sometimes unexpected ways.[9]

The second section is a general examination of the shortcomings in the theory of natural selection and some problems this introduces into evolutionary science when Darwinism is actively maintained as the central foundational discourse. Not only are the values of Victorian industrialism and colonialism embedded in traditional selectionist readings within life sciences, driving their explanations of the living world, but related evolutionary disciplines have to contend with Darwinism as they grow and change. Darwinism is a non-specific, generalised science that can skew focused disciplinary stories. Panbiogeography, as one example, has implications for species distribution that suggests radial biogeographic migration from centres of dispersal is a very limited explanation as to how species come to be in very different locations. Stories like panbiogeography are also not focused on individual competition and genetic selection, and can be marginalised in a neo-Darwinian worldview that does not

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8 Michael Denton, *Evolution: Theory in Crisis* (Maryland: Adler and Adler, 1985).
9 Ibid, 69-78. Denton uses the term 'cosmogenic myth' when referring to Darwinian evolution as a replacement myth for Christian creationism.

consider the multiple agential possibilities and constructions of evolution that include the environment.

The scientific and cultural centrality of Darwinism is such that theories that disturb Darwinism or neo-Darwinism may even be attacked. Punctuated equilibrium is one such theory, and a consideration of Darwinism and punctuated equilibrium comprises the third section of this chapter. Punctuated equilibrium revises Darwinism to argue that change in phylogeny, or speciation, can occur rapidly rather than having to be gradual. Proposed by Stephen Jay Gould and Niles Eldredge in 1972, punctuated equilibrium attempts to stay under the protective umbrella of Darwinism but in fact destabilises it significantly as a scientific theory and brings boundary issues and resonances of carnival to a debate focused on the momentum of change. Grounded in the discipline of palaeontology, punctuated equilibrium also belongs with the multidisciplinary group of 'post neo-Darwinian' theories discussed in chapter five of this thesis because it tells a story of change with multiple agency and a responsive organism, but it is examined in this chapter because it forms a direct challenge to gradualism, a central tenet of Darwinism. Gould and Eldredge's theory is discussed in this chapter in terms of Kuhnian paradigm shift, their position with respect to the evolutionary concept of adaptation, the foreshadowing of other 'post neo-Darwinism' science in their story and cultural threads in punctuated equilibrium which touch on feminist and ecofeminist critiques of science.

Darwinian evolution is a complex cultural site. Not only has it become a metanarrative affecting politics, economics, education, health and many other institutions and discourses, it is complicated by its own history and by being a touchstone for so many scientific theories and practices. Solid in its popular acceptance (barring creationists) to the point where survival of the fittest seems to be a self-evident, commonsensical truth in Western thinking, Darwinism has nevertheless been subjected to many interdisciplinary interpretations that have stretched and challenged the theory in its scientific specifics. Sometimes the theory retains its usefulness, whether it retains its primacy is a very different matter.

The argument in this chapter, and the three following chapters on "Evolutionary Narratives", suggests a possible reframing of Darwinism together with other evolutionary theories and sciences into a larger ecofeminist narrative of multiple and partial stories that speaks to the postmodern imagination. The heart of this process lies with accepting evolutionary science as interdisciplinary and emergent, and evolutionary theory as decentred, destabilised and multivocal. Karen Barad argues for

a new approach that can link bodies, science and theory in performative understandings of discursive sites/practices. If this can be done with evolutionary thought, then an historical, scientific *and* cultural *onto-epistemology* of evolution would support a multi-agential realist approach to a 'world making itself intelligible'.[10] That is, evolution needs to be recognised as a materialist/discursive/dialogic site moving between, and including, material bodies, material science, science theory, science studies and cultural studies.

Darwinism and dogma

Evolutionary theory and Western Christianity have not only had a fraught history, they have had a complex history. From attempts through the middle-ages to explain fossils via the flood to the recent debates on teaching 'intelligent design' as part of current high school science curricula, there have been struggles with the interpretation of material information, the construction of knowledge and the assumption of authority between the two. However, the relationship between religious discourse and scientific discourse is not simply oppositional. It is layered and - at times - manifests a surprising reciprocity. At this particular point in history, it is also marked with ironies and reversals as science and religion evidence borrowings from each other that reveal a carnivalisation of belief systems and possibly both a collision and collusion of cosmologies. Religion has always been a staple of carnival, mocked and parodied from the medieval market place onwards, but, according to Bakhtin, science can also be implicated in carnival at times of great change and can contribute to carnival's subversive 'gay relativity of prevailing truths and authorities'.[11]

This is evident from early and specific conflicts between proponents of evolution and the church through one hundred and fifty years of historical change in both science and religious thought. Recently, for example, orthodox creeds have become more cautious about challenging scientific knowledge but fundamentalist Christian sects have become more militant and have taken the teaching of evolution into Western schools and then into the American courts a number of times in the twentieth century. The intense battle between science and creationism in America has seen a reactionary

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10 Karen Barad, 'Posthuman Performativity: Toward an Understanding of How Matter Comes to Matter', 89. This proposal draws on Barad's notion of 'posthuman agential realism', which aims to reconfigure experience, knowledge and representation as non-anthropocentric and to open the doors to multidisciplinarity by replacing the notion of 'interaction' with 'intra-action', indicating the interconnectedness of all socioscientific and material phenomena. She says a posthumanist materialist account of the world actively works against the Cartesian split of words and things, and is 'part of the world making itself intelligible'.

11 Bakhtin, *Rabelais and His World*, 11.

fundamentalism around molecular biology and neo-Darwinism. The irony is that there is now extensive use of science by creationists to disprove Darwinism while discontent grows among scientists with regard to the religious sub-texts of Darwin's ideas. In some respects this ongoing and difficult interaction of religion and science has reached an impasse in the current 'intelligent design' debate, one that indicates that neither authority is willing to cede, yet neither is able to claim the entire territory under dispute. The reason for this is because evolution is an extraordinary juncture of matter and what matters. Evolution is an extraordinary meeting of the organic and inorganic, theories of how organic and inorganic entities change, cultural perceptions of organic and inorganic matter(s), cultural theories about cultural perceptions of organic and inorganic matter and the ideologies that drive those theories.

When it was first presented, Darwin's work was actually as unpopular for its science as much as for the challenge its natural materialism posed to existing Christian orthodoxy. According to J.R. Lucas, Samuel Wilberforce, often demonised by anecdotal accounts of the exchange between himself and Huxley at the meeting of the British Association on June 30, 1860, primarily mounted a scientific rather than theological criticism of Darwin's work. In his speech he called Darwin's work a 'hypothesis' not a theory and drew attention to the fixity of species. Three problems he identified with the theory of natural selection were the lack of development of new species over human history, that selective pressures were more likely to have an effect on species rather than produce new species, and that the phenomenon of sterile hybrids witnessed for fixity.[12] These criticisms of Darwin's ideas fell into line with other scientific criticisms of the day but it was the barbs that passed between Wilberforce and Huxley at the end of the presentation that galvanised historical interest. And, Lucas points out, the words exchanged have always been in question, because there is no definite record anywhere of what they were. Joseph Hooker, however, was an eyewitness and did record it in his diary as a definite cultural frisson:

> Accordingly it was to him [Huxley], thus marked out as the champion of the most debatable thesis of evolution, that, two days later, the Bishop addressed his sarcasms, only to meet with a withering retort. For on the Friday there was peace; but on the Saturday came a yet fiercer battle over the `Origin' which loomed all the larger in the public eye, because it was not merely the

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12 J.R. Lucas, 'Wilberforce and Huxley: A Legendary Encounter', *The Historical Journal* 22, no. 2 (1979), 320.

contradiction of one anatomist by another, but the open clash between Science and the Church.[13]

Mercifully, the questionable compatibility of religion and science that was brought to consciousness in Britain through the high Anglican Church at this time had a gentler reception than previous European experiences with the Catholic hierarchies. Giordano Bruno, Galileo and even Descartes had suffered greatly in the wake of the Copernican discoveries, but British Catholicism in the middle of the nineteenth century was positively benign to evolutionists in its ranks. Robert Reid documents the case of St George Jackson Mivart, author of *On the Genesis of Species,* which critiqued Darwinism scientifically but vindicated it as non-threatening to Christian doctrines. The irony is that Mivart suffered quite badly at the hands of the evolutionists he had tried to support as they attacked his religious vindication of Darwinism with relish. Reid lists Mivart's very clear and useful criticisms of selectionism, but sees him as half flash and half foolish for his attempt to unite religion and science.[14] At that time in European history, Darwin marked a changing of the intellectual guard. Death by burning at the stake may no longer have been the result of disagreement with the church, but battle lines had been drawn and any attempt to negotiate a truce was seen as a betrayal in both camps.

The religious reaction to evolution in America was different again, with a strong anti-evolutionist feeling taking root in the 1920s, then revitalizing in the 1960s and more recently at the end of the century. Popularly perceived as a 'southern Baptist' phenomenon, creationism also has strong roots in Presbyterianism and Seventh Day Adventism. Donald Dayton argues that, although a number of secular causes have been proposed for that original burst of anti-evolutionist feeling, from the naturalisation of evolution and the repugnance for social Darwinism to increased numbers of high schools and science teachers, it was also driven by strong theological reasons. At the end of the nineteenth century a certain kind of religious pre-millennial thinking did not support popular ideas of progress and increased secularization, but rather looked at decline and degeneration as the tenor of coming times and connected that to apocalyptic readings in the bible.[15] Ancillary to Dayton's argument, the original anti-

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13 Ibid, 314.

14 This writer had considerable misfortune, according to Reid. While Mivart's paper on evolution was acceptable, he unfortunately followed it up with a paper calling attention to the historical problems the church had with science. He was asked by the church to reject his representation of the church. He refused and was excommunicated. Sadly, he won no friends among the scientists either.

15 Donald W. Dayton, 'Creationism in Twentieth Century America', *Zygon* 32, no. 1 (1997).

evolution fervor was fed by the 1925 Scopes trial and the passion of the prosecution lawyer William Jennings Bryan who had also been a liberal Democratic presidential contender who supported suffrage, consumer rights and child labour laws. Therefore anti-evolutionism began its life in America on the side of liberal politics, associated with protections of the vulnerable and having a patina of 'doing the right thing'.

Later resurgences of creationism led to further court challenges and strategies to reinstate creationist teaching in school curricula, while challenging and compromising the teaching of evolutionary science.[16] Prior to the Scopes trial, George McCready Price critiqued the then central evolutionary discipline of geology. He contended that fossils were used to date rocks and rocks were used to date fossils, leading to a problematic circularity in that specific area of knowledge. Price was not a qualified geologist but he went to the heart of the issues involved by seeking to challenge the authority of science and reinstate the authority of religion. His technique was to force ambiguity on scientific information and recast knowledge in ways that may well be rejected by experts in the field, but were difficult for non-specialists to critically engage with. This technique of arguing religion through science has endured through the twentieth century with some carnivalesque results.

An example of a mid-century creationist argument that uses genuine contemporary scientific information to challenge scientific authority is Shute's *Flaws in the Theory of Evolution.* Shute, a trained medical practitioner, questions evolution in a pragmatic fashion, drawing attention to a fossil record which gives no evidence of transitional species, pointing out the failure of homology, where morphology may be assumed to indicate a common ancestor, and giving examples of complex biological patterns that seem to deny 'survival of the fittest' such as symbiosis and parasitism.[17] More than this, Shute draws attention to problems with serology, studies of blood chemistry. He claims serology has frequently been used to present distorted human/animal and animal/animal connections (the commonly used example is humans and chimps having a difference of only 3% of their DNA) and he indicates that ultimately such similarities and differences express no orderly pattern. He also discusses the very complexity of evolution and its seeming impossibility.

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16 See 1981, McLean vs Arkansas Board of Education (Arkansas); 1987, Edwards vs Aguillard (Louisiana) ; 2005, Kitzmiller vs Dover Area School District (Pennsylvania).
17 A distinction is drawn by Michael Denton, *Evolution: Theory in Crisis* and E. Shute, *Flaws in the Theory of Evolution* (New Jersey: Nutley, 1962) between homologous relationships, which imply some sort of developmental connection such as a common ancestor, and analogous relationships that merely imply a similar development in form. This issue is discussed in more depth later in this chapter and also in Chapter 5 under convergent evolution.

Rejecting Darwinism on theistic grounds, Shute finds natural materialism incompatible with the idea of divine creation. His subtext is clear: accept scientific information but deny macroevolution as heresy. Occupying a late seat in the creationist debate and an early one in the post-modern unease with Darwinism, and uninformed at that stage by the Kuhnian analyses of science, Shute produces sound scientific criticism. However, his work is a paradox of demands to return to a less complex story of origins via ultra-modern transportation, and his scientific data is often undermined by the nostalgic politics of the language in which he expresses his ideas. For example, when discussing the unlikelihood of various hominid groups in the ancestral 'bush' practicing complete genocide on each other, he says:

> [T]he cultural difference between a hunter armed with blade tools and one armed with flake tools must have been infinitely less than between Englishmen armed with rifles and Australian aborigines. Neither cultural difference nor repugnance at the grotesque elf-like faces of the aborigines prevented the English from doing what wandering men have been doing with foreign women throughout recorded history.[18]

Shute's politics are revealed in this passage: he stands between William Jennings Bryan's early Presbyterianism, which was aligned with liberal humanism and a certain late Victorian generosity, and the slick, extreme right wing conservativism that is orchestrating the current battle of beliefs at the beginning of the twenty-first century. Shute challenges Darwinism on scientific grounds, but his writing also exposes a nostalgic, culturally produced acceptance of imperial colonialism, racism and male sexual domination. In this story, colonisation is a naturalised process: the land and women are alien and territory to be possessed and repossessed, and race is both exotic and threatening. Shute's book is scientifically sound for the time in which it is published. His criticisms of Darwinism are criticisms that other scientists make even now; however, his text provides an interesting example of the shifting grounds of the argument and the crying need for recognition of the cultural investments in both scientific and religious narratives of origin and change. It also provides an example of carnival logic. While addressing the undesirability and unlikelihood of a split between humans and apes, Shute's story proceeds to split the modern scenario of humans between Tally Ho explorers and the fey, indigenous inhabitants of unexplored lands.

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18 Shute, *Flaws in the Theory of Evolution*, 224.

Intelligent Design is a more aggressive recent incarnation of creationism. Barbara Forrest and Paul Gross deconstruct the arguments of Intelligent Design as a sophisticated, media savvy plan by a right wing think tank intended to undo evolutionary teaching in schools and colleges in America.[19] They identify the science it uses as a Trojan horse, an attempt to smuggle creationism into school science curricula through mathematics and the 'hard' science of biochemistry. William Dembski's numerical interpretations of regularity and chance look at a statistical impossibility for the creation of life by evolution and replaces 'regularity' and 'chance' with 'design'; that is, life on earth has to be a product of intelligent design by an intelligent designer. This is a deliberate replication of William Paley's words with respect to the impossibility of organic evolution and the necessity of a creator for the complexities of organic design,[20] and is used to reignite the same tension, with Dembski this time arguing that science has come across to support theology. Other writers perform similar feats of rhetoric. Michael Behe touts his notions of the 'irreducible complexity' of living cells, and the necessity of an ultimate, supernatural designer, as the shock of the century. This 'shock' is disingenuous and his science won't be winning Behe a Nobel Prize any time soon.[21] Rather, the authors of these ideas and their publications have been 'outed' as part of a program set by the Discovery Institute of Seattle to actively defeat the materialist discourse of science and to replace it with theistic science. The Institute has extensive conservative connections, and a long-term agenda, which '...seeks nothing less than the overthrow of materialism and its cultural legacies'. [22]

This quote comes from the now infamous 'Wedge Document', addressed by Forrest and Gross. The 'Wedge Document' was apparently stolen from the Institute and then

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19 Barbara Carroll Forrest and Paul R. Gross, *Creationism's Trojan Horse: The Wedge of Intelligent Design* (New York: Oxford University Press, 2004).

20 William Paley, *Natural Theology* (1839), http://home.att.net/~p.caimi/paley.html (accessed March 14, 2007).

21 Michael J. Behe, *Darwin's Black Box* (New York: Simon and Schuster, 1996), 252. Behe credits Paley with first using the term 'irreducible complexity'. This is a term that haunts evolutionary writing. Gould and Eldredge use it in 'Punctuated Equilibria: An Alternative to Phyletic Gradualism', reprinted in Niles Eldredge *Time Frames: The Rethinking of Darwinian Evolution and the Theory of Punctuated Equilibria* (New York: Simon and Schuster, 1985), 193-223. (All subsequent page references will be to this edition). This example of the borrowings of key phrases between religion and science, and science and religion, and then mainstream science and subversive science illustrate the dialogia that marks evolutionary debate.

22 *The Wedge Strategy*, http://www.antievolution.org/features/wedge.html and Lenny Flank, *The 'Wedge Document'*, http://www.geocities.com/CapeCanaveral/Hangar/2437/wedge.html (Accessed 15th August, 2005)

published on the web.[23] A five-year plan by the Discovery Institute, it outlines a way of attacking science through introducing doubts about scientific authority and building the profile of Intelligent Design as a specific alternative to the thorny problem of evolution. Intelligent design and its context of 'wedge' politics and Western religious fundamentalism present as oxymoronic and carnival in a number of ways: open conspiracies, political theology, theological politics, popular elitism, scriptural science and absolute knowledge. This document represents a conflation of political and divine power, a traditional marker of carnival. Just as medieval clerics and religious were portrayed in the carnival of the marketplace as being over worldly in their interests and appetites, so are the twenty first century religious evangelists shown in courtrooms as being Machiavellian schemers. By promoting creationism the authors of the 'Wedge Document' say they seek to protect children from the dangers of secular culture, a position that stands in direct contrast to prominent cultural and science theorist Donna Haraway's statement that teaching children creationism under the guise of evolution is a form of child abuse.[24] The creationist position also inverts and subverts ideas of academic freedom and freedom of speech, discrimination, radicalism and fair play. In a truly carnival ploy, Intelligent Design proponents argue for themselves as dangerous radicals within a system. They say they are being silenced by not being allowed to publish and they make appeals to teach their theory based on fairness and democracy.

The reach of the anti-evolution program of Intelligent Design is extensive. Feeling is running so high in Britain that the Catholic church found it necessary to publish a teaching document in October 2005 stating that historical precision and accuracy should not be expected from the bible.[25] Five hundred New Zealand schools received unsolicited DVDs and workbooks from the Christian-based Focus on the Family organization; a division of the Seattle based Discovery Institute.[26] In 2006, the Australian Federal Education Minister, Brendan Nelson, also gave qualified approval to the teaching of Intelligent Design as part of the science curriculum,[27] while Sydney's

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23 *The Wedge Strategy.*
24 Donna Haraway, *Simians, Cyborgs and Women*, 152.
25 Ruth Gledhill, *Catholic Church no longer swears by truth of the Bible,* TIMESONLINE, October 5, 2005, http://www.timesonline.co.uk/article/0,,13509-1811332,00.html (accessed October 29, 2005).
26 Chris Barton, 'Intelligent Design - Coming to a School Near You', *The New Zealand Herald*, August 27, 2005, http://www.nzherald.co.nz/section/story.cfm?c_id=1&objectid=10342658 (accessed August 29, 2005).
27 David Wroe, 'Intelligent design' an option: Nelson', *The Age*, August 11,2005, http://www.theage.com.au/news/national/intelligent-design-an-option-nelson/2005/08/10/1123353386917.html (accessed August 11, 2005).

notoriously conservative Catholic Archbishop, George Pell, said he approved of the idea being taught in classes where evolution was sometimes taught in an 'anti-God way'. The path being cleared for them, Pacific Hills Christian School in Sydney put Intelligent Design into the curriculum as a theory that claims to have scientific evidence of a designer for life.[28] Early twenty-first century western Christian, anti-evolution fundamentalism has its own structures and logics with the exaggerated features of caricature and aggressive ideology. To this way of thinking, there has to be a 'wrong' and a 'right' and a large part of their position depends on demonizing science, specifically Darwinism. This also is a carnivalised position as those who argue against Darwinism for its lack of Godliness have no awareness that the discourses of religion and science are not as separate as they might imagine, and many scientists have expressed discomfort with the degree of religious baggage found in Darwinism.

In 1917, D'Arcy Thompson complained, 'To buttress the theory of natural selection the same instances of adaptation are used, which in an earlier but not distant age testified to the wisdom of the creator'.[29] Mae wan Ho also says in the introduction to *Evolutionary Processes and Metaphors* that 'just so' stories of genetic selectionism reflect 'optimality research'. In optimality research a characteristic of an organism is selected and a scientific story is fabricated around that characteristic to show why it was absolutely appropriate that that organism develop that feature. Ho doesn't see this as helpful thinking about evolution because it is extrapolating the cause of the evolution of a feature from an effect observed much, much later. Such a theory also has no predictive value or capacity to say what might happen to an organism or how the process might work in the future. Furthermore, she says in a specific analysis of randomness versus determinism in selection, ' A disorderly universe is a random universe requiring God or natural selection to put it right'.[30]

Hilary Rose, feminist science theorist, says unequivocally that Darwinism's strength and continuance come from Judaeo-Christian stories of human domination of nature. She even reads the burial of Darwin at Westminster Abbey as a 'recognition by church and state that at core the Darwinian theory of evolution sustained the Victorian rendering of the Judaeo-Christian belief in Western Man's right to treat nature, women

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28 Roy Eccleston, 'Designed to put God into the gaps,' *The Australian*, September 3, 2005, http://www.theaustralian.news.com.au/story/0,25197,16472668-30417,00.html (Accessed September 12, 2005) need to check consistency in date presentations
29 Reid, *Evolutionary Theory: The Unfinished Synthesis*, 34.
30 Ho, ed., *Evolutionary Processes and Metaphors*, 4-6.

and others as his things'.[31] Evolutionary scientist Adrienne Zihlman commented on her discomfort on observing a diorama of the Laetoli ash field in the American Museum of Natural History. The museum's representation of the original creation of the early hominid footprints found in this area of Africa involves two figures, a male and female Australopithecine, walking across ash being strewn by an active volcano painted into the background. Zihlman says of the representation, 'This diorama mirrors Adam and Eve's ejection from the garden of Eden and illustrates visually how religious beliefs from the Old Testament about Man, Woman and God (or Nature) – a scene depicted repeatedly by the greatest western artists for the past millennium – is now a part of the most up-to-date scientific presentation of human history and evolution.'[32] In this chapter Zihlman also draws attention to an article by Perper and Schrire, which points out a parallel between the biblical fall from grace and the defining human moment in many human evolutionary studies: in the first it is the eating of forbidden fruit and in the second it is the desire of an originally vegetarian hominid to catch and eat meat. Although Zihlman is pointing out the flaws in the hunting hypothesis and the revisions it has undergone, she is also signalling her discomfort with the fact that evolution stories tend to reaffirm and express embedded unconscious religious imagery and metaphors.

Ironic to the point of paradox is the transfer of dogmatism from fundamentalist religious resistance against evolution to scientific arguments for evolution. Ultra-Darwinists, as Niles Eldredge calls them, bring a certain fanaticism to selectionism and make it clear the primary issue is one of belief. Richard Dawkins, science populiser, goes out of his way to make the ground between evolution and religion slippery by the metaphors he uses. In *The Blind Watchmaker*, the title of which is a direct reference to Paley's argument of theistic design, he tackles an evolutionary theory that seeks to modify Darwinism.

In 1972, Eldredge and Stephen Jay Gould introduced punctuated equilibrium to evolution. This theory challenged Darwinist gradualism through the fossil record, pointing out the fossil record was probably more faithful to evolution than Darwin had thought. Gaps, according to Eldredge and Gould, were not an inadequacy in the records of life, but were an accurate reflection of evolutionary process where species stayed stable for long periods of time and then went through rapid periods of change.

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31 Hilary Rose, *Love, Power and Knowledge* (Bloomington: Indiana University Press, 1994), 231-232.
32 Adrienne Zihlman, 'The Paleolithic Glass Ceiling: Women in Human Evolution', in *Women in Human Evolution*, ed. Lori D. Hager (London: Routledge, 1997), 108.

These rapid periods of speciation, they thought, might allow for macroevolution, which had never been satisfactorily explained by Darwinian gradualism. Undermining gradualism is a serious step towards undoing the entire natural selection schema, although it is not often presented as such, and punctuated equilibrium has experienced considerable antagonism, from scientists who labelled it 'evolution by jerks'.[33] It is worth quoting Dawkins at some length on the peculiar analogy he selects to refute the idea:

> The children of Israel, according to the Exodus story, took 40 years to migrate across the Sinai desert to the Promised Land. That is a distance of some 200 miles. Their average speed was, therefore, approximately 24 yards per day, or 1 yard per hour; say 3 yards per hour if we allow for night stops. However we do the calculation, we are dealing with an absurdly slow average speed, much slower than the proverbially slow snail's pace ...But of course nobody believes that the average speed was continuously and uniformly maintained. Obviously the Israelites travelled in fits and starts, perhaps camping for long periods in one spot before moving on. Probably many of them had no very clear idea that *travelling* in any particularly consistent direction, and they meandered round and round from oasis to oasis as nomadic desert herdsmen are want to do.
>
> But now suppose that two eloquent young historians burst upon the scene. Biblical history so far, they tell us, has been dominated by the 'gradualist' school of thought. 'Gradualist' historians, we are told, literally believe that the Israelites travelled 24 yards per day; they folded their tents every morning, crawled 24 yards in an east-north easterly direction and then pitched camp again. The only alternative to 'gradualism', we are told is the dynamic new 'punctuationist' school of history. According to the punctuationists, the Israelites spent most of their time in 'stasis', not moving at all but camped often for years at a time in one place ... Their progress towards the promised land, instead of being continuous, was jerky: long periods of stasis punctuated by brief periods of rapid movement. Moreover, their bursts of movement

33 I have not been able to identify exactly who came up with the expression. It is also generally now used in tandem with another similar expression: Punctuated Equilibrium is 'evolution by jerks' and gradualism is 'evolution by creeps'!

> were not always in the direction of the Promised Land, but were in almost random directions...
>
> Such is the eloquence of the punctuationist biblical historians that they become a media sensation. Their portraits adorn the front covers of mass circulation news magazines. No television documentary is complete without an interview with at least one leading punctuationist. People who know nothing else of biblical scholarship remember just one fact: that in the dark days before the punctuationists burst upon the scene, everybody else got it wrong. Note that the publicity value of the punctuationists has nothing to do with the fact that they may be right. It has everything to do with the allegation that earlier authorities were 'gradualist' and wrong. It is because the punctuationists sell themselves as revolutionaries that they are listened to, not because they are right.[34]

This is a revealing passage. To Dawkins, any attempt to rewrite gene-centred neo-Darwinist selectionism is equivalent to rewriting Exodus, the second book of the Old Testament, where the chosen people begin to understand the laws of God. In this book they learn their God is a wrathful, jealous God and that his rules are carved in stone. In Christian history, this is the birthplace of orthodoxy. Dawkins' choice of metaphor is not innocent. In an ambiguously carnival fashion he counter positions neo-Darwinism as a faith. Any challenge to that scientific belief can then be described as heretical and pointless, whether the critic is a creationist or a fellow scientist. Using this analogy, Dawkins builds an alliance between Darwinism and the deepest roots of Judaeo-Christian history, attacking two enemies at once, aligning those in the life sciences who do not subscribe to the creed of the selectionism with creationists. With such strong mixings of antagonistic ideas, the outcome is not always clear, and with his extensive religious appropriations Dawkins creates himself as a paradoxical figure in the debate.

Dawkins' proselytising, evangelical style conjures up another image from carnival. Richard Dawkins, best selling author and public religious provocateur on all matters evolutionary, is something of a 'king', and Bakhtin notes that carnival kings are suspect figures. Just as the creationist geologist is a walking incongruity - the fool

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34 Richard Dawkins, *The Blind Watchmaker* (Essex: Longman Scientific and Technical, 1986), 223-224.

engaged in an oxymoronic quest to prove the existence of a deity through the use of science – so Dawkins can be seen as incongruous too. He is the fool using genes and Darwin to apparently disprove God when nothing can, and elevating himself above his fellow scientists and pouring scorn on attempts to have scientific dialogue about the problematics of evolutionary science and thinking. On the dark side of carnival, kings are often brought down to base level and simultaneously rewarded and paid out for their sins or crimes.[35] Richard Dawkins presents ambivalently when defending genocentric Darwinism, and through his enormous faith in scientific materialism appears more the disciple or fan than the man of reason. Despite the fact that he is a central spokesperson for these ideas, he brings a degree of disrepute to the discourse by his excessive and unquestioning support of individual selectionism, and his repeated connection – albeit apparently ironic and deliberately provocative – of Darwinist discourse to religious fundamentalism. Philip Johnson, in *Darwin on Trial*, talks about this problem of scientists embracing Darwinism as a faith and not maintaining a scientific approach to the theory. Johnson is one of the leading minds behind the Discovery Institute and one of the authors of the 'Wedge Document', but he has a point when discussing scientists of Dawkin's stamp. It is inevitable that satire and extreme confrontation will eventually turn Dawkins own arguments into parody.

In its time, Darwinism offered a replacement cultural umbrella to religious stories of creation, which in the previous century were being challenged by more and more discoveries that contradicted or confused biblical history. By the middle of the eighteenth century, devout, bible-based Christianity was an insufficient narrative to those actively curious about the strange and barbarous cultures and monstrous biological specimens that were found on long oceanic voyages of trade and exploration. Darwinism offered a sense of continuity to the western experience that religion was losing. Michael Denton says Darwinism is a replacement cosmogenic myth for the twentieth century, a story that was very successful because it offered a replacement, similarly totalised reading of nature to religion.[36] An individual organism, separated from its environment, changing randomly and subject to 'natural selectionism' that proved the worth of the survivor was also a story that resonated with the industrial revolution and its terrible human and ecological costs in the nineteenth century. A matter of faith from its inception – witness the labelling of the main competing theory as 'the Lamarckian heresy' – Darwinism is oppositional to Christian

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35 Bakhtin, *Rabelais and His World*, 196-200.
36 Denton, *Evolution: Theory in Crisis*, 358.

creation stories, but it is also riddled with Christian metaphors and ideas. Culturally conjoined twins, can religion and Darwinism be successfully separated? It is doubtful. They are ultimately incompatible epistemologies but they are joined at the hip by history, both seeking to explain the world in totalising languages. Potentially tragic, the situation is also humorous and carnivalesque. Currently, patriarchal creationism shares the task of unseating Darwin with feminism and a slew of other radical, post-modern scientific stories while science insists on performing a crude, Kuhnian dance around the gathering anomalies that contradict Darwinism while those anomalies (literally) witness for creationist doubts in the Western legal system. That the scientist is culturally and historically forced to lay down with the evangelist is just another example of the absence of 'footlights' in carnival. As Bakhtin says, it is almost impossible to separate audience and actors, participants and players, as the whole world becomes part of the riotous mix. 'Carnival is not a spectacle seen by the people: they live in it, and everyone participates because its very idea embraces all the people.'[37] Secular, scientific critics, however, have a different set of problems with Darwinism.

Secular/scientific resistance to Darwin

Although resistance to Darwinism is still popularly perceived as predominantly creationist, resistance to Darwinism and neo-Darwinism is *not* simply creationist in origin, and therefore not ultimately dualistic. As was seen towards the end of the last section, questioning of evolutionary theory also comes from scientists trying to come to grips with the shortcomings of natural selection, and wanting to advance their own ideas. Many complain about discipline specific failures of the theory, and some scientists who are also science theorists are discontented with evolutionary stories from both Darwinism and its problematic offspring neo-Darwinism.

Michael Denton, in *Evolution: A Theory in Crisis,* completely denies a religious agenda, as does Robert Reid in *Evolutionary Theory: The Unfinished Synthesis*. These authors are scientists, but they are unhappy with the scientific underpinnings and content of evolutionary theory. Both originally published in 1985, they take quite different critical approaches. Denton recapitulates Shute's scientific criticisms, together with a non-creationist reading of irreducible complexity, but his main focus is on failures of the taxonomic system. He believes the morphologically based science of cladistics can undo problems with Darwinian ideas of descent and rewrite evolutionary

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37 Bakhtin, *Rabelais and His World*, 7.

understandings of animal morphology. Reid, like Stephen Jay Gould, describes Darwinism as a scientifically contested field from the time of the publication of *The Origin of Species* to the time of the publication of his own book. Reid then argues for emergence to replace natural selection, saying that Darwin investigates the conditions of evolution (i.e. change) but overlooks the significance of emergence. Also publishing in the 1980s was British scientist Mae-Wan Ho, who edited two volumes of scientific papers specifically challenging Darwinism and neo-Darwinism. Hers is a multidisciplinary, interdisciplinary story that rejects natural selection altogether and proposes the alternative of complexity theory. Ten years after Ho's first collection, Robert Wesson argues through countless examples from natural history that self-organisation and chaos theory offer a more effective framing of evolution than natural selection.[38]

The scientists are definitely restless; however, there are persistent carnival dimensions to the unresolved story of evolution. No single satisfactory solution is being presented and scientists arguing for a more open presentation of the many stories in the master narrative of evolution are being shouted down, not only by a growing contingent of creationists, but by other scientists who find the logic of gene selectionism a sufficient explanation for the history of life. Darwinian evolutionary theory is like an old quilt; a comforting master narrative, but it is becoming increasingly difficult to present it as a consensus theory or as fundamental biological scientific truth. Even superficial historical analysis reveals Darwinism as a contested theory, science has made advancements in the last century that are difficult to account for in Darwinism, and there is a growing pressure to acknowledge the cultural dimensions of the theory of change.

Classification of species is a perennial boundary issue affecting not only the situation of organisms but also the contemporary and historical relations they have with each other – a sort of identity politics for nature. Historically, taxonomic boundaries have changed radically. Denton looks at various models. Aristotelian archetypes reject intermediate types and situate species in hierarchically constructed sub-groups that might share certain features. Carl Linnaeus, Georges Cuvier, Richard Owen and Louis Agassiz are all typologists, acknowledging intra-type variation but perceiving organisms as absolute and discontinuous from each other, while Haeckel's nineteenth century evolutionary tree keeps major classes of animals separated, and nominates relationships between organisms as 'cousin' connections. Haeckel paved the

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38 Robert Wesson, *Beyond Natural Selection* (Cambridge, Mass.: The MIT Press, 1994).

way for Darwinism, which maintained discrete species but promoted the idea of common ancestors, which has since become default thinking on anything evolutionary. In an attempt to escape all these flawed models of classifying and relating organisms, Denton argues for cladistics as a model of re-perceiving the natural world and connections between organisms. Cladistics builds a non-hierarchical, non-sequential model of life by constructing diagrams to track shared homologies or characteristics. Cladograms do not actively disprove ancestry, but they rarely support the traditional Darwinian idea of ancestry either. What is noteworthy about taxonomic shifts is the way they construct continuities or discontinuities between each class of organism and the way they reflect social structure, knowledge and experience from the culture contemporary to the particular taxonomic model employed. Post Darwin, taxonomic divisions were generally viewed as hierarchical. This perception had its roots in the strong divisions of class in Victorian society and was reinforced by Spencerian notions of progress. Examining and changing taxonomies in the way that Denton postulates can mean resituating our species, reconceptualizing our sense of ourselves and revising our relationships to other organisms and to the world. This model of taxonomy is more synchronic than diachronic, relying on current analyses of similarities and differences, and searching for connections between species in a postmodern and global way, presenting multiple possible schemes of ancestry and descent through homologies and the biomolecular 'occult anatomies' of living things.[39] So, what are the implications for science in connections made outside traditionally accepted scientific sequences and hierarchies? And if traditional scientific authorities are dismantled, and previous ancestral links reconceptualized, who will have authority and speaking positions in such a new world order?

Denton's position is problematic. He views Darwinism as a belief system, a cosmogenic myth. He sees the theory of natural selection as unfalsifiable and dismisses Darwin's observations of differences in finch beaks in the Galapagos Islands and Kettlewell's moth findings as trivial and insufficient indicators of macroevolution.[40] According to Denton, homology – explaining structural similarities through descent –

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39 Gee, *Deep Time: Cladistics, the Revolution in Evolution*, 136-198.

40 H. B. D. Kettlewell, 'A Resumé of the Investigations of the Evolution of Melanism in the Lepidoptera', in *Evolution*, ed. Mark Ridley (Oxford: Oxford University Press, 1997), 62-66. Kettlewell's experimental study of a moth traces different phenotypes, black, light coloured and peppered in England in the 1950s. These moths showed a marked tendency to change their dominant population colour from peppered to black near industrial areas, as the darker colour offered more protection from predators in areas where trees and buildings had become discoloured by pollution. Its significance lies in it being one of the rare studies that gives material support to the theory of Darwinian selectionism.

may turn out to be something more like analogy, and indicate a predisposition for organisms to favour a particular pathway of development. The fossil record is remarkably quiet on intermediate species and molecular biology is giving the idea of descent a further battering as organisms previously apparently connected by homology are proving to be unrelated in their genetic chemistry. This is not, however, where Denton is problematic. Rather, he becomes a carnival figure himself as he is driven to echoing creationist positions despite his disavowal of them. He considers the perfection of complex organisms and wonders at the possibility of them coming into being, he explodes a cell to the size of a city and says we have not got the maths to comprehend this complexity, he wonders about beauty and the way humans are a 'special case' with respect to our aesthetic senses. He accepts the idea of the horse changing from a five-toed to a one-toed organism, but wonders about the creation by evolution of the circulatory, non-bellows formation of the bird lung.[41] And when he is stumped, he resorts to Paley's analogy of design. For most scientists, Denton sails way too close to the whirlpool of creationism.

Reid is more consistent in his approach. In his critique of Darwinist theory, he flags early incarnations of much of the science that is treated in this thesis. For example, he reads St George Jackson Mivart, a contemporary of Darwin and Huxley, as foreshadowing punctuated equilibrium in his then contemporary objections to the marriage of gradualism and natural selection. Reid quotes Mivart as saying, 'That there are grounds for thinking that specific differences [in species] may be developed suddenly instead of gradually', and that 'certain fossil transitional forms are absent, which might have been expected to be present'.[42] Reid also has Charles Dixon anticipating panbiogeography and allopatric speciation when Dixon contended that geographical upheavals were as significant in evolution as natural selection,[43] and he talks about neo-Lamarckianism, epigenesis, homeostasis and 'holobiotic' precursors to Margulis' Serial Endosymbiosis Theory. The difference between Reid's proposals and Denton's idea is that he speaks against Darwinism, but he proposes a cogent alternative. While Denton collapses and says we just don't have the maths to explain the mystery, Reid says the mysterious aspects of evolution are part of emergence and a focus on that would reveal more.

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41 Origins Research Archive, *An Interview with Michael Denton* (Vol. 15 No. 2), http://www.arn.org/docs/orpages/or152/dent.htm (accessed May 15, 2000).
42 Reid, *Evolutionary Theory: The Unfinished Synthesis*, 55.
43 Ibid, 64-67.

Emergence is a complex notion and worth briefly considering here. According to Reid, Karl Popper sees quantum physics as rescuing humanistic physics from the nightmare of the physical determinist, and Reid himself sees emergence as rescuing biology from the neo-Darwinist genetic determinist.[44] Popper's sense of emergence has a philosophical basis and argues advancing levels of self-organisation when applied to the organism. Writers examined by Reid in his early (1985) book are largely historical in the field of evolution and view emergence as possible 'hierarchical jumps' made by organisms that require reorganisation for survival, and connect emergence to 'holism'. More recently, in 2007, he considers a fresh field of writers: Gerd Müller and Günter Wagner on novelty in evolution; Brian Goodwin's mathematical approach to physicochemical and biological emergence; Jack Cohen and Ian Stewart who write about emergence as the force that collapses chaos;[45] Stuart Kaufman's ideas of self-organisation; Jeffrey Schwartz in palaeontology and biology, and many others. Reid's own interpretation of the emergence/holism paradigm of evolution is multidisciplinary, going beyond structural mutation to embrace the associative, behavioural, functional-morphological, epigenetic, molecular biological and physico-chemical dimensions of the organism. He adopts the hierarchical jump model and includes sudden change, pervasive change, instant benefit and feedback, and altering the environment under the aegis of evolutionary science. He also considers consciousness, including a sense of 'beauty', in the organism as being part of emergence. Much more than Denton, he manages to keep hold of the baby as the bathwater is discarded and he ventures into the unknown possibilities of evolution.

The difference between Reid's story of emergence and the story in this thesis of narratives of evolution as a potential ecofeminist synthesis is one of orientation. Reid addresses many of the same theories as this thesis, but he frames them as 'emergence' in biology, a new material/biological synthesis, while this thesis insists on a cultural component of evolutionary theory and reads the same ideas as Reid presents (panbiogeography, punctuated equilibrium, serial endosymbiosis theory, etc.) as ecofeminist interventions in natural selection orthodoxy. Reid's argument does not

44 Ibid, 340-341.

45 The summary Reid offers for this process excited me as it seems to relate to the model I am constructing of the emergence of new evolutionary unities out of carnival, thus these ideas may also travel in physics as well as biology. On a scientific front it would seem that Cohen and Stewart see the pressures of chaos as external and the reorganisation in emergence as internal – a sort of macro-to-micro process. My argument, (without the maths), would be to refer here to Barad's notion of 'intra-action' where nothing is an ultimate 'outside' space. It would appear this is also Reid's criticism of Cohen and Stewart's theory. See Robert G.B. Reid, *Biological Emergences: Evolution by Natural Experiment* (Cambridge, Mass.: The MIT Press, 2007), 389-328.

examine the embedded political values of the science he discusses. He perceives bias only in terms of scientific argument and sees little of the wider implications of scientific stories. This thesis, on the other hand, sees cultural reciprocities in *all* science stories and less of a polarisation and more of a carnival dissolution of scientific authority in the larger struggle. While Reid's vision of evolutionary theory and science is also one of a dialogic, open ended, master narrative consisting of multiple and partial stories, he does not see the necessity of understanding the non-historical cultural elements of those stories, but cultural perceptions and politics drive evolutionary thinking every bit as much as science does. Reid's limitation is a limitation of scientific understanding, thus he is the police investigating the police.

Mae-Wan Ho also gathers scientific stories of resistance to Darwinism and neo-Darwinism. Her edited collections are radical, multidisciplinary underminings of the paradigm. She, however, lets practicing scientists speak for themselves, thereby creating a polyvocal base of dissent and giving more immediacy and a sense of exchange to the processes of questioning Darwinism and neo-Darwinism and sorting through possible scientific complementarities. Protobiology, the chemical studies of generation of new life; pan biogeography, dispersal theories that take into account geological change and time lines; convergent evolution, which suggests common morphological limitations cross-species, and a number of non-Mendelian reproductive strategies such as neo-Lamarckian genetic feedback and heritable mutation, are gathered in an attempt to jump-start the next bio-evolutionary revolution.

Of particular relevance to this thesis, the writers Ho collects in her books mount significant individual challenges to Darwinism and the determinism of molecular biology, and they rewrite scientific narratives of possibility. Beyond that, they offer great potential to redefine the field culturally through deep shifts in perspective. These stories represent an intervention and rewriting of a masculinist master narrative of science and are possibly profoundly ecofeminist, without articulating those particular politics. On the whole, they seek to reintegrate the organism and the environment, they accept partial and multiple perspectives on the organism and the processes of change, and they consistently insist on constructing multiple agencies for organism and environment. Fox's 'self-organisation' of macromolecules, Steele's neo-Lamarkian adaptive immune system mechanisms and Craw's multidimensional panbiogeography join to produce a 'posthuman' account of organism and environment.

Robert Wesson's *Beyond Natural Selection* is yet another text that interrogates multiple challenges to Darwinism and neo-Darwinism. The incompleteness of the

fossil record, the lack of utility in supposedly naturally selected traits, the high cost of sexual developments, altruism, patterns of attractors (issues of homology again), feedback loops between organism and environment, and the development of consciousness and intelligence are his topics. His sub-text is that there are forces of order and forces of chaos simultaneously working in the living world, and he believes chaos theory can contribute to understanding biology. Wesson is useful for evidentiary research and his contribution as a critical, academic, non-scientist contributes to the carnival of voices that paradoxically articulate the multidisciplinary voices of evolution as a fresh unity. He has a materialist, acultural reading of biological change that is revealing. His polite but pointed question for life scientists is, 'Well, if natural selection is all there is, how do you explain these problems that don't support that program?' The objective of Wesson's writing is that the complexity of the scientific record of the world witnesses for itself against reductive selectionism.

The larger questions raised by specific scientific questioning of Darwinism are difficult ones to think about, answer and – most of all – contextualise. Why, if there *are* so many problems with the Darwinian model, and there is no direct evidence through homology *or* biochemistry *or* the fossil record that confirms ancestral relationships between species, and we even have a new collection of ideas waiting in the wings, do we not have a failure of the paradigm? And why do these problematic constructions of the last century still underpin the major modern sciences of biology and evolutionary biology and filter into so many other scientific and cultural discourses? These are questions with complex answers and the carnivalising of information and theory is one of the reasons. Firstly, critics who interrogate the Darwinian model may be raising real issues and challenging hierarchical, competitive representations of nature, but their own ideas can often be challenged and critiqued in the same piecemeal way that they themselves criticise Darwinism and/or neo-Darwinism. Denton, for example, talks about pre-biotic life and the necessity for DNA to be present for evolution to occur. Research done prior to the publication of Denton's work, however, suggests that protein enzymes predate DNA as the information carriers of the cell.[46] So why didn't Denton know this and adjust his ideas accordingly? Information is replicating and mutating like a virus through the world and the vectors have become almost impossible to track, particularly since the advent of virtual space.

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46 Sidney W. Fox, 'Proteinoid Experiments and Evolutionary Theory', and Koichiro Matsuno, 'Open Systems and the Origin of Protoreproductive Units,' in *Beyond Neo-Darwinism: An Introduction to the New Evolutionary Paradigm*, eds. Mae-Wan Ho and Peter T. Saunders (London: Academic Press, 1984), 15-60 and 61-88.

Interdisciplinary borrowings have become unpredictable, as have random intersections of information. Wide ranging explorations focused on doctrinal evolutionary issues can easily be researched and published in fragments. This fragmentation is characteristic of carnival, generating anomalies but militating against any concerted gathering of oppositional positions and isolated critiques into a cohesive alternative paradigm.

With regard to replacing the paradigm, there are a number of issues at work. Kuhn contends that acceptance of a new paradigm is partly dependent on the literal death of the old guard who defend and maintain an existing paradigm, but even boundaries demarcated by death are not as neat as they sound. Gould refers to the 'hardening' of the new synthesis that occurred at the 1960s and 1970s as the adaptationist paradigm took hold and dominated evolutionary thinking. He notes that during the professional life of the main spokespersons for the new synthesis there was a noticeable 'hardening' of their readings of biological change with a reduced emphasis on pluralism and more emphasis being placed on individual natural selection.[47] As this model of evolution became more fixed, these men (they *were* all men) became senior in academic and scientific positions and taught or mentored others. Some of the hard line evolutionists may not be prominent any longer, but their teachings continue as a significant and vociferous strand in the life sciences carnival, partly through their writings and partly through their students, some of who have gone on to represent their ideas as doctrine rather than science. And, of course, the genocentric fundamentalism that has become the unchallenged face of popular biology is also exacerbated by other fundamentalisms that contextualise evolutionary thinking, predominantly Christian creationism.

The main reason, however, that no paradigm has gained favour with all interested parties is the very difficulty of the multiple and different investments scientific disciplines have in evolution. Evolution, or the idea of organic change, is not generally questioned outside creationist circles, but the specifics of evolution and organic change are topics of endless debate. Embryologists, geologists, palaeontologists, geneticists, bacteriologists and countless others all lay claim to some paragraph of the evolutionary narrative. Already in this section some of the ideas considered indicate the way that scientists and science thinkers are approaching this issue. Emergence, complexity theory and chaos theory are just three of the ideas put forward in an attempt to rationalise the subject and to introduce a framing discourse.

The problem of a failing paradigm and its potential successor will be examined in more detail in chapter five, but for the moment it should be noted that there is still a

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47 See Gould, *The Structure of Evolutionary Theory*, 503-584.

deficit in any framing discourse that attempts to restrict the discussion of evolution only to science, because evolutionary thinking and all its participating science stories have some level of cultural content. This is very evident in the first big disruption to Darwinism and neo-Darwinism that will be considered in the thesis. Punctuated equilibrium is a theory that suggests Darwin got it wrong about the rates of evolution and it is a theory that is self-consciously understood by its authors as a cultural as well as scientific artefact.

Punctuated equilibrium

Punctuated equilibrium, proposed by Stephen Jay Gould and Niles Eldredge in an article published in *Models in Paleobiology* in 1972, has been the single greatest challenge to Darwinism to date in Western science.[48] Describing the situation prior to the emergence of punctuated equilibrium in 1972, Donald Prothero speaks to the lack of theorising in palaeontology:

> Virtually all the palaeontology textbooks of the time (such as the classic text by Moore, Lalicker and Fischer, first published in 1952) were simply compendia of fossils, and the broader theoretical issues were confined to a few sketchy introductory chapters. The meetings of the Paleontological Society at the Geological Society of America convention were dominated by descriptive papers ("a new fauna from X" and "a new species of Y"), with only occasional broader theoretical papers that appealed to anyone other than the narrow specialist. This approach was called *idiographic* by Gould (1980a), since it focuses on the studying objects for their own sake. Others sneered and called it "stamp collecting."[49]

Although Prothero attributes the change in this model to a generation of 'young Turks' finishing their degrees at the end of the revolutionary sixties, more than a fresh dose of anti-establishment testosterone was needed to catalyse the major shift provoked by the theory of punctuated equilibrium. Post WWll, attitudes to the western science project had already been steadily changing. Atomic technology engendered deep sociocultural anxiety about scientific authority and capacity, and the boundaries of scientific practice.

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48 Refer footnote 21, this chapter. Gould and Eldredge, 'Punctuated Equilibria', originally published in *Models in Paleobiology*, ed. T.J.M. Schopf (San Francisco: Freeman, Cooper & Co., 1972) 82-115, was reprinted in Eldredge, *Time Frames,* 193-223.

49 Donald Prothero, 'Punctuated Equilibrium at Twenty: A Paleontological Perspective', *Skeptic* 1, no. 3 (1992) 38.

Two major figures stand out in post war philosophy of science. Karl Popper, a philosopher of science, applied principles of verisimilitude and falsifiability to distinguish what he believed to be authentic scientific activity from more sociological practices (such as psychology) that had fallen under the aegis of science. Popper relied on checking for internal contradictions in a theory, axiomatising the theory, comparing the theory to other similar existing theories and testing the conclusions drawn from the theory by empirical applications. Theories that could not be falsified could be provisionally retained as the best available theory at the time. Although Popper made moves towards contextualising science in society, his approach was more concerned with the verifiability of theories and the demarcation of what he saw as *more* scientific activities from *less* scientific activities.[50]

Thomas Kuhn viewed science differently, seeing it not as a necessarily deductive true or false process, but as inseparable from history. He believed science depended on history because prior experience in a science was relevant to scientific development, as were certain accidents of timing and the individual who might work in science and forge its motion and direction. In his words:

> An apparently arbitrary element, compounded of personal and historical accident, is always a formative ingredient of the beliefs espoused by a given scientific community at a given time.[51]

Published in 1962, *The Structure of Scientific Revolutions* contends that 'paradigms' or 'conceptual world views' are central in the creation and maintenance of scientific activity, but that no paradigm explains all the facts that require explanations from it. Thus anomalies are created from paradigms that necessarily offer sound but only ever partial answers to scientific dilemmas. If enough anomalies are generated in a field, a crisis occurs. The old paradigm becomes less and less adequate, and when a new paradigm is proposed that resolves a good number of those anomalies then the old paradigm is discarded in favour of the new one. One example Kuhn wrote about was the overthrow of geocentric Ptolemaic cosmology by Copernican heliocentrism. The Ptolemaic spheres, which explained the movement of heavenly bodies for many centuries finally became absurdly complex in their attempts to accomodate new information. The Ptolemaic system then gave way to the more mathematically simple and elegant explanation of a heliocentric solar system. Such a transition means that the continued cultural production of the old paradigm must gradually be phased out and

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50 Karl Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge* (London: Routledge, 1963).

51 T. S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: Chicago Press, 1970), 4.

this involves rewriting textbooks and sometimes literally waiting for the 'old guard' of the traditional ideas to die out or retire. While Kuhn argues for understanding science through historical context, there are dimensions of the story he omits. The change from geocentrism to heliocentrism was deeply traumatic, implicating religious, political and cultural belief systems at the time and having a high personal cost for the scientists involved. It also took a long time to reach levels of professional and popular acceptance that would ensure the continuance of the new paradigm. This needs to be kept in mind when looking at the story of Darwin's theory which has already claimed casualties of life and reputation and will surely have a further effect as it progresses to being discarded or amalgamated into an alternative vision. [52]

Although the original punctuated equilibrium article draws on other specific writers in the philosophy of science and science theory, such as Paul Feyerabend and N.R.Hanson, Gould and Eldredge took advantage of the climate created by Popper and Kuhn, identifying a theme that would dominate their work – 'The Cloven Hoofprint of Theory'. Stressing the historical contextualisation of science, they argue that theory precedes empirical investigations, rather than the reverse, and inevitably shapes and guides those investigations. The hermeneutic circle of genre reappears. Their article is as interesting for its rhetorical language and structure – a feature of many evolutionary stories – as it is for its scientific content, and it is pioneering in being self conscious of its own processes on a number of levels. Punctuated equilibrium is not only a significant intervention in the traditional Darwinian model, it is a theory that is coherent with this thesis in that it insists on recognition of the contribution of cultural and historical knowledge to scientific paradigms.

While Gould and Eldredge appear to follow scientific tradition by deferring to the patriarchs, their introduction critiques Newton's 'inductivist credo', a belief in facts alone constituting scientific information and research, as naïve. They then select quotations from Darwin, one that firstly shows him supporting the inescapability of theory in scientific studies then one proclaiming that he did not theorise his information but relied on facts alone to produce his conclusions. These constructions

52 Arthur Koestler, *The Case of the Midwife Toad* (New York: Random House, 1971). Koestler documents the campaign of scientific harassment Paul Kammerer experienced and theorises it contributed to his suicide. See also Gould, *The Structure of Evolutionary Theory*, where Gould notes the politics of the 'hardening' of the new synthesis saw academics like Sewall Wright and G.G. Simpson, neither of whom supported selectionism as the sole mechanism of evolution, excluded from participation in major conferences. See also Reid, *Evolutionary Theory: The Unfinished Synthesis*, 51-55, where Reid talks about the effect of resisting Darwin on several people, including St George Jackson Mivart, who ended up both alienated from scientists and excommunicated from the church for his reconciliatory stories of religion and Darwinism.

are not innocent and reveal the agenda of the new story of punctuated equilibrium. Newton was the father of pre-quantum physics and the advent of Einstein's theory had brought about a clear paradigm shift earlier in the twentieth century. At the time, this was quite a fresh and dramatic story and would ensure their readers retained a receptivity to the possibilities of paradigm change. Newton was a respected but supplanted member of the old guard. His was a respected but compromised paradigm by the middle of the twentieth century. With this precedent established, Gould and Eldredge's selected statements from Darwin illustrate a contradictory view of the naturalist's own scientific process. In Darwin's own words, he claims both to respect the fact that theory directs research and yet considers his own material to be based on unbiased selection and presentation of information. Thus he is shown, right from the beginning of this challenging article, in the company he is destined to keep – a venerable patriarch with edited relevance to this century – and he is also shown to be, at the least, conflicted in his own methodological approach. In two short pages the pedestal Darwin sits upon has cracked.

Rejecting the authority of a 'value free' view of science is paradoxically empowering for these particular scientists. Their deliberations on the place of theory in the scientific process liberates them to challenge a master narrative of science and, within their own discipline, to propose a different way of reading information:

> The inductivist view forces us into a vicious circle. A theory often compels us to see the world in its light and support. Yet we think we see objectively and therefore interpret each new datum as an independent confirmation of our theory. Although our theory may be wrong we cannot confute it. To extract ourselves from this dilemma, we must bring in a more adequate theory; it will not arise from facts collected in the old way. Palaeontology supported creationism in continuing comfort, yet the imposition of Darwinism forced a new, and surely more adequate, interpretation upon old facts. Science progresses more by the introduction of new world-views or 'pictures' than by the steady accumulation of information.[53]

This is a determined break from a dry list of geological ages teamed with an endless catalogue of long dead life forms. The new story, constructed by Gould and Eldredge, is based on allopatric speciation, a prefabricated tale imported whole into palaeontology from biology. According to Kuhn, paradigmatic shift is often provoked

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53 Gould and Eldredge, 'Punctuated Equilibria,' 195-196.

by information brought in from another field of study, often by a younger scientist, but the combination of a life science with palaeontology is not just a transdisciplinary story, it is also a carnival story because it looks beyond the living capacity to interbreed as the boundary of a species and questions the species boundary as it is constructed between living and present organisms and dead and absent organisms. When this happens, time, behaviour, ecology and distribution also become important – more agents enter the performative drama of evolution.

Theoretically, allopatric speciation occurs when a daughter population becomes geographically distant from its parent species and the gene pools separate over time. Eventually, when there is no gene flow between the two populations, there comes a point where it can no longer recur. Gould and Eldredge examine these stories, and the complications to these stories, through species of interest to them. The different populations of trilobites studied by Eldredge express evolution by changes in eye morphology – historically moving from a greater number of lenses in one population, to a lesser numbers in another, and then back again later to the higher number. The change in number of lenses was clearly an affect of geographical location as the number changed in different localities at different times and followed no discernible pattern of progress through time. The trilobites did not seem to develop more or less lenses as a pattern of morphological sophistication, but rather adapted backwards and forwards to environmentally required lens numbers as the Devonian seas changed depth. The trilobite story is one of widespread stability, because these body forms lasted millennia, with the lens changes occurring in peripheral populations. Based on morphology alone, Gould's Bermuda snails seem to argue for gradational change. The populations, on first inspection seem to grade into each other with a large sample of snails seeming to have graduated from the original population he was studying. However, taking into account not just appearance but also stratigraphy and geography, in other words time and location, it becomes apparent there have been four offshoots from the original population. The full picture of the snail history includes banding and immature features (morphology), where in the red soils and wind blown sands specimens are found (geographical distribution), and how deeply they are buried (time scale).

Eldredge and Gould offer a carnivalised, interdisciplinary approach to the study of mutable bodies and their environments. These scientists are disruptive, moving outside the traditional paleontological framework and interpretations of phyletic gradualism, and compromising one boundary meant challenging other disciplinary boundaries.

When they 'borrowed' allopatric speciation from biology and introjected its ideas into palaeontology, they came up with a model that also had strong resonances of modern panbiogeography.[54] The model they propose includes time, geography and morphology rather than just time and morphology, and shows the history of life as complex and staggered, and the science of the history of life as vulnerable to the limitations of received wisdoms. Contributing further to a sense of disorder, they put the question of macroevolution back on the table, where the new synthesis had used random genetic mutation, natural selection and gradualism to take it off. And they challenge authority by reading the fossil record literally and refusing to accommodate patriarchs, both historical and contemporary, that demand evolution be perceived as orderly and sedate. They resist Darwinism by rejecting one of the prime supports of the natural selection theory, and they antagonise neo-Darwinists by insisting that both punctuated moments of change and great periods of stability in species raise questions of homeostasis, self-regulation of species and organism, mechanisms of differentiation and why those mechanisms work on some isolate populations and not on others. And, of course, they bring the whole Western science project into question with their Kuhnian insistence on contextualising the process historically and around individual scientists.

Since its publication, both Gould and Eldredge have protested about the way that their youthful article has seen them positioned them as anti-Darwinian. They were not trying to undo Darwin, apparently, but rather to tailor the accepted Darwinian model to make it more culturally and scientifically relevant. Both accommodate a certain awareness of the reciprocity of sociocultural values and science. They insistently historicise, with Gould pointing out that the success of Darwinism reflected the radicalism of revolutions in France and America and was underwritten by Victorian expansionism and colonialism,[55] while Eldredge speaks with mild irony on the pioneering and colonial predilections of certain fossilised species:

> The European-North American collision that began about 380 million years ago did more than change the face of the globe: it also grossly affected the face of life in North America. Many of the Hamilton species that were to dominate American life for the next 8 million years were immigrants from Europe and Africa, derived from species living in the early Middle Devonian whose fossils now come from the Rhine Valley in Germany and the desert reaches of what

54 Leon Croizat, *Space, Time, Form: the Biological Synthesis* (Caracas: published by the author, 1962). Chapter 5 of this thesis presents a more detailed presentation of this idea.
55 Stephen Jay Gould, *Dinosaur in a Haystack* (London: Jonathan Cape, 1996), 134.

> was, until recently, the Spanish Sahara. *Phacops africanus*, a species closely related to *P. rana*, is known from northern Africa, and it, several other trilobites and a number of brachiopods, clams and snails simply came in and took over the new habitats that were formed as the inland sea encroached over the continental interior. This "Christopher Columbus" effect was repeated several times in the history of life. The "new world" was the land of opportunity over and over again during the past 600 million years.[56]

Scientifically, punctuated equilibrium proposes a model of branching, non-linear change that connects environment with time and the changing body, both individual and species. Culturally, it expresses the anti-hierarchical sentiments of the 1970s and deliberately disrupts patriarchal pictures of descent in unbroken lines. It also probably mirrors the late twentieth century break up of the nuclear family and the enabling of women with the splitting of 'daughter' species from 'parent' populations, and anticipates the tensions between globalism and local economies and cultures. The theory allows that both the local and larger environments of an organism *and* the organism itself are significant in speciation events, with an emphasis on the rapid change of peripheral isolates. Thus isolation is likely to emphasise genetic drift and foster useful adaptations, but in opportunistic rather than orderly ways. The environment has significance in this evolutionary theory and, potentially, can have great effect upon the organism, but also the organism changes in response *to* the environment. Thus agency is redistributed beyond the gene. Population explosions and widespread colonisations by organisms are also parts of the theory that are coherent with a cultural logic where stability is recognised as the dominant mode for long periods, but the current focus is on rapid and uneven change. Geographical fragmentation and a different experience of the environment for different populations resonate with cultural pluralism and segregated social interests. That scientific theory accepts that the environment contributes to the biological production of an organism mirrors the increasing social awareness that socio-economic factors are highly instrumental in the production and maintenance of various human cultures.

Punctuated equilibrium is a theory which reviews history, in this case the fossil record, in a radical fashion and teeters on the brink of becoming a disruptive post-modernist science, which is perhaps one reason why Gould and Eldredge have tried to keep it firmly under the aegis of traditional Darwinism. Genies, however, are

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56 Eldredge, *Time Frames*, 57.

notoriously difficult to rebottle, and it is hard for Gould and Eldredge to stay on the side of Darwinism after presenting it so ceremoniously for critique into the modern world. The logic of punctuated equilibrium is that it anticipates, in the undoing of gradualism, many of the more radical theories that are now being developed such as neo-Lamarckianism, convergent evolution, panbiogeography and niche biology.

An insistent humanising of Darwin, the man, is a persistent feature of Stephen Jay Gould's work. He has read everything written by Darwin, including diaries, personal correspondence and notes jotted in the margins of papers, but he has also been critical of Darwin's methods and the contradictions that contemporary debate forced out of him in his revisions of *The Origin of Species*. Although his ambivalence towards Darwin cannot be entirely restricted to a psychological reading, it probably can be understood in some respects as a publicly performed Oedipal struggle, conducted within the family of scientists and displayed through the body of Gould's work.

This drama began with Darwin. His passion was studying living things, nature, and he left a rich heritage of ideas. However, he singled out palaeontology, the discipline that worked with the *history* of living species, as a Cinderella discipline. According to Darwin, palaeontologists were destined to deal with inadequate materials. Time and geological processes are against them, working to continually erase the evidence they need to make their research more complete.[57] Darwin held that problematic information – such as the sudden appearance of whole groups of species – had to be explained by the inadequacy of the fossil record or even the poor interpretations of what information was there. This troubled Darwin: his arguments are detailed on the difficulty of measuring geological periods, of tracking geological change, of dating and identifying species that are abundant, of understanding the life spans and generation of species, but his attitude is summed up in this statement.

> I do not pretend that I should ever have suspected how poor was the record in the best preserved geological sections, had not the absence of innumerable transitional links between the species which lived at the commencement and the close of each formation, pressed so hardly on my theory. [58]

It is a circular argument – the absence of the material that could lead to proving or disproving Darwin's theory does not disprove the theory, it only proves its own absence. This is not to say Darwin supported bias with the lack of information. Rather,

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57 Darwin, *The Origin of Species*, 429.
58 Ibid, 432.

he presented palaeontology as a science that would never be a precise; however, he was also nervous of palaeontology and he knew that the failure to find examples of phyletic gradualism through the fossil record was the weak link in his own argument. He says:

> The number of intermediate varieties, which have formerly existed [must be] truly enormous. Why then is not every geological formation and stratum full of such intermediate links? Geology assuredly does not reveal any such finely graduated organic chain; and this, perhaps, is the most obvious and serious objection to which can be urged against the theory.[59]

This was Gould's heritage as a palaeontologist. If the Darwinian theory of phyletic gradualism, the natural selection of traits by a species over a long period of time, held good, then palaeontology could never be anything but a poor relation to biology. This could not be a satisfactory situation to a young palaeontologist who, while he may very well support the Darwinian paradigm, could see it was not in turn supportive of his chosen discipline. At the time Gould entered the field, palaeontology had originally been marginalised by Darwin, and then the processes of evolution had been hijacked by molecular biology and been given an obsessive genetic focus, further alienating study of fossils from evolutionary theorising. To Gould, that would surely have presented a problem.

Pictures of historical change drive Gould, as does a fascination with time and timing, a love of novelty in the world and a refusal to accept orthodoxies of any sort. This makes him a carnival writer on nature, evolutionary science and evolutionary theory. His first full length work, *Ontogeny and Phylogeny* (1977), re-examines Haeckel's law and rehabilitates the idea of recapitulation through heterochrony - radical ways of changing the evolution of the organism by retarding or accelerating developmental processes. This is a story of the carnivalised body, the appearance of the juvenile maintained in the adult (neoteny), the 'other' in the embryonic self (recapitulation), the sexually mature juvenile (paedogenesis), the pregnant juvenile (progenesis), and so on. His last full-length work, *The Structure of Evolutionary Theory* (2002), advocates a multidisciplinary pluralism, embracing all scientific ideas that touch on Gould and Eldredge's open idea of the time/geography/morphology model of change. What he terms 'pluralism' is an attempt to create a new molecular biology/palaeontology friendly synthesis, but this story has limited success. Gould

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59 Ibid, 406.

vehemently resists panglossian, sociobiological stories, [60] subverts scientific orthodoxies of molecular biology, rehabilitates outcast and discarded ideas, insistently historicises both material and theoretical science, explores the grotesque heterochronic body in his study, and popularises the grotesque body in his famous collections of essays that range through topics from the Piltdown hoax to Erasmus Darwin's poetry, and from the evolution of whales to the body of a giant fungus. Gould is a carnival writer from his obsession with the strange material subject to his subversive, resistant theoretical complexity in the community of scholars and his delight in crossing the Bakhtinian footlights into popular communication.

Eldredge, a less flamboyant scientific figure, supports natural selection but argues that it takes place more on the level of species and is not a significant factor in individual lives. His strong criticisms of 'ultra-Darwinist', deterministic molecular biology also anticipate 'post neo-Darwinist' sciences and a more open and problematic model of evolutionary change. Studying trilobite populations and working out that there was not one single morphologically consistent ancestor to be held responsible for the widespread and highly differentiated species, Eldredge says:

> it is rather interesting that trilobites time and again struck on the same body plans, proffering the same basic *Gestalt,* in groups only remotely related to one another. In other words, it seems a near certainty that the Cambrian olenillids had a general mode of life that was exploited once again, hundreds of millions of years later, by the Gondwana trilobites – whose most immediate ancestors did not seem to resemble olenellids at all. Repetition of adaptive themes seems very definitely to be a strong signal in the history of life.[61]

Eldredge's particular approach, also grounded as it is in time, geography and morphology, encompasses convergent evolution, parallelism and niche biology, and foreshadows the important post neo-Darwinist notion of self-organisation in the species, and agency in both organism and environment. Convergent evolution is seen when organisms with a different evolutionary history develop similar adaptations. Examples can be found in Antarctic notothenioid fishes and several northern cods, fish that are barely related and have developed, in completely separate polar environments

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60 Stephen Jay Gould and Richard Lewontin, 'The Spandrels of San Marco and the Panglossian Paradigm,' in *Evolution*, ed. Mark Ridley (Oxford: Oxford University Press, 1997), 139-153. The prompt for this article, which speaks about exaptation – the altered use of already existing structures in organic evolution – was a 'scientific' story about Aztec human sacrifice being a response to a meat shortage.

61 Eldredge, *Time Frames*, 183.

and at different times, nearly identical antifreeze glycoproteins (AFGPs).[62] Parallelism, on the other hand, acknowledges similar developments between related lineages, the classic example being where most common placental animals in Europe like fox, deer and squirrel have a marsupial counterpart in Australia. Complicating these models of evolutionary development is niche biology. Niche biology is a further extrapolation of the thesis of punctuated equilibrium and posits that peripheral isolates may adapt to very specific niches that have not been filled in certain ecologies. An example of this is the unusual growth of Komodo dragons in Indonesia in an ecology that was lacking (and possibly needing?) a large predator on the food chain. These examples are tiny synopses of massively complicated processes and models of mapping the complexities of these sorts of changes are in their infancy still. As Eldredge says, it is impossible at this point to completely define even what an evolutionary unit is. The current belief is that it is a gene or a single organism, but Eldredge says punctuated equilibrium suggests it may be a species, an ecosystem, even a planet. Strongly resistant to reductionism and definitely subversive about the limitations of human knowledge, he participates in the layered stories of carnival that see the potential parameters of the organism through time and space as unexplored, and the environment as dynamic partner of the organism, with an as-yet-to-be-discovered order and as-yet-to-be-understood relationship.

Punctuated equilibrium is a 'post neo-Darwinist' theory. It reopens the field of evolutionary change for debate some twenty to thirty years after the new synthesis tried to shut it down, and it foreshadows new scientific unities and interdisciplinarities, reaching beyond, yet still including, sciences that can be legitimately linked to Darwin Central. Punctuated equilibrium is presently sold as a modified Darwinian narrative, but it is more than that – it is an unravelling story that has undone key threads in the master narratives of both science and Darwinist evolution in the twentieth century. Gould and Eldredge recontextualise the organism within its environment, and they recontextualise science and society as necessarily reciprocal processes. This theory is a major step towards recognising that the study of evolution cannot be maintained as a gene-centred, 'value free' discourse and that any story we tell of ourselves and the world lies at the heart of a web of historical antecedents and current responses that give it dimension across many discourses.

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62 Liangbiao Chen, Arthur L. De Vries, and Chi-Hing C. Chen, 'Convergent Evolution of Antifreeze Glycoproteins in Antarctic Notothenioid Fish and Arctic Cod,' *Proceedings of the National Academy of Science USA* 94 (1997).

Responses to Punctuated Equilibrium

Punctuated equilibrium has been absorbed by a number of disciplines. For example, a simple 'google' search shows how the idea has been appropriated by economics and has also become familiar in political science. Cataloguing the broader cultural appropriations and adaptations of punctuated equilibrium, Gould lists sociology, history studies, pop science (of course!), art history and even self-help books that have used or mentioned the theory. He points out that Isaac Asimov lists punctuated equilibrium as a significant event in the growth of twentieth century knowledge and Michael Kenyon, Stephen King and John Fowles all accord a place in their literary writings to the theory. In literary criticism, Gould says Moretti 'cited punctuated equilibrium to epitomise the history of the epic as a literary genre',[63] while this thesis seeks to engage with punctuated equilibrium and other post neo-Darwinian theories as reflected in the narrative structures of feminist science fictions. This cultural recognition and spread of punctuated equilibrium shows it is not simply oppositional in its appeal, existing as the carnival knockabout antagonist to phyletic gradualism, creationism and/or Dawkins genetic reductionism. It has a transdisciplinary appeal that sees its scientific authorisation of rapid change being appropriated in many different ways by various cultural groups and academic disciplines. In this section, three examples of punctuated equilibrium's effect in different areas will be considered. First will be the debate and changes it has brought to the study of palaeontology itself, second will be a brief consideration of punctuated equilibrium as participant in the science wars and third will be a consideration of punctuated equilibrium in the light of feminist science theory.

Within palaeontology, there are two major accomplishments for punctuated equilibrium. The first is the renovation of the discipline from an apologetic 'stamp collecting' science to one where there is now a sense of theoretical vitality. Rather than relying purely on finessing practical fossil studies, theoretical studies are now a significant pedagogical feature of postgraduate studies in the area, and professionals from other life and earth sciences also engage with questions that punctuated equilibrium generates about species boundaries and the interrelationship of time, geography and morphology. The second accomplishment comes from the actual application of the idea of punctuated equilibrium to paleontological information by practitioners looking to support or contest the theory. Results from the many studies

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63 Gould, *The Structure of Evolutionary Theory*, 972-1024. These are items selected from a long list that Gould gives on the effects of punctuated equilibrium.

are mixed and do not seem to prove either gradualism or punctuation, but the results have generated new discussions, not only on species, but also on 'species selection' as opposed to individual selection.

Species sorting is selection practiced between competing species. That is, this large unit at the top of the hierarchy of genes, individuals, populations and component populations (demes), may well survive and stabilise due to species-specific properties which are as yet unknown. Gould argues that species selection cannot depend on causes of change manifesting from conventionally 'lower' levels of gene and organism. The example he gives is the proliferation of a particular species of snails with a method of reproduction that would normally rate them as 'less fit' on an individual basis, compared to another species with a less costly reproductive process existing in the same time and space. The assumption that the difficult reproductive process would make that particular species more limited than its competitor species simply wasn't proved. An unknown mechanism, in this case, supported a counterintuitive change in species.[64] Prothero, who believes this is the main argument in the evolutionary field at the moment, summarises the major issue of 'species sorting' as a separating out of micro and macroevolutionary processes. Together with Shubin he undoes the gradual descent story of the horse by finding five different but contemporary species in Wyoming fossil deposits.[65] In his study of the Big Badlands of South Dakota this pattern of punctuated equilibrium and species sorting was present for all species except for one.[66] Elizabeth Vrba observed a 'turnover pulse', a major climactic change in Africa that affected speciation through branching and extinction of antelopes, a particularly stable species.[67] She argues, as do Brett and Baird who worked in the Appalachian basin, for patterns of prolonged stasis in linked species, then a process of 'species sorting' in times of change.[68]

These studies raise many questions about species selection that work on a significantly different logic to individual selection. Those unfamiliar with the debate generally assume individual selection to be the primary shaping factor in the life and reach of a species, and of its success as an entity through time. This is not true. The studies actually uncouple the idea of individual selection and species selection. Despite

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64 Ibid, 659-662.
65 Donald Prothero and E.R. Shubin, 'The Evolution of Oligocene Horses', in *The Evolution of Perissodactyls*, eds. Donald Prothero and R.M. Schoch (Oxford: Oxford University Press, 1989), 142-175.
66 Prothero, 'Punctuated Equilibrium at Twenty', 38-47.
67 E. Vrba, 'Evolution, Species and Fossils: How Does Life Evolve?, *South African Journal of Science* 76 (1980), 61-84.
68 Gould, *The Structure of Evolutionary Theory*, 866-867.

an acknowledgement of stasis as a dominant mode, the theory of punctuated equilibrium provokes questions of liminality and the complexities of boundary questions in speciation processes. Is it legitimate, for example, for Vrba to term a million year period in the fossil record a 'pulse'?[69] Reviewing the temporal boundaries of a species also becomes very complicated. How can non-morphological (genetic) species breaks be detected? A species life span is so long, it is difficult to apply the notion of selection to such supraorganisms, particularly when we understand the whole concept of selection as applying to individuals. The only studies on punctuated equilibrium in living species involve microscopic, asexually reproducing organisms, which biases the studies to that particular reproductive mode. Also, such studies prefer naturally unstable subjects, more 'interesting' organisms, over stable ones. Observations drawn from the fossil record are also problematic because demes, populations that are likely to express similar variation, are usually interactive and therefore always unstable as elements of species and difficult to track.

As can be seen, punctuated equilibrium appears to be primarily about gradualism and it would appear it has generated an argument between two interpretations of the fossil record, or as Prothero says, two world views:

> In reading the literature, it is clear that the debaters are talking past each other, since each has a fundamentally different perception of the world. Traditional neo-Darwinists come from a reductionist viewpoint that cannot see species as entities, even after all the evidence that has accumulated. The opposing camp sees the world as hierarchically ordered, with each level having its own reality. As long as this fundamental difference in worldview underlies the argument, neither side will convince the other, even with the clearest possible examples.[70]

Punctuated equilibrium, however, is not simply oppositional. It is a far-reaching story and the questions it raises are numerous and complex. Punctuated equilibrium does not just encourage a revision of one point of Darwinian theory; it challenges many of the smaller stories that were folded neatly inside gradualism and opens them up for examination. As a theory it tips evolution towards paradigm change by acting as a carnivalising force, reshaping palaeontology as a science of boundaries rather than record keeping. Punctuated equilibrium reviews ancestral configurations and bodies,

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69 Richard A. Kerr, 'New Mammal Data Challenge Evolutionary Pulse Theory', *Science* 273 (1996) 431-432.
70 Prothero, 'Punctuated Equilibrium at Twenty', 39.

attempting to find their limits as they spread through space and time. The extended body is a common element of Rabelaisian carnival where symbolic figures of largesse devour feasts big enough to feed small countries, and figures of death might drown armies in urine. An ultimate image of carnival is the pregnant hag – the continuously birthing, dying world that is the territory of the paleontological narrative as it offers patched and incomplete pictures of what has gone in relation to what has followed. Punctuated equilibrium also implicates other disciplines in palaeontology's giant wobble, leading to subversions, arguments and even public drubbings among scientists, those representatives of reason constructed as significant figures of authority in the late twentieth and early twenty-first centuries.

While palaeontology struggles to accommodate the new dis/order generated by punctuated equilibrium, there is a reciprocal hostility between Gould and Eldredge's camp and the genetic reductionism of neo-Darwinism as non-genetic change in organisms and reciprocity of organism and environment start to be foregrounded, and individual selection fails to carry through to species selection.[71] Richard Dawkins, a strident supporter of genocentric evolution, has previously been mentioned in this chapter for framing the argument between gradualism and punctuationism as a religious challenge. In *The Blind Watchmaker,* Dawkins also associates punctuated equilibrium with saltationism,[72] arbitrarily and derogatorily renames the theory 'variable speedism', and completely minimises its importance. These responses are not only indicative of a failure to consider punctuated equilibrium in an open scientific fashion, they also tend to reflect the antagonism expressed with the entry to a game of a problematic player. Punctuated equilibrium changes the landscape of biological sciences and evolution in unpredictable ways and opens up earth and life sciences to cultural debate, and cultural debate in any science is significant within the larger framework of the 'science wars'. In the science wars, 'realists' and cultural relativists are pitted against each other, with realists supporting traditional notions of objectivity and agendas of progress in science while cultural relativists see science as shaped by

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71 In some respects, while punctuation is fascinating in the questions it raises, there are also big questions that need answering regarding the process of stasis. For example, if isolation and climatological factors are part of what triggers speciation, why does it not occur on some occasions when organisms are subject to extreme conditions such as ice ages?

72 Dawkins, *The Blind Watchmaker*, 230-36. Saltationism is the belief that helpful macromutation can occur in a sudden jump. It is usually connected with the ideas of Richard Goldschmidt, who alienated himself completely from the new synthesis when he wrote in 1940 about 'hopeful monsters', mutations leading to the creation of new but viable species.

sociocultural and political agendas, escaping scrutiny under the guise of value free knowledge.[73]

This conflict reached carnival proportions in the 1990s. Gross and Levitt's *Higher Superstition: The Academic Left and its Quarrels with Science*, published in 1994, was a spirited attack on postmodern science studies. This later prompted physicist, Alan Sokal, to submit a parodic article entitled, 'Transgressing the Boundaries: Towards a Transformative Hermeneutics of Quantum Gravity' to a non-refereed cultural studies journal, *Social Text*.[74] The publication was immediately denounced by Sokal as a hoax and he later published on the incident.[75] For 'realist' scientists, this was the intrusion of left wing humanities based science studies in their disciplines, while science studies scholars believed that the 'realist' scientists were not adequately understanding the critical discourses they were criticising. The stoush moved out of the academic arena and into the newspapers, a carnival beating of scholars by scholars that became public spectacle. Although both participants are scientists, much of Dawkin's public antagonism to Gould comes from being a player in the science wars and his rejection of Gould's historical relativist position. Gould also makes his position clear by tilting at the biomolecular bias of evolutionary stories as proposed by the new synthesis. In a carnival the form of conflict is less of a polarisation and more of a brawl.

While punctuated equilibrium is not at the forefront of the battle, Gould's perception of science as historically contingent means he attracts some direct criticism from other participants in the science wars. Michael Ruse has specific problems with Gould and with Gould and Eldredge's theory. A Professor of Philosophy at Florida State University, specialising in Darwinian ideas, he initially rejected punctuated equilibrium on the grounds of Darwin's support of individual selection, as opposed to group selection.[76] He later modified this perspective and acknowledged that punctuated

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73 Writers in the sociology of scientific knowledge that underpin the science wars include pioneers like Kuhn and Popper, and more recent critics, such as Bruno Latour and Paul Feyerabend. Feminist critics used in this thesis include Donna Haraway, Evelyn Fox Keller, Sandra Harding, Karen Barad and others. The primary impetus for the science wars was a challenge to the notion of scientific objectivity, but this has expanded into many broad and specific political critiques of science, and critiques of the divisions between humanities and sciences.

74 A. Sokal, 'Transgressing the Boundaries: Toward a Transformative Hermeneutics of Quantum Gravity', *Social Text* 46/47, Spring/Summer (1996), 217-252.

75 A. Sokal and J. Bricmont, *Fashionable Nonsense: Postmodern Intellectuals' Abuse of Science* (New York: Picador, 1998).

76 M. Ruse, 'Charles Darwin and Group Selection', *Annals of Science* 37 (1980), 615-630.

equilibrium offered a new model of change;[77] however, his analysis of Gould and his work in *Mystery of Mysteries: Is Evolution a Social Construction* looks remarkably like he is delivering a carnival 'thrashing' to Gould. Ruse offers a caricature of punctuated equilibrium as science and punctuated equilibrium's scientific process. According to Ruse, Gould and Eldredge wrote the original paper on punctuated equilibrium to bring prestige to the low status career of palaeontology.[78] In saying this, Ruse reinforces hierarchies of knowledge within science. Also, according to Ruse, the subject of the paper is a demeaning petty squabble in the grand narrative of Darwinism, Gould has never presented anything else of genuine scientific interest, and the original editor of the collection in which the punctuated equilibrium paper appeared had to be 'bullied' into accepting it. Ruse does not consider Gould a scientist in the traditional sense and believes he is not supported by other scientists because his work has not been cited as many times as the examples Ruse chooses to give, such as the controversial father of socio-biology, E.O.Wilson. Ruse mocks Gould as scientist but also brings anyone who gave Gould his certification or accreditation into disrepute. Medieval carnival mocks authorities, according to Bakhtin, so as well as mocking churches and the propertied classes, carnival also mocks the intellectual authority of the Sorbonne. In this case it may be one authority mocking another, but the process is still public and extreme.

This is Kuhn's scientific revolution in action, but there is none of the comfortable clarity offered by historical distance. These exchanges are recent and some of the material in Ruse's attack on Gould is downright unpleasant. Kuhn may well write with detachment about the switch from Ptolemaic to Copernican astronomy, but immediate tussles in science are painful for both the individuals involved and precarious for the process of knowledge construction. Possibly Ruse felt he was paying Gould back in his own coin, contextualising Gould's scientific theory in authorial politics and sociocultural experience, but he works with old and worn dichotomies of personal/professional, private/public and subjective/objective. Ruse claims to be excising 'non-epistemic' factors from Gould's scientific enterprise, but he draws

77 M. Ruse, 'Is the Theory of Punctuated Equilibria a New Paradigm?', in *The Dynamics of Evolution: The Punctuated Equilibrium Debate in the Natural and Social Sciences*, ed. A. Somit and S.A. Peterson (Ithaca, NY: Cornell University Press, 1992), 139-167.
78 M. Ruse, *Mystery of Mysteries: Is Evolution a Social Construction* (Cambridge, Mass: Harvard University Press, 1999), 143. Ruse says, 'Although the study of fossils is the science ordinary people think of first when they think of evolution, in the professional world palaeontology has low status indeed – far below the work of the fruit fly geneticist. All of those years when palaeontology was found less in universities and more in museums, when entertaining or instructing the public was its chief function, when the significant theoretical occupation was making up histories of life, have left their mark.'

attention to Gould's Jewishness, Marxism and his association with Germanic science. This information is biographically relevant, but unless Ruse follows their theoretical 'footprints' into Gould's work, they tell us nothing about the influence of the 'non-epistemic' factors in the science.[79] Ruse affords no insight into the theory *or* the processes of punctuated equilibrium, or Gould's world picture and how it connects to his research. In Donna Haraway's words, he maintains and exploits 'that rupture between subject and object to justify the double ideology of firm scientific objectivity and mere personal subjectivity'. [80]

More needs to be said about responses like these, which represent a significant way in which new knowledge can be received in the scientific culture and in the broader culture. Joanna Russ, feminist science fiction writer, parodies many of the techniques Ruse uses in his attempts to deny legitimacy to Gould as author and scientist. In her case she is specifically addressing the exclusion and denial of female writers, particularly ghettoised feminist science fiction writers. She says:

> *She didn't write it.*
> *She wrote it, but she shouldn't have.*
> *She wrote it, but look what she wrote about.*
> *She wrote it, but 'she' isn't really an artist, and 'it' isn't really serious, of the right genre-i.e. really art*
> *She wrote it, but she only wrote one of it.*
> *She wrote it, but it's only interesting/included in the canon for one limited reason.*
> *She wrote it but there are very few of her.*[81]

Ruse's attacks on Gould exercise a surprising number of the techniques mentioned by Russ that are used to deny agency to women writers, which implies that Gould, and possibly Eldredge, occupy a similar position with regard to patriarchal authority that feminist writers do. Gould, Eldredge, Dawkins, Ruse and others personalise the

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79 Ruse's approach seeks to make connections, but only creates ruptures and raises questions about his own methodology and purpose. One of Gould's stories relates a similar sort of oppositional political energy. Beverley Halstead, a committed British neo-Darwinist, took exception to a dinosaur exhibition at the British Museum that was based on cladistics and wrote a letter about it to the *Times*. In Gould's words: 'He accused – and I swear that I do not exaggerate – the British Museum of foisting Marxism upon an unwitting public in this new exhibit, because cladism can be equated with punctuated equilibrium, and every one knows that punctuated equilibrium, by advocating the orthodoxy of revolutionary change, represents a Marxist plot' (Gould, *The Structure of Evolutionary Theory*, 984). This humorous anecdote fits with carnival in evolutionary theory.

80 Haraway, *Simians, Cyborgs and Women*, 8.

81 Joanna Russ, *How to Suppress Women's Writings* (London: The Women's Press, 1994), 76.

process as they fight about the specifics of interpolating punctuated equilibrium into Darwinism, but social commentators like Russ and Bakhtin politicise their debates in a more global sense. Russ recognises the devalued and feminised position of knowledge that runs contrary to current authority, while Bakhtinian dialogia would read punctuated equilibrium as the 'unofficial consciousness', as opposed to the 'official consciousness' of the new synthesis.[82] Bakhtin uses Freud's notions of the conscious and unconscious, but he resists pathologising the division. Instead, he reads the unofficial consciousness as 'that part of perception governed by social prohibitions and censorship, while the privileged pole exists in accordance with dominant community standards and values'.[83] At first this seems to reinforce the oppositional reading of punctuated equilibrium, but the theory partakes of so many dualisms that any dichotomous argument inevitably collapses into a carnival *melee* at some point. Gradualists versus punctuationists, molecular biologists versus uppity palaeontologists, scientists versus science theorists, punctuationists and molecular biologists versus creationists. The arguments are never simple, and the composition of the defending and opposing teams changes depending on what is being contested. The replacing of the old guard that Kuhn talks about is never clearly 'out with the old' and 'in with the new', or the simple replacement of a bad idea with a good one – *thus* the science wars, *thus* the personal attacks, *thus* the sense of carnival and danger that accompanies these kinds of debates and the reception of challenging ideas.

Feminist science study is a further thread in the discursive potentialities of Gould and Eldredge's theory. Punctuated equilibrium appears to be very relevant to feminist writings in the field of both science and science fiction because it proposes large, rapid changes to organisms and pluralistic mechanisms for that change. However, just how responsive is the theory to the feminist analyses of science, and what are its contribution to gender perspectives in science?

On first inspection, the punctuated equilibrium story seems to be strictly a boy's scuffle. All the major proponents on both sides are male and, historically, palaeontology is not a female-friendly science.[84] Gould and Eldredge have also gone to great pains to keep punctuated equilibrium within the fold of Darwinism and have held academic and scientific positions that have guaranteed their own credibility and

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82 Pam Morris, ed., *The Bakhtin Reader: Selected Writings of Bakhtin, Medvedev, Voloshinov* (London: Arnold, 1994), 44-48.
83 Tess Williams, 'Skywatch: Map of Power and The Cassandra Continuum' (MA Creative Writing Thesis, University of Western Australia, 1998), 611.
84 Lori D. Hager, 'Sex, Gender and Paleoanthropology', in *Women in Human Evolution*, ed. Lori D. Hager (London: Routledge, 1997); see also Gould, *Dinosaur in a Haystack*, 187-201.

legitimacy via the scientific and academic hierarchies. They have also conducted debate in conventional ways, mostly with other prominent male institutional figures, accessing scientific journals and academic and popular press. In fact, the history of the theory itself is such a story of high profile masculinized conflict, it is of interest to wonder how punctuated equilibrium might have fared had it been proposed by female scientists. Would it have generated such controversy and would its science practices have been significantly different?

The October 29th Group from Wisconsin University attempts to construct a model of what feminist science might look like in action in 1989. Firstly, they consider the problematic qualities of masculinist science: nature is perceived as being there to serve man; hierarchy and competition are perceived as predominant forms of interaction in nature and human society; and masculinist science offers abstract absolutes about nature. Sabatini, Witt and the other members of the group also nominate the characteristics of a potential feminist science model: veracity, communality, more democratic, less elitist, results less linked to career structure, more social and environmental responsibility, and an acknowledgement of subjectivity. Idealistically, the group also favours veracity above the pressure to publish, a democratic and communal social structure in science practice, social and environmental responsibility, community participation, and thoughtful rather than fashionable choices of research topics.[85]

Punctuated equilibrium is masculinist in its practice in a number of ways, but also connects with this broad, feminist model at certain points. Dealing with such enormous scale and richness of fossilised life tends to enlarge the perspective of nature and the theory has already been identified as working on boundaries via the constitution of species over time and space. This suggests that absolutes and reductionism are out of place, at least in this particular science. The content of the punctuated equilibrium debate – extinct species – also brings a public focus onto a carnival of 'other', non-human bodies that militates against anthropocentric grandstanding. Both Gould and Eldredge have also taken explicit positions against the neo-Darwinist obsessions with competition and reductionism. Beyond that, the scientific processes of punctuated equilibrium are conducted in, and validated by, a masculinist science community that often fails to stress democratic structures, environmental concerns and community

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85 Patricia L. Witt et al, 'The October 29th Group: Defining a Feminist Science,' *Women's Studies International Forum* 12, no. 3 (1989), 253-59.

participation.[86] Perhaps the most important thing to note, at this point, is that while punctuated equilibrium may not conform to this very specific picture of early feminist science studies constructed by the October 29th group, it takes important steps away from certain problems perceived as being rooted in masculinist models of science.

In different feminist analyses of science, Harding and Haraway focus more on epistemic gender politics. These feminist writers contend that problematic issues like objectivity are inescapable in feminist, post-colonial, class and ethnic readings of science. Both these critics explicitly call for revisions of the parameters of objectivity. Harding's argument is that excluded racial and ethnic groups, and women have particularly revealing perspectives on the problems with science.[87] She says that, therefore, a useful critical detachment (as opposed to objectivity) can be constructed from their perspectives of the 'politics of the obvious'.[88] Haraway similarly places demands upon science itself to acknowledge its inevitable partiality and contingency, and for it to be held accountable and responsible for that partiality and contingency.

> So, I think my problem and 'our' problem is how to have *simultaneously* an account of radical historical contingency for all knowledge claims and knowing subjects, a critical practice for recognising our own 'semiotic technologies' for making meanings, *and* a no-nonsense commitment to faithful accounts of a 'real' world, one that can be partially shared and friendly to earth-wide projects of finite freedom, adequate material abundance, modest meaning in suffering, and limited happiness.[89]

While Gould and Eldredge are not standpoint scientists, they do appear to comprehend standpoint politics within and beyond the scientific community,[90] and recognise that historical contingency is foundational to their scientific process and the theoretical underpinnings of their evolutionary narrative. Their work is predicated on multiple and partial science stories – personal and disciplinary, local and global,

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86 It should however be noted here that Gould frequently witnessed in the court cases on teaching creationism and creationist science in schools.
87 Sandra Harding, 'Feminist Standpoint Epistemology', in *The Gender and Science Reader*, eds. Muriel Lederman and Ingrid Bartsch (London and New York: Routledge, 2001), 145-168.
88 Sandra Harding, 'After the Neutrality Ideal: Science, Politics and "Strong Objectivity"', *Social Research* 59, no. 3 (1992), 567-587.
89 Haraway, *Simians, Cyborgs and Women*, 187.
90 Gould, *The Structure of Evolutionary Theory* and Eldredge, *Reinventing Darwin*. Both books focus on mapping debate in evolution and track the factionalism of the field in the new synthesis debates. Eldredge mainly considers the tensions between 'naturalists' (paleontologists) and 'ultra-Darwinists' (geneticists), while Gould devotes over 1400 pages to acknowledging individuals and finessing their arguments.

historical and contemporary. They are also aware of the connections *between* the various levels of stories that constitute science, but they pay little direct attention to issues of gender and science. Their politics are self-conscious, as they claim their theory speaks from - and to - a twentieth century *zeitgeist* of punctuationism. They say, 'contemporary science has massively substituted notions of indeterminacy, historical contingency, chaos and punctuation for previous convictions about gradual, progressive, predictable determinism'.[91] However, Gould and Eldredge add the caution that a *zeitgeist* is but a ghost, transient and untrustworthy. Both in its radical instabilities and in its transience and untrustworthiness, this *zeitgeist* sounds carnivalesque.

A *zeitgeist* of punctuationism could well be a trickster *zeitgeist* and mimic carnival by representing itself in science and through science to legitimate the disruptive process. Punctuated equilibrium subversively overturns 'science as normal', challenges Darwinist patriarchal thinking, and foregrounds theory and history as driving science practices. However, the politics of punctuated equilibrium may not be simply disruptive. Ironically, while the theory breaks down masculinized practices in science and appears 'feminist friendly' it participates extensively in patriarchal institutionality and it feeds off the deep roots of patriarchal psychologies.

Evelyn Fox Keller says the logic of objectivist thinking, which Harding and Haraway see as a broader cultural phenomenon, is embedded in the psychological narrative of the fearful child who chooses power over the object rather than a loss of sense of self when separating out from the object. She says, 'The (male) child achieves his final security by identification with the father – an identification simultaneously requiring denial of the mother and a transformation of fear and guilt into aggression'. This reading of the scientific process is profoundly Oedipal and results in a disconnection from the feminine (nature), a disconnection that has been identified by Merchant and Bordo in the polarised and sexually problematic languages of foundation science writers such as Descartes and Bacon. These 'fathers' of modern science offer their activities as deeply oppositional to the natural world, which they seek to either control or bypass in their search for inarguable truth (objectivity).

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91 Gould, *The Structure of Evolutionary Theory*, 46. Gould says, 'Finally, my general love of history in the broadest sense spilled over into my empirical work as I began to explore the role of history's great theoretical theme in my empirical work as well – contingency, or the tendency of complex systems with substantial stochastic components, and intricate non-linear interactions among components, to be unpredictable in principle from full knowledge of antecedent conditions, but fully explainable after time's actual unfoldings.'

Gould protests his initial innocence about the challenge that his theory would eventually pose to Darwinism, but the rhetoric of the original paper bears out the reading of punctuated equilibrium as an Oedipal struggle. The unappreciated son, studying the science that the father says can never be a real science, repudiates the father's knowledge with his own. Of course, the story is not that simple. Part of the complication is that, in this carnivalised version of the Oedipal myth, there are multiple fathers that the theory and its practitioners challenge. The fathers of the modern synthesis, Eldredge's ultra-Darwinists, are taken to task along with Darwin, as are populist progenitors of reductionist evolutionary theory such as Richard Dawkins, and also the fathers, leaders of creationist religion, are literally taken to task by the punctuationists before legal patriarchs in the courts.

Keller's feminist psychoanalytic model further identifies the heart of enlightenment and modernist science as a project to undo nature's secrets – particularly those of life and death. Nature is perceived as having a monopoly on birth and death, and she contends that scientists ultimately seek to appropriate that power. To illustrate this she chases down the key priorities of molecular biology and atomic weaponry:

> I want to explore a perennial motif that underlies much of scientific creativity – namely, the urge to fathom the secrets of nature, and the collateral hope that, in fathoming the secrets of nature, we will fathom the ultimate secrets (and hence gain control) of our own mortality. This motif, like mortality itself, has two sides..., both of which are evident through the history of science: They are the search for the wellspring of life, and, simultaneously, forever more effective instruments of death.[92]

Using these criteria, palaeontology is a masculinist science, one of the foremost disciplines dedicated to excavating the secrets of both life and death 'still laid up in the womb of nature'. [93] Fossils tell significant stories of life and death, and the scientific curiosity is deeply aroused by the enigma of the creation of species, the enduring natures of species and the passing away of species. What is more, because fossils present only the 'bare bones' of a story, palaeontologists become fabricators of central myths that guide thinking on origins and change. Gould is fascinated by the explosion of life in the Cambric period, the earliest blossoming of life on the planet. He lovingly documents, in his many popular essays, the extraordinary variety and bodily carnival

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92 Evelyn Fox Keller, *Secrets of Life Secrets of Death: Essays on Language, Gender and Science* (New York London: Routledge, 1992), 40.
93 Carolyn Merchant, *The Death of Nature.* (San Francisco: Harper and Rowe, 1980), 169.

of the finds of that period. However, he knows he chases the deepest mystery, the origin of life, when he says:

> The Cambrian explosion is the key event in the history of multi-cellular animal life. The more we study this episode, the more we are impressed by its uniqueness and of its determining effect on the subsequent pattern of life's history. The basic anatomies that arose during this episode have dominated life ever since, with no major additions – and with subtractions imposed for reasons that may more resemble the luck of the draw that the predictable survival of superior lines. The pattern of life's history has followed from the origins and successes of this great initiating episode.[94]

In a psychoanalytic framework this 'great initiating episode' can be interpreted as the ultimate desire to witness (or reconstruct) the primal scene, the origins of (one's own) birth – certainly a very 'secret' act in this case, one conducted 535 to 530 million years ago. Niles Eldredge, on the other hand, is not only interested in the planet as ultimate progenitor and the excavation of its interior in the search for origins and difference, he is also fascinated by the earth and nature as 'tomb' as well as 'womb'. He is the ultimate scale writer and imbues his readers with a sense of awe regarding the huge planetary parent that, like Chronos, swallows all of its children whole. When contemplating such vastness, Eldredge's language becomes almost eerie and is suggestive of Lovelock and the Gaia theory.

> The possibility that there exist these other, larger-scale entities are perhaps the major gift of punctuated equilibria to the ongoing task of learning more about how the evolutionary process really works. The idea itself – that there are large-scale entities so vast in space and time that we, locked into our humanly scaled perceptions, are scarcely aware of them – has been around for a while. But it forms no functional part of conventional evolutionary theory, which deals only with genes, organisms, populations – and to some narrow extent, species. Punctuated equilibrium above all else suggests that species really do have a concrete reality. Species really are actors in the evolutionary drama.[95]

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94 Gould, *Dinosaur in a Haystack*, 120.
95 Eldredge, *Time Frames*, 185.

Together, the creatures that Gould and Eldredge include in the carnival of evolution via punctuated equilibrium represent a size difference that makes them invisible to humans at either end of the spectrum. Other than the planetary and microscopic, the theory embraces extraordinary and grotesque bodies, varying from the mineralised remains of organic traces that are fossilised bodies, to the indeterminate bodies of species as they stretch through time and space forming strangely composite entities. Punctuated equilibrium does not resolve the mysteries of evolution, rather it increases them exponentially, and, as can be seen, it is not an easily gendered theory. Punctuated equilibrium has loaded what was seen as a relatively uncomplicated cataloguing science with questions about boundaries. A position exists within the punctuated equilibrium version of history for the stable, centralised reality of a dominant and unchanging species, even stable groups of linked species; however, now there is also a place for the vitalising, changeable and liminal. With the focus shifted from exclusively individual selection in evolutionary theory, the scientific frontier moves from the more predictable certainties of genetic and molecular biology back into an arena of interactive organic and inorganic uncertainty. This shift away from reductionism in evolution may possibly reflect a resistance toward entrepreneurial hyperindividualism and a desire to reengage with more democratic expressions of science within the culture. If punctuated equilibrium is to be trusted equally with DNA sequencers, the 'secret of life' is not just a code waiting to be deciphered but is more a wealth of staggered, buried stories of stasis and change, and we will have ongoing difficulty in mapping this story because we are trapped *in situ,* in the species and unable to see or measure the boundaries of species, including our own, from where we are.

On the other hand, that limitation could be an ultimate advantage and is coherent with punctuated equilibrium generating and participating in a more inclusive synthesis, possibly even an ecofeminist synthesis founded on multiple and partial stories that challenge the nature of the knower, and (re)connect the knower, the language and the referent within a new, politicised epistemology of science. Donna Haraway insists upon a world of complete connection. She recognises the complexities of braided stories that involve the organic, the technoscientific, the mythic, the textual, the political and the economic,[96] and she knows evolutionary stories are deeply implicated in this braiding process. Her basic critical tenets are hybridity (cyborg politics and

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96 Donna Haraway, 'Cyborgs and Symbionts: Living Together in the New World Order', in *The Cyborg Handbook*, ed. Chris Hables (New York and London: Routledge, 1995), xii.

body), situated knowledges (partial stories, no transcendence), and diffraction of difference (which allows reconnection in new configurations, as opposed to reflection which does not). The value of Haraway's approach, according to Kirsten Campbell, is that her model of diffraction and situated knowledges ultimately offers opportunities for new connections between human and non-human actants/agents that may take place outside recognised networks of domination.[97] Beyond the politics of feminist science and feminist science studies already mentioned, punctuated equilibrium may also be participating in a radical strand of ecofeminism. Gould and Eldredge's theory could very possibly be assisting in the reconfiguring the 'ontologically disjoint domains of words and things'[98] and promoting a multiagential materialist/discursive practice and study of the history of life.

The story of punctuated equilibrium is a complicated one, requiring extensive reconceptualisations of stories of change by people from all walks of life. It has resonances of the fairy tale about the Emperor's new clothes. That Gould and Eldredge named and supported what they saw in the fossil record is not just a partial story contributing to the grand narrative of evolution, it brought with it factionalism, such as the emperor's courtiers would have inevitably have experienced, and it left the Emperor in an exposed position. Darwinism is the naked Emperor in this carnival story and it is worth thinking about the nature and effect of the revelatory 'truth telling' *act* (as opposed to truth telling *science*) that undid Darwin's original narrative of 'inadequacy' and 'incompleteness' in the fossil record and produced an intelligible theory with potential posthuman connection of language, matter, history and science.

Conclusion

The adaptive/selective metanarrative of Darwinism pervades evolutionary thinking and goes beyond science and biology to become foundational in other significant twentieth and twenty-first century discourses and sites where meaning is produced. Through the popular understanding of science, neo-Darwinism has been universalised and become a form of cultural common sense – the logical extension of Darwinism. This means that Darwinism has often escaped direct interrogation yet it underpins multidisciplinary understandings of evolution and sociocultural perceptions of change.

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97 Kirsten Campbell, 'The Promise of Feminist Reflexivities: Developing Donna Haraway's Project for Feminist Science Studies', *Hypatia* 19, no. 1 (2004), 175-177.
98 Barad, 'Posthuman Performativity: Toward an Understanding of How Matter Comes to Matter', 811.

Historically, Darwinism incorporated a number of significant scientific ideas to become what we understand today as neo-Darwinism: a comprehensive genetically based paradigm of origins and change. The Weismann barrier, Mendelian genetics, population genetics, and biomolecular science progressively shaped its scientific expression, and the modern synthesis hardened Darwinism into problematic neo-Darwinism with its flagship of selfish-geneism. The explicit narrowing and dominance of this story has produced two main sites of resistance to Darwinism itself at this point. The first is religious and the second comes from a multidisciplinary examination of this central evolutionary discourse and its relevance to, and coherence with, the specifics of 'other' scientific stories of change. Thus the master narrative of evolution and its resistances form an odd collection of historically mutated and adapted ideas: traditional Darwinist science and its incorporations; doctrinaire neo-Darwinism; creationist belief and creationist science; and a chorus of secular scientific and cultural commentary on Darwinism. This unstable domain creates a carnival of possibility that leads to scientific 'truth telling', but also to the subversion, inversion and ironising of scientific 'truth telling'. The field is also carnivalised because it is grounded in the material complexities of organisms and their permeable, multi-field, internal and external environments and processes.

While noting the complexities of all these intersections, this chapter has focused on just three particular stories from evolution. The first was the complex relationship of religion and Darwinist evolution, where the mutual borrowings and some of the extremities of both stories were considered. The second section looked at general secular and scientific critiques of Darwinism, and the third considered the most direct challenge to Darwinism in current science, the story of punctuated equilibrium.

There has been over one hundred and fifty years of resistance to Darwinism on religious grounds. However, where the debates may seem polarised between right wing divine creationism and the natural materialism of evolutionary science, this chapter has shown that the politics of both religious and scientific discourses are complicated and often entwine in unexpected ways. Historically, evolution and religion have an intricate relationship that sees them in situations of mutual borrowings as well as antipathy. Creationism, holding to stories of fixity of species, can be read as an expression of the Bakhtinian 'classical' body. For creationism, the body is more likely to be static, closed and masculinized, as it is the living expression of patriarchal divine will and perfection. However, in the increasingly secular environment of Western culture this can be difficult ground to hold. Thus creationism has its own carnival response to the

dilemmas produced by science – it counter-colonises science, appropriating scientific concerns with evolution, and investing those scientific concerns with a nostalgic politics. The nostalgic politics of this discourse seeks the reinstatement of an ultimate fatherly authority and an uncomplicated origin narrative.

This process is less simplistic than it sounds because, even though creationism cannot forge ideological links with science, it does forge links with critical 'truth telling' through contemporary scientific narratives that seek to challenge Darwinism, and through its own invented 'scientific' discourses like intelligent design. As well as critiquing creationist science, this chapter has also encouraged a re-evaluation of the religious content of Darwinism, and an appreciation of the borrowings from religion by evolutionary science. This reciprocal borrowing by creationism from science and Darwinism from Christianity lends a carnival dimension to this debate that points to the necessity of cultural and political critique in this specific field.

Beyond religious resistance to Darwinism, some scientific and secular commentators believe the field has so many anomalies gathering that it is in a state of crisis,[99] some believe it is important to identify the stakeholders and map the field,[100] and some offer what they believe are new ways of unifying the anomalies such as complexity theory, chaos theory and emergence.[101] All of these approaches have contributed to a carnival of ideas and positions in evolutionary theory, sometimes marked by extremity, and sometimes by odd hybridities. The second section of the chapter briefly treated general resistance to Darwinism and shortcomings in the theory of natural selection, particularly in the light of problems this introduces into specific disciplines that contribute to evolutionary science and theory. Many of the disciplines that now have problems with Darwinism either did not exist in Darwin's time, such as microbiology, or they have changed significantly, such as biogeography, which has become the multidimensional *pan*biogeography. Darwinism is a non-specific, generalised narrative that can skew focused disciplinary stories, and taking issue with Darwinian precepts can result in a marginalisation of significant ideas in a scientific field that is generally reluctant to move away from the central selectionist/adaptationist paradigm.

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99 Denton, *Evolution: Theory in Crisis*; Reid, *Evolutionary Theory: The Unfinished Synthesis*.
100 Eldredge, *Reinventing Darwin*; and Gould, *The Structure of Evolutionary Theory*.
101 Mae-Wan Ho, 'On Not Holding Nature Still: Evolution by Process not by Consequence', in *Evolutionary Processes and Metaphors*, eds. Mae-Wan Ho and Sidney W. Fox (Chichester: John Wiley & Sons, 1988); Ho and Saunders, eds, *Beyond Neo-Darwinism*; Wesson, *Beyond Natural Selection*; Reid, *Biological Emergences*.

Punctuated equilibrium, addressed as the final section of this chapter, is one resistance to Darwinism that has had a significant impact. This is because it does not set itself so much against the neo-Darwinist genetic science of the new synthesis that has emerged from Darwinism; rather, it challenges the central Darwinian precept of gradualism. According to Darwinism, random mutation and selection only work to change species through ancestral pathways if done gradually. Rapid change implies saltation, the instant creation of new species, which is not acceptable in current biological thinking. Punctuated equilibrium, however, argues from the fossil record that change in phylogeny, or speciation, is not always gradual but can occur rapidly. Punctuated equilibrium attempts to stay within the aegis of Darwinism, but it actually destabilises one of its central tenets, and it brings boundary issues and resonances of carnival to a debate focused on the momentum of change in species. Punctuated equilibrium is a culturally rich science site and is examined in this chapter as a paleontological contribution to evolutionary thinking; however, it is also examined as a potentially feminist disruption to a dominant, masculinist master narrative. Punctuated equilibrium suggests itself for feminist analysis with respect to being an Oedipal challenger in the grand narrative of Darwinism, and it suggests itself for ecofeminist analysis in its earth-centred practices of palaeontology, its acknowledged partialness, its self-conscious discursive/materialism and its multi-agential realist approach to species emergence and creation. In the words of Karen Barad, this theory is part of a 'world making itself intelligible'.[102]

Punctuated equilibrium is one of the stories used in this thesis, together with other evolutionary theories and sciences, to support a larger ecofeminist model of multiple and partial stories that speaks to the postmodern imagination on change in biology and culture. It is a big theory that acts as an unravelling story for Darwinism. Once gradualism is challenged, other major ideas of Darwinism become imperilled. The heart of this unravelling process does not lie with invalidating scientific information and interpretation. It lies with accepting evolutionary science as interdisciplinary, culturally produced and emergent, and evolutionary theory as decentred, destabilised and multivocal. Linking bodies, science and theory in performative understandings of discursive sites/practices, punctuated equilibrium could be included in the range of 'post neo-Darwinist' theories collected in Chapter Five of this thesis, but it has been considered here due to its particular impact on Darwinism.

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102 Barad, 'Posthuman Performativity: Toward an Understanding of How Matter Comes to Matter', 89.

These three sections in this chapter – Darwinism and religion, secular and scientific critiques of Darwinism, and punctuated equilibrium and its eco/feminist potentials –draw attention to the complexities and ambiguities of discourse and discipline in this area. Together, they appear foundational to a carnival of life science. In this carnival, Darwinism is challenged by its own complicated cosmogenic origins, by numerous disciplines grown and developed beyond its original reach, and by multiple stories and perspectives arguing for the multiple material fields of the organism/environment or the properties and processes of the organism/environment. Considered together, even these three stories alone begin to undo the classical, closed bodies of life and life sciences as they have been historically imagined. They do not, of course, completely undo traditional Darwinism, but they are congruent with demands for a less controlled/ing authoritative view of nature and for a different sort of intelligibility to the stories science tells about itself and the material subjects of its stories.

Chapter 3
Genes-R-us

One consequence of such skepticism about the older internalist theories of knowledge appears in the shift from the old to the new objectivity question. The old one asked 'Objectivity or relativism? Which side are you on?' The new one takes this question itself to be a topic of discussion – a historic and epistemic problem to be explained. The new one is still directed toward many of the concerns addressed by the older question: Which of the competing grounds for claims about nature and social relations should we prefer? How can we block 'might makes right' in the realm of knowledge production? How can we systematically identify widespread cultural assumptions about both nature and social relations, and the social projects that generate them, which have distorted so much of what heretofore has passed as universally valid scientific knowledge? However, the new objectivity question takes the status and underlying assumptions of the old objectivity question also to be one of its problems. It asks, what should be rejected and what saved of the older objectivism? How can the notion of objectivity be updated so that it is more useful for contemporary attempts to understand nature and social relations?

Sandra Harding[1]

It comes down to this: the competing allure of an essentially reductionist stance – with its charms of apparent simplicity and elegance – versus a partitioning of complexity into component systems – the naturalistic theory edifice that, while perhaps not as neat, seems to me a more accurate description of actual biological systems.

Niles Eldredge[2]

To destabilise a story field, one must do many things, such as write computer programs, argue for different data collection protocols, take photographs, consult on national science policy bodies, write high school texts, publish in the right journals, etc. Even to imagine destabilizing stories, one must be formed at a social moment when change is possible, when people are producing different meanings in many other areas of life. Destabilization is a collective undertaking. Within the altered field structure, new dominations are possible, but so might be something else.

Donna Haraway[3]

Introduction

This chapter focuses predominantly on genetic reductionist argumentation in sociobiology and neo-Darwinism. Neo-Darwinism at its most dogmatic suggests that evolution is a perfect biological sorting process, and promotes the idea that currently-existing members of species represent a pinnacle of perpetually successful organic adaptation. Extending this premise, sociobiology argues that much animal behaviour, including human behaviour, reflects this sorting and selection process and therefore behaviour is likely to have a genetic basis.[4] While it is reasonable to assume some

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1 Sandra Harding, *Is Science Multicultural? Postcolonialisms, Feminisms, and Epistemologies* (Bloomington: Indiana University Press, 1998), 128.
2 Eldredge, *Reinventing Darwin*, 226-227.
3 Haraway, *Primate Visions*, 303.
4 E.O. Wilson, *Sociobiology: The New Synthesis* (Cambridge, Mass.: Harvard University Press, 1975); E.O. Wilson and C. Lumsden, *Genes, Mind and Culture: The Evolutionary Process* (Cambridge, Mass.: Harvard University Press, 1981); Richard Dawkins, *The Extended Phenotype: The Long Reach of the Gene* (Oxford: Oxford University Press, 1982). See these texts as primers for this notion.

kind of link between genes and behaviours, the boundaries of such research and its applicability to humans and their behaviour present many problems. This chapter will address some of the problems of the sociobiological approach in both animal and human studies by looking at issues with respect to constructions of scientific authority, rigour in interdisciplinary accounts of gene linked behaviour and the particular rhetorics of sociobiological language.

While the extremities and demands of genetic reductionist stories promote an unraveling of much deeper, epistemological elements of modernist science and thought, the case of sociobiology specifically sounds alarms on issues of scientific authority. Authority is an issue in this discipline because of how it is conferred, taken or perceived by both advocates and opponents of the extensive narratives of sociobiology. Because the field is so multivalent and complex, this chapter focuses on only a small number of the initiators and contributors to sociobiological discourse, but it reveals them as ambiguous, carnivalised figures through the complexities of their scientific and writerly credentials. The three main scientists discussed are the founder of the discipline of sociobiology, E.O. Wilson; neo-Darwinism's most strident advocate, Richard Dawkins; and feminist sociobiologist, Sarah Blaffer Hrdy.

Wilson and Dawkins have the intriguing double effect of presenting as high-level authorities and respected scientific thinkers to the public and their peers, yet in a 'carnival' critique, using Bakhtinian theory, they can also be perceived as caricaturing scientific authority. Ironically, while both seek to extend the 'value free' scientific model and discourse into the social sciences and humanities, they instead provoke questions and critical responses to biology and scientific history from scholars of many disciplines, including the sciences. With Wilson the resistance is due to his nostalgic politics, his desire to maintain patriarchal and colonial values, and with Dawkins it is due to his antagonistic politics, specifically his desire to confront any form of religious belief with materialist genic accounts of the origin of the living world. The particularised carnival reading of Wilson in this chapter also reveals the permission his interdisciplinary sociobiological model offers for hostile, opportunistic, social reductionism and the failure of critique in his sociobiological language. The particularised reading of Dawkins is different. He is king of the publishing pile on populist evolutionary theory, but his reductionist position drives him into difficult semantic cul de sacs. His genes/memes model illustrates a reductionist desire to atomise human experience, not just biology, and a desire to protect his own extreme atomized interpretation of knowledge. Both these practitioners call on gene-based

understandings of behaviour, but the problematics of their positions are evident through examination of their attitudes to science and its capacities, the way their work invites a development of political extremity and the androcentric, ethnocentric speech they use to produce their science.

Sarah Blaffer Hrdy is different. She is also a doubled, carnivalised figure in her dealings with the discourse of the socially manifest gene, and the way it can confuse objects of study with subjects in question. Her carnival character identity and writing is, however, quite different from both Wilson and Dawkins. Her sociobiology is gene based and conventionally produced through an interdisciplinary interest in the primate body, but she practices political resistance with her insistent focus on female sexual and reproductive strategies. Like Wilson, she works through a composite methodology, but her subjects and politics present direct challenges to nostalgic, androcentric conceptions of animals, humans and human culture. She is a feminist primatologist/ anthropologist/psychologist/sociobiologist who uses and subverts the gene/behaviour link and her language demonstrates disciplinary particularity, an awareness of multiple agency and an appreciation of cultural/social context. She, a writer with a carnivalised identity, creates a carnivalised primate by confronting masculinist science stories with narratives of the sexually pro/active female and the endangered/valued infant. Hrdy is a subversive figure, a scientist who appears conservative but deliberately complicates neo-Darwinist stories of dominance and selectionism.

The final section of the chapter will look at the carnival identity of sociobiological theory in broad terms. Sociobiology is commonly hijacked by conservative and reductionist agendas, political and scientific, but it is also a wild card in a postmodern circus of ideas. Here, I read sociobiology as also having the potential to destabilize traditional discourses at a profound level. Producing high indignation when it 'naturalises' personal, social and institutional oppressions of class, race, ethnicity and gender, this discipline also offers a critical pathway out of other, more closed and difficult scientific enlightenment dualisms such as those of mind and body, human and animal. After considering problems of scientific authority, the challenges of interdisciplinarity and language and the construction of sociobiology and its subjects, this section will address the place of sociobiology in epistemological 'undoing'. Sociobiology argues that there is an undeniable connection between bodies, particularly genes, and society and culture and that humans are not 'special case' biology. In a carnival/cyborg boundary challenge, sociobiology rejoins what religion put asunder, humans with animals, and claims humans are just as much at the mercy of

their biology as any other mammal. Therefore, sociobiology may represent not just a carnival problem of legitimacy and boundaries, but also a viable attempt to renegotiate Cartesian binarism and anthropocentrism in late capitalist western culture. Looked at in this way sociobiology is not only a problematic, politically conservative, patriarchal science, it is also a potentially powerful tool to be co–opted in creative ways into critical revisionings of scientific and cultural evolutionary stories.

The reductionism of evolutionary theory

Contextualising neo-Darwinism within the field of evolutionary theory, it is important to recognize the growing hold of the didactic 'ultra–Darwinists'. Niles Eldredge sees the evolutionary field as currently dominated by splits between naturalists/ paleontologists and geneticists, but he recognizes other stakeholders such as creationists and ecologists.[5] Robert Reid describes the 'paradigm drift' from an evolutionary understanding that included neo-Lamarckianism, mutation and emergentism in the early twentieth century, to the restrictive population/gene model of modern synthesis that he largely attributes to Ernst Mayr.[6] Steven Jay Gould agrees with Reid on this and documents the history in more detail. He contends that the fifty year celebrations of the publication of *The Origin of the Species* held at Cambridge in 1909 was still a time of pluralism and openness in evolutionary theory, with most attendees agreeing that Darwin had made an invaluable contribution to the field, confirming the reality of biological change, but generally arguing that Darwin had overrated natural selection in positing it as the main mechanism of evolutionary change. According to Gould, by 1959, when the centennial celebrations were held, the picture had changed completely.[7] The Chicago conference of that year was attended by prominent twentieth century evolutionary scientists such as Ernst Mayr, John Maynard Smith, Theodore Dobzhansky, Ledyard Stebbins and other scientists who would soon go on to build their reputations either by their adherence to, or their deviations from, a rigorous adaptationist, random mutation program.[8] Intolerant of any ideas in evolution

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5 Eldredge, *Reinventing Darwin*, 35-40.
6 Reid, *Biological Emergences*, 27-65.
7 Gould, *The Structure of Evolutionary Theory*.
8 Gould, *The Structure of Evolutionary Theory*. Gould discusses the panel that met in Chicago in 1959. With hindsight he comments on how restrictive the paradigm had become: 'Of the panel's stated agenda of 16 points, only one even hints at non-adaptive phenomena, and only as an adjunct to selectionist orthodoxy' and of the individual scientists who attended, he remarks that the 'lone and very gentle doubter', E.C. Olsen, ventured some comment, but his words were not considered (559). Further, he discusses Sewall Wright's marginalization by new synthesis scientists, due to his theory of genetic drift in populations (522-24), and claims G.G. Simpson was the 'whipping boy' of the modern synthesis because of his saltationist theories,

that diverged too much from adaptation as the singular driving mechanism, this famous contingent had already contributed to the historical narrowing and hardening of evolutionary thought by completely rejecting any theory that might entertain saltationism, the belief that speedy, viable macromutation is possible. [9] They also rejected orthogenesis, the belief that evolution 'proceeds along defined and restricted pathways because internal factors limit and bias variation into specified channels'[10] and labelled Lamarckianism as 'heresy'. They had then built on adaptation and selection as the central evolutionary mechanism, becoming fixed in their emphasis on natural selection, especially at the level of the individual organism.[11]

A slight, fairly specific disciplinary loosening occurred somewhat later in the 1960s and 1970s with a growth in contributory studies and related fields. Scientific surveys multiplied in animal behaviour, particularly primatology, and popular science texts focused on human evolution, opening the debate of origins to a wider community.[12] The publishing industry backed a winner as scientists of different stripes and educated lay people began to participate in broad based bookologues,[13] following and/or creating

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even though saltationism only formed a small part of his scientific output (528-531). See also Reid, *Biological Emergences*; Reid points out that Julian Huxley was specifically excluded from this conference by Ernst Mayr, despite originally proposing a synthesis of ideas, because he was considered too soft on non-adaptationist thinking (39).

9 Gould, *The Structure of Evolutionary Theory*, 557. Gould quotes Ernst Mayr with respect to saltationism: 'The few dissenters, the few who still operate with Lamarckian and finalistic concepts display such colossal ignorance of the principles of genetics and of the entire modern literature that it would be a waste of time to refute them.'

10 Ibid, 352; also Richard Dawkins, 'The Evolutionary Future of Man: A Biological View of Progress', *Economist*, 1993, 87. Dawkins' explanation is that 'It was once fashionable for biologists to believe in something called orthogenesis. This was the theory that trends in evolution constitute a driving force and continue under their own momentum. The Irish Elk was thought to have been driven extinct by its huge antlers, which in turn were thought to have grown bigger under the influence of an orthogenetic force. Perhaps initially there was some advantage in larger antlers and this was how the trend started. But, once started, the trend had its own internal unstoppability, and, as the generations went by, the antlers continued inexorably to grow until they drove the species extinct. We now think that the theory of orthogenesis is wrong. If a trend is seen towards increasing antler size, this is because natural selection favours larger antlers. Individual stags with large antlers have more offspring than stags with average-sized antlers, either because they survive better (unlikely) or attract females (probably irrelevant) or because they are better at intimidating rivals (likely). If the trend appears to persist for a long time in the fossil record, this indicates that natural selection was pushing in that direction for all that time. Metaphors like "inherent force" and "inexorable momentum" have no validity.'

11 Gould, *The Structure of Evolutionary Theory*, 524-541. Gould reads early and later writings of Dobzhansky, Simpson and Mayr to track the move from a more tentative model of adaptationism to one which leaves no room for other mechanisms to work in a species over time other than random genetic change and natural selection on the oranismic level.

12 Haraway, *Primate Visions*, 127.

13 Gould, *The Structure of Evolutionary Theory* and Eldredge, *Reinventing Darwin*; both comment that the writing of books, rather than the publication of journal articles is the way that debate is conducted in the field of evolutionary theory. This accounts, to some extent, for the

different threads of practice and theory within evolutionary debate and generating a carnival of position and belief. This tightly knit, reactive process made (and still makes) it difficult to track all subsequent development of ideas, their intersections and much of the subtle differentiation of thought that occurs in this prolific, multidisciplinary, personality driven field. Yet for all this exploration and evolutionary reflection, the grip of the central tenet of the modern synthesis – adaptation and selectionism – tightened. According to this tenet, random mutations are selected for in all populations and this process works at the level of the individual: evolution is resolutely adaptationist. The result has been escalating polarization of scientific opinion, a degree of media spectacle, and a long and arduous struggle that has engaged some of the best minds of the century for decades. On one side are figures such as Steven Jay Gould, Richard Lewontin and Niles Eldredge, who have all drawn back from rigid neo-Darwinian interpretations of adaptationism and selectionism to a more pluralistic perception of change. In this particular battle, they face heavyweights such as Ernst Mayr, E.O. Wilson, John Maynard Smith and Richard Dawkins, scientists who have enthusiastically embraced the neo–Darwinian model, going so far as to tie much of human behaviour and culture directly to genetic selectionism.

This polarizing process has its most direct genesis in the 1962 writings of Vero Wynne–Edwards. He wrote on 'group selection', a theory that shifted the mechanism of competition from a purely individual level to one that involved populations in the same species (demes), noting that demes experience colonization and extinction at a roughly balanced rate through history. Wynne–Edwards contended that in 'interdemic selection' there were two points of vulnerability for a population – the first at the time of colonization, when the population was young and trying to establish itself, and the second when the population was older and had reached the carrying capacity of its environment. The paradox this presented was that while a population experiencing the vulnerability of overload was best served by the mechanism of competition and survival of the fittest, a population that was vulnerable as it established itself was best served by altruism between individuals. Within the adaptationist program,

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skewing of popular understandings. For example, the mass paperback publication of Daniel Dennett's *Darwin's Dangerous Idea: Evolution and the Meanings of Life* (New York: Simon and Schuster, 1995) capitalizes on the simplicity of the genocentric adaptation program, while scientist who are trying to finesse ideas are usually less popular and confine themselves to journal publication.

Wynne–Edwards had pointed out contradictory drives and a mechanism was needed to connect the two.[14]

Wynne–Edwards had put his finger on the big issue of sociobiology when he proposed self–sacrifice of both survival and fertility as mechanisms for keeping populations below crash level,[15] but the idea failed to strike a sympathetic chord with those who supported competition and individual selectionism. George Williams refuted Wynne–Edwards by saying that group selection was an overly difficult model when a simpler and – most importantly – more parsimonious theory could be had by using individual selection alone.[16] Following in the footsteps of population geneticists J.B.S. Haldane, R.A. Fisher and Sewall Wright, Bill Hamilton worked out a genetic resolution to the 'problem' of altruism, using 'fitness' of the organism as a guide. According to his theory, individual selection is supported by 'kin selection' and fitness takes three forms. Firstly, 'direct fitness' is the fitness of the individual, gained through the production of offspring. 'Indirect fitness' is a component of fitness gained from the aiding of non-descendant kin, such as siblings, and 'inclusive fitness' is the combination of both direct fitness and indirect fitness.[17] Hamilton's paper was mathematically based and assumed the primary drive would be for the organism to trade moderately altruistic behaviour for an increase in fitness.

Kin selection – the argument that offered notions of direct, indirect and inclusive fitness – then became the more acceptable platform for further development of evolutionary discussion. Bob Trivers looked at the problem that natural selection raised of accounting for acts of altruism between unrelated individuals and why altruism pays off for humans,[18] and Maynard Smith combined game theory and evolutionary theory

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14 J. Maynard Smith, *Did Darwin Get it Right? Essays on Games, Sex and Evolution* (London: Penguin, 1989), 54. Maynard Smith summarises Wynne-Edward's theory: 'Animal populations rarely outrun their food supply and starve, because their numbers are usually regulated behaviourally; animals refrain from breeding before their numbers rise too high. To bring this about, special "epideictic" displays have evolved that signal to individuals the density of the population. These displays form the basis of social evolution.' This means that natural selection would act to favour populations and not only individuals.

15 Wilson, *Sociobiology: The New Synthesis.* Wilson claims altruism is *the* problem in sociobiology. See also Ullica Segerstråle, *Defenders of the Truth: The Sociobiology Debate* (Oxford: Oxford University Press, 2000), 40. Segerstråle says, with regard to the altruism issue, that Wilson was actively wanting to couple his moral and scientific concerns as part of his long-term sociobiological project.

16 George C. Williams, *Adaptation and Natural Selection* (Princeton, NJ: Princeton University Press, 1966).

17 William D. Hamilton, 'The Genetical Evolution of Social Behaviour I' and 'The Genetical Evolution of Social Behaviour II', *Journal of Theoretical Biology* 7 no. 1 July (1964) 1-16, 17-52.

18 R. L. Trivers, 'The Evolution of Reciprocal Altruism,' *Quarterly Review of Biology* 46 (1971), 35-57. Trivers looks at altruism cross species with altruistic advantage declared for fish

to argue that co–operation (such as that between two lions guarding a pride together) is an evolutionary stable strategy (ESS), that enhances species survival (the two lions produce more offspring than one beleaguered one would).[19] Trivers then went on to look at what would also become a central issue in studies of animal behaviour, parent-offspring conflict – and Hamilton reformulated his theory of kin selection to include group selection by calculating larger patterns of relatedness between individuals. [20] This gene-dependent, adaptationist, strategic selfish/altruistic model of understanding evolution and animal and human interaction forms the heart of neo-Darwinist/ sociobiological thinking. Within its own parameters it is supported by the logic of math; however; it very often fails to account for itself as a sociocultural discourse driven by historical and current politics, and its interpretations can suffer depending on the language used to promote it. To contextualise the basic ideas, it is necessary to look at other commentaries.

Ullica Segerstråle contributes a brief but interesting observation on the wider cultural shaping of this dialogue in her comprehensive study of the sociobiology debate. She says the concerns and most of the arguments for altruism were generated by British scientists in response to an American insistence that the focus of evolutionary change was firmly fixed with natural selection at an individual level.[21] It is enough of a national distinction, in this case, to note that history and social attitude were probably being affectively expressed through the evolutionary science of the two nations. The British scientific brotherhood was still, to some extent, servicing proper Victorian notions of public responsibility – which had been one response to the dreadful poverty that had accompanied the industrial revolution – while America was definitely moving to more fully embrace entrepreneurial capitalism and the cult of the individual.[22] However, the vested interests of evolutionary thinking can be pursued even further to reveal reflexivities and complexities that suggest subversive upsettings

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that are cleaned by smaller fish, for calling birds with warning calls in 'open' populations of birds, and for humans living a long time and in small groups that can accumulate altruistic debts, sometimes with interest.

19 J. Maynard Smith and George R. Price, 'The Logic of Animal Conflict', *Nature* 246 (1973), 15-18.

20 R. L. Trivers, 'Parent-Offspring Conflict', *American Zoologist* 14 (1974), 249-264; W. D. Hamilton, 'Innate Social Aptitudes of Man: An approach from Evolutionary Genetics', in *Biosocial Anthropology*, ed. R. Fox (London: Malaby Press, 1975), 133-153.

21 Segerstråle, *Defenders of the Truth*, 134-155.

22 The exceptions to this rule are so strong that they may possibly be regarded as the 'shadow' figures of their cultures. Engaging in very public battles over genocentric Darwinism were Richard Dawkins, privileged Oxford don, who argued passionately for the 'selfishness' of the evolutionary process, while American Stephen Jay Gould, committed Marxist, argued for pluralism and multiple mechanisms of change and different measures of 'success'.

of disciplinary mythologies and a significant carnivalising of scientific process that seems – at times – parodic.

Supporting the reading of science as a social activity, as opposed to a form of absolute knowledge, Evelyn Fox Keller says that, '[o]n every level, choices are ... made that are social *even* as they are cognitive and technical.'[23] She analyses gene-based molecular biology, core to the new synthesis, together with military science, arguing specifically that westernized, masculine, psychological anxieties about controlling nature drive the partiality for, and development of these sciences. Thus it could probably be argued that sociobiology naturalises the behaviour of sociobiological scientists as a 'kinship' group, one that is formed through shared history, knowledge and a certain kind of privilege, and one which then maps its own processes on all other social groups it considers, including other forms of organic life. Sociobiologists argue the inescapability of genetics and analyse genetic self-interest as game strategy. Is it viable, then, to argue that kinship is not just a mathematical construct for some scientists. Rather, it is a metaphor that allows them to comment on the processes of science in an almost satirical fashion. Competition was and is a key driver for most scientists. Scientists must compete for grades, scholarships, positions, grants, publication and public credibility, so is it a surprise that sociobiologists, explicator's of the biological basis of behaviour in all species, see competition everywhere they look? Scientist Peter T. Saunders presents the issue in this way:

> [W]e might ask whether it is perhaps not entirely surprising that some of us who have done considerably better than the average inhabitant of this planet would be attracted to a theory which ascribes so much to our genes, thereby reassuring us that our favoured position is largely a consequence of our innate superiority rather than merely a reflection of the much better than average environment in which we have had the good fortune to be raised.[24]

Donna Haraway's revealing research speaks to kinship in science by identifying male progenitors and patrilines of disciplinary knowledge, and the feminist 'daughters' that challenge the father's thinking. And Kuhn's notion of scientific revolution acknowledges the Oedipal struggle of the 'old guard' of science refusing to cede to new knowledge and new practitioners. In such a gendered and intergenerational competitive situation, it is very important to understand altruism as a modifier. What is

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23 Keller, *Secrets of Life, Secrets of Death*, 26.
24 Peter T. Saunders, 'Sociobiology: A House Built on Sand?' in *Evolutionary Processes and Metaphors*, ed. Ho and Fox, 289.

the benefit in researchers working with each other and sharing their territory? Could scientists and scientific successors be perceived as parent-offspring competition? And has the advent of women's liberation and the issues of women in science, and the female as object/subject of study, provoked the acute masculinisation of many neo-Darwinist and sociobiological stories? Ruth Bleier believes so, extensively documenting the preference for stories of male promiscuity and the naturalization of male dominance in neo-Darwinist and sociobiological stories and pointing out the neglected stories that would serve feminist interpretations of nature.[25]

This chapter, however, argues that sociobiology and neo-Darwinism, with their dominating concerns of selfishness and altruism, travel beyond intergenerational and feminist conflict narratives into the material and discursive dimensions of carnival. Discursively, this argument is supported by looking at examples of constructions of authority and some of the particularities of language found within some of the many narratives that contribute to the composite nature of sociobiological and neo-Darwinist thinking. Materially, following the discourse, we find skeletons in closets,[26] certificated academics resurrecting racist phrenology, evangelical scientists, infanticidal primates, termite monarchies, seagull nuclear families, nature's favouritism for blue-green algae, and paranormal sciences (memetics) built around fantasy particulate carriers of knowledge in the infosphere. Looked at this way, sociobiology and neo-Darwinism range from their politically conservative roots into a capacious, inclusive caricature of the 'Theory of Everything' (TOE), but through carnival analysis they also become unraveling discourses that contribute to their own criticism as well as acting as their own propaganda.

E.O.Wilson as ringmaster

With the centrality of issues such as competitive survival and altruism, and the way the scientific dialogue was conducted, there was a certain inevitability to what came next. It was not so much a man with an unusual idea or insight, it was more a man in the right place at the right time and prepared to take a bolder step than others in the

25 Ruth Bleier, *Science and Gender: A Critique of Biology and its Theories on Women* (New York: Pergamon Press, 1984).

26 These skeletons are professional. See W. Provine, *Sewall Wright and Evolutionary Biology* (Chicago: University of Chicago, 1989). Sewall Wright believed that drift was an important part of the evolutionary process and split from R.A. Fisher and B.S. Haldane over this point. They went on to support the new synthesis argument of natural selection as the primary force in evolutionary development, while Wright became academically isolated over his 'shifting balance' theory in genetics. Gould's identification of Goldschmit as the whipping boy of the new synthesis and Reid's note of Huxley's exclusion from the modern synthesis have already been mentioned in footnote 8.

field. In 1975, E.O.Wilson broke new ground when he published *Sociobiology.* The coffee table-style text offered a comprehensive summary of animal behaviour studies but it contained a crucial chapter that became problematic for many science practitioners and for anyone with an interest in, or reservations about, sociobiological speculation. In this chapter Wilson appropriates anthropology into biology, connects social patterns of behaviour in humans with genes and makes authoritative statements, in scientific language, that naturalise class distinctions and ratify a history of sexual discrimination against women and possibly homosexuals. He also makes universal naturalizing statements about family structure that are clearly linked to capitalist and patriarchal models of society:

> Perhaps the earliest form of barter in early human societies was the exchange of meat captured by the males for plant food gathered by the females. ... Fox (1972), following Levi–Strauss (1949), has argued from ethnographic evidence that a key early step in human social evolution was the use of women in barter.

And

> The building block of nearly all human societies is the nuclear family (Reynolds, 1968; Leibowitz, 1968). The populace of an American industrial city, no less than a band of hunter–gatherers in the Australian desert, is organized around this unit. ... During the day the women and children remain in the residential area while the men forage for game or its symbolic equivalent in the form of barter or money. The males cooperate in bands to hunt or deal with neighboring groups. If not actually blood relations, they tend at least to act as "bands of brothers". Sexual bonds are carefully contracted in observance with tribal customs and are intended to be permanent. Polygamy, either covert or explicitly sanctioned by custom, is practiced predominantly by the males. [27]

Wilson's authority is biology underpinned by genetics, but his rhetoric imposes white western capitalist cultural values onto pre-technological culture. Wilson's critics baulk at such universalizing tendencies, and rightly so. He exceeds both his brief and his authority, however it is constituted, when he makes panhistorical, pansocial comments about human cultural groups. Ullica Segerstråle, a sociologist strongly supportive of sociobiology, understands why this sort of scientific theorising can meet

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27 Wilson, *Sociobiology: The New Synthesis*, 276-277.

strong resistance. One of the most vivid historical examples she gives while documenting the early history of sociobiology, is the difficulty that Bill Hamilton had in getting a university department to accept his PhD proposal. Hamilton was 'obsessed' with the mathematical/genetic problem of altruism, but was unable to get any genetics department to fund his research. Finally, the London School of Economics took him on board, but they were 'cool' towards his topic because, according to Segerstråle, the academic hierarchy was nervous about the eugenicist implications of his work.[28]

Wilson is an ambiguous figure, selectively insensitive in understanding how his sociobiology theories can be perceived or applied and unjustifiably coy about the political implications of his work. Segerstråle defends him as a self-identified, misunderstood liberal, but she does this partly by situating his politics against the radical Marxist political sympathies of two of his strongest critics, Stephen Jay Gould and Richard Lewontin, [29] and partly through identifying Wilson as a 'scientific liberal'. According to her, he is a 'scientific liberal' because he actively distances himself from what he calls 'humanistic liberals'.[30] Marrying the terms 'scientific' and 'liberal' appears to be identity carnival, a political elusiveness generated by linguistic smoke and mirrors. Segerstråle uncritically follows Wilson's process.

At the time of the publication of *Sociobiology,* the cold war and the Vietnam war were just ending. The political hot potato in America was still human aggression – the question being, 'is it innate, or is it acquired? In the passage where she identifies Wilson as a 'scientific liberal', Segerstråle shields the scientist from charges of claiming aggression as innate by saying – in a very suspect line of reasoning on her part – that he cannot be challenged on this subject because he does not claim aggression as an innate human characteristic, but rather as a 'recently acquired evolutionary characteristic'. For her, this speculation on the recent appearance of a 'new' violence gene in humans repairs the problem of Wilson's association with theories of genetically determined behaviour. She positions him then, due to this qualification, as 'speaking *against* a nasty vision of humans, *against* a vision of innate aggressiveness in animals and aggression as a ubiquitous trait, and *against* over-

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28 Segerstråle, *Defenders of the Truth*, 58-60; also Matt Ridley, *The Origins of Virtue* (London: Viking, 1996), 19. Ridley offers an even more cautionary tale: George Price, who taught himself genetics with the express purpose of disproving altruism as genetic selfishness, collaborated with Hamilton, developed religious mania and committed suicide.
29 Segerstråle, *Defenders of the Truth*, 107-126 on Gould, and 40-48 on Lewontin.
30 Ibid, 95.

emphasis on the importance of competition in nature as a force of evolution'.[31] To put it mildly, this is an odd argument: it asserts that violence and competition are not innate in humans, but have recently been genetically acquired (therefore violence is still innate, just more recently innate?).This is semantics, and highlights one of the main problems with sociobiology and neo-Darwinism. Language is key to this carnivalised, scientific discourse and is often revelatory of politics argued through the 'neutrality' of science.

Constructions of authority are also key to understanding the politics of sociobiology and neo-Darwinism. Both Wilson's and Segerstråle's claims of Wilson's political naivety and liberalism present as carnival, farce and irony when viewed in the context of her record of the 'Man and Beast Conference'. Held in Washington some years prior to the publication of *Sociobiology*, the conference was a space where Wilson's implicit politics met the explicit politics of a conservative American government. Scientists, including Nobel laureates, rubbed shoulders with senators as they addressed the physiological and behaviourial mechanisms underlying social behaviour. Crucial questions about aggression were being fielded between scientists and politicians. Was war inescapable? Were xenophobic responses natural? One senator present is quoted as saying:

> If we assume that men generally are inherently aggressive in their tendency ... if this is inherent and man cannot be educated away from it, it certainly makes a great deal of difference in one's attitude towards current problems .... If we are inherently committed by nature to this aggressive tendency to fight, well then, I certainly would not be bothering about all this business of arms limitations or talks with the Russians.[32]

This conference highlighted not only the direct congress that scientific discourse can find with political discourse, but framed scientific discourse as guiding top level government policy formation. Sociobiology became a battle of scientific Titans in the publishing war that followed the publication of *Sociobiology*, but its disciplinary roots are found in meetings like these. Sociobiology has never been confined to scientific detail, discipline or paradigm. It is always about who claims authority, who will be listened to by whom and who is saying what. Thus Washington lobbyists actively courted *particular* scientists so they could formulate social policies on contemporary

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31 Ibid, 95.
32 Ibid, 92.

issues, particularly issues dealing with conflict, confident that they then had justification for their positions. That scientific speculations about the relationship of genes and behaviour could influence international policy was of concern, but it was also of concern that domestic areas of governmental policy could be influenced too. Racial minority groups, women and homosexuals were also concerned that they could find themselves discriminated against on the basis of their biology.[33]

The lines of argument are not always easy to see. Clearly genes must have something to say in the social behaviours of animals. Therefore, they probably also influence the individual behaviours of animals in some way too. But what other systems might complement, modify or intervene in expressions of behaviour that have a genetic base? And does selection work best and/or only on the individual animal expressing a particular gene? And upon which animals can we legitimately make definite genetic pronouncements? Which discipline will reveal these genetic necessities most accurately – anatomy, biology, psychology, sociology, or something else completely different, like sociobiology? Even if it was scientifically appropriate to assume a direct connection between genes and social patterns, a path most senior scientists navigate with excruciating care, it seems there are many modifying variables intervening in any attempted study, including the scientist's own training and perception.

In the contentious chapter in *Sociobiology*, Wilson transfers his sociobiological understandings to human culture, and explores the possibility of an 'upwardly mobile gene'.[34] He then goes on to disprove his own proposed gene, conceding that the mathematics of such a gene is not an accurate predictor of social differentiation – even when looking at heavily and consistently stratified societies like the Indian caste system. Putting aside a straw man argument reading of Wilson trying to preempt objections to his own program as he simultaneously activates current prejudice, it is important to ask why he would suggest such a specific example, work out the math and then concede that the example is pointless. The question becomes pressing in the context of an earlier quote from the chapter:

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33 Haraway, *Simians, Cyborgs and Women*, 74-75. Haraway discusses Wilson's participation in the NEXA conference, supported by the Science-Humanities Convergence program. She notes his introduction to the publication that came out of that conference expresses wonderment at umbrage with sociobiology. She also notes Wilson repeatedly cries innocent of any political overtones to his science. While this position represents his comfort with dominance politics, and strong belief in scientific ascendancy, it is also a position that lends itself to the exaggerations and humour of carnival. Complete failure of critique and inability to respond to critique suggest patriarchal caricature and expose the politics being protected to legitimate charges of extremism.

34 Wilson, *Sociobiology: The New Synthesis*, 278-279.

> Within a small tribe of !Kung Bushman can be found individuals who are acknowledged as the "best people" – the leaders and outstanding specialists among the hunters and healers. Even with an emphasis on sharing goods, some are exceptionally able entrepreneurs and unostentatiously acquire a certain amount of wealth. !Kung men, no less than men in advanced industrial societies, generally establish themselves by their mid–thirties or else accept a lesser status for life. There are some who never try to make it, live in run down huts, and show little pride in themselves or their work.[35]

Wilson is an expert entomologist. His speciality is termites and other social insects that have biologically produced cast divisions, so his training and experience leads him to look for and focus on divisions, or 'classes' in any animal society. While Wilson points out in his first chapter that 'socialisation can ... amplify genetic variation of individual behavior within [primate] troops',[36] his reading of his insect subjects, his own culture and the !Kung are all on social positioning. His area of intense scientific study has particular issues with anthropomorphic language and concepts. Workers, drones, soldiers and entrepreneurial, colonising alates are among the inhabitants of the queendoms that Wilson looks into. All these appellations having meanings that extend well beyond their scientific value, chosen for that reason and then reinvested with more complex resonances within the scientific context. Imperial power relations and western standards of success are mapped on to termite 'colonies', Wilson in turn remaps them back onto human culture using the gene as the common denominator and the driver.

Any sense of reflexivity disappears as Wilson mistakes his own training and culturally induced understandings for a universal pattern of organization. As Ruth Bleier says of the male scientist generally, 'there is a pervasive sense of the investigator's perception of his own self as a universal reference point, as equivalent to humanity, viewing all others – the other sex, other classes, races, cultures and civilizations, species and epochs – in the light and language of his own experiences, values and beliefs'.[37] Bleier also critiques Wilson's sociobiology as this new discipline rushes in where anthropology and primatology had learned not to tread at least a decade before, and Camilla Power says Wilson 'let[s] his ethnologist forebears – Robert Ardrey, Desmond Morris, Konrad Lorenz – do his thinking for him, following

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35 Ibid, 272.
36 Ibid, 12-13.
37 Bleier, Science and Gender, 23.

in their old groove'.[38] In the same vein, Wilson's uncritical overfocus on enlightenment science discounts revisionary work and his reductionism exhibits, as Haraway notes, a nostalgic debt to cybernetic functionalism and its concomitant shaping of biology through communications and engineering.[39] Consider the rhetoric of the following passage:

> The transition from purely phenomenological to fundamental theory in sociology must await a full, neuronal explanation of the human brain. Only when the machinery can be torn down on paper at the level of the cell and put together again will the properties of emotion and ethical judgement come clear. Simulations can then be employed to estimate the full range of behaviourial responses and the precision of their homeostatic controls. Stress will be evaluated in terms of the neurophysiological perturbations and their relaxation times. Cognition will be translated into circuitry. Learning and creativeness will be defined as the alteration of specific portions of the cognitive machinery regulated by input from the emotive centers. Having cannibalised psychology, the new neurobiology will yield an enduring set of first principles for sociology.
>
> The role of evolutionary sociobiology in this enterprise will be twofold. It will attempt to reconstruct the history of the machinery and identify the adaptive significance of each of its functions. Some of the functions are almost certainly obsolete, being directed toward such Pleistocene exigencies as hunting and gathering and tribal warfare. Others may prove currently adaptive at the level of the individual and the family but maladaptive at the level of the group – or the reverse. If the decision is taken to mold cultures to fit the requirements of the ecological steady state, some behaviors can be altered experientially without emotional damage or loss in creativity. Others cannot.[40]

This passage is more like bad science fiction than good science. In a tautological fashion, scientific positivism and reductionism authorizes the rhetoric and, in turn, the rhetoric assists in constructing Wilson's scientific authority. Fox Keller's psychological analysis of post-world war science applies as Wilson posits hard science

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38 Camilla Power, 'Sociobiology, Sex and Gender', unpublished paper (London: University College, n.d.), http://homepages.uel.ac.uk/C.Knight/CAMILLA%20ON%20SOCIOBIOLOGY%20AND%20GENDER.pdf (Accessed December 12, 2006).
39 Haraway, *Simians, Cyborgs and Women*, 57-68.
40 Wilson, *Sociobiology: The New Synthesis*, 575.

as the panacea for mortality: infinite knowledge equals an ultimate and inevitably utopian control of nature (and society). The (human) body, basis for an industrialised biological science, will be 'torn down' to the level of cells and reassembled more accurately than when it was originally created. The death knell of pseudosciences like sociology and psychology will be sounded by a *more* scientific science, that of neurobiology. *Sociobiology*, with its debts to Popper as well as its cybernetic modeling, is a rallying call for the resituating of a monolithic 'science' as the central jewel in the crown of western knowledges.

The irony is that exactly the same text has also proved deeply contentious in the fields of biology and evolution and has also proved a clarion call for the very kind of criticism it intended to dispel. This kind of unintentional inversion, extremism and nostalgic cultural politics all have their place, however, in the odd reflexivities of a contemporary knowledge carnival where the vital postmodern business of critiquing science seeks to undo the secrets of this privileged discourse, in a similar way in which traditional science sought to undo the secrets of nature.[41]

Still driven by unificatory visions of knowledge, Wilson published *Consilience* over three decades after *Sociobiology*. This book is autobiographical and contains a patchwork of current science information, interspersed with selected 'two culture' humanities, arts and sociology. Consilience, as it is represented in Wilson's book, is not consilience but reiteration of received knowledge. Wilson simply reproduces disciplinary hierarchies, repeating the ascendancy of science and recreating the scientist as hero: 'To put that in a nut shell – knowledge, obsession, daring'.[42] Once again there is a complete failure of critique: poetic inspiration (for example) will be explained by science because science will explain everything including creative desires and appreciation of beauty. In carnival terms it is almost as if the king is revealed, and is ready for his own decrowning, a task undertaken by many participants in this debate. Stephen Jay Gould and Niles Eldredge recognize *Consilience* as a conceit for sociobiology and attack its reductionism, dualism and lack of complexity.[43] Richard Lewontin critiques sociobiological ideology and the way genetic determinism can be used to perpetuate social inequality and other scientists band together to point out the shortfall sociobiological ideas present for the growth of their various disciplines if

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41 Evelyn Fox Keller, *Reflections on Gender and Science: Tenth Anniversary Edition* (New York: Yale University Press, 1985); Susan Bordo, *The Flight to Objectivity: Essays on Cartesianism and Culture* (New York: SUNY Press, 1987); Carolyn Merchant, *The Death of Nature*.

42 Wilson, *Consilience: The Unity of Knowledge* (New York: Knopf, 1998), 70.

43 Niles Eldredge, 'Cornets and Consilience', *Civilization* 5, no. 5 (1998), 84-86.

genocentrism prevails.[44] Feminists resist the selective nature of the story telling process and the patriarchal politics of a genocentric dominator science.[45] Wilson represents conservative inertia, both scientifically and politically, and he provokes a carnival of critics in the absence of his own critique, and in his own carnival extremity.

His story is archetypal. Like Mary Shelley's Promethean scientist, Wilson creates monsters. He believes he has special insight as he plunders the accumulated materials of various disciplines to construct the 'new syntheses' of *Sociobiology* and *Concilience*, but he ends up bear-leading unstable, unsustainable creatures onto centre stage with him. His potentially dangerous monsters are composed of selected texts and studies that support Wilson's vision of nature, man, family and culture stitched together in the hope of creating new living theory and knowledge. However, his failure to critique leads him into self-parody and caricature. Science theorists are currently undoing many traditional ideas and authorities and have set loose uncertainty, so supporters of those traditional knowledges and authorities – like Wilson – seek to reassemble constructs that return a sense of safety and predictability. Though theories such as sociobiology and consilience may appear to many to reinstate the/a 'natural' order, they are inevitably volatile. They are large, complex ideas, dependent for their coherence on nostalgic politics, and on who is speaking to these 'new syntheses'. Wilson, in fact, sets a dangerous precedent by transferring his expertise in one field to authoring interdisciplinary stories in a newly coined field.

Philippe Rushton, Professor in Psychology at the University of Western Ontario, is a very worrying example of the potential misuses and confusion of sociobiological authority. He produces politically reprehensible, racist material under the cover of the new discipline. An accredited academic, he follows Wilson's example of transferring his authority from one discipline to another. If an entomologist can become a sociobiologist, so can a psychologist. Familiar with university models of research, Rushton simply amasses a vast number of individual studies and applies them as legitimising authorities of his own viewpoint, and the gene/behaviour link of socio-biology gives him permission to reinvent the worst kind of xenophobia. He probably rationalizes his own xenophobia in the same way – it's natural, his genes made him that way. While the written product is politically abhorrent, his process is initially difficult to distinguish from general western academic practice so he 'passes' as

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44 Richard Lewontin, Steven Rose and Leon J. Kamin, *Not in Our Genes* (New York: Pantheon, 1985); Lewontin, Rose and Kamin, *Biology as Ideology*; Mae-Wan Ho and Peter T. Saunders, eds., *Beyond Neo-Darwinism*.
45 Haraway, *Simians, Cyborgs and Women*; Bleier, *Science and Gender*; Hilary Rose, *Love, Power and Knowledge*.

academic because of his qualifications in psychology, and he is then in a position to authorize his vision and to be 'knowledgeable' and an expert in the new field.[46]

Stephen Jay Gould examines racially-based science in *The Mismeasure of Man* (1981) in an attempt to undo authority that historically supported racial bias, while Rushton, in *Race, Evolution and Behavior* (1995), uses interdisciplinary sociobiological gene/culture stories to restore the disputed concept of race, and to reinstate extreme stories of racial stereotyping and privileging. That both Gould and Rushton seek to reinterpret statistical and historical information such as craniometry, IQ tests, and monogenism and polygenism[47] in such very different ways is a marker of the late twentieth century carnival of knowledge. Gould's investment lies with sifting information, contextualising it historically and critically examining it within a framework of more relativised knowledge. Rushton, on the other hand, uses his information to reconstruct a discriminatory picture of racial difference based on physique, intelligence and behaviour. His discourse is apparently genetic but it is driven by colonialism and white supremacist politics. He does not seek to interrogate notions of intelligence or explore discredited theories like craniometry, rather he seeks to align them and reinstate them so he can conclude that 'asians' are the most intelligent group, 'caucasoids' the next and 'negroids' the least:

> For both the black and the white children, the correlation among the head circumference measures at all ages predicted the mental ability scores. As can be seen, the head circumference of white children is greater than that of black children in each of the age categories by a mean of 0.36 cm or approximately 0.2 SD. The greater head size of white children is not a function of greater body size because black children are taller than white children at both 4 and 7 years of age...the three tests of mental ability all favoured the white children while the measure of motor ability favoured the black children. [48]

Another technique used to support his science includes conflating cross-cultural data to show consistent, hereditary patterns in human interaction according to race. Rushton identifies what he calls the 'African pattern', a pattern of behaviour applicable

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46 Philippe Rushton, *Race, Evolution and Behavior: A Life History Perspective* (New Brunswick: Transaction Publishers, 1995).
47 Stephen Jay Gould, *The Mismeasure of Man* (New York: W.W.Norton, 1981); Rushton, *Race, Evolution and Behavior*. Monogenism argues that all humans belonged and belong to the same species, while polygenism argues for races as separate biological groups.
48 Rushton, *Race, Evolution and Behavior*, 41.

to groups of African appearance from the Congo to London. This pattern includes the early onset of sexual activity, loose emotional ties between spouses, the expectation of sexual union with many partners and children by them, lowered maternal nurturing with long term fostering of children 'with the stated reason sometimes being to remain sexually attractive to future sexual partners, and increased male–male competitiveness with lower paternal involvement in child rearing or maintenance of single pair bonds'.[49] Rushton offers documentation to support all of his statements, drawing from hundreds and hundreds of sociological, psychological, anthropological and physical studies and from statistical information when it is available, but that does not make his work sound. Rather, he has created a seriously frightening, interdisciplinary monster under the rubric of sociobiology. More eugenic than nostalgic, his model and style are a logical development of Wilson's sociobiology program. The gene is an ideal carrier for science stories that screen out politics, even when the science is weak or questionable. In a section on 'Law Abidingness' Rushton says:

> With respect to crime, J.Q. Wilson and Herrnstein (1985) review much of the relevant literature. Afro–Americans currently account for about half of all arrests for assault and murder and two-thirds of all arrests for robbery in the United States, even though they constitute less than one-eighth of the population. Since about the same proportion of victims say their assailant was black, the arrest statistics cannot be attributed to police prejudice. Blacks are also overrepresented among persons arrested for most white-collar offences. For example, in 1980 blacks made up about one-third of those arrested for fraud, forgery, counterfeiting, and receiving stolen property, and about one fourth of those arrested for embezzlement. Blacks are underrepresented only among those white–collar offences that ordinarily require, for their commission, access to high status occupations (tax fraud, security violations).[50]

According to Rushton, sociological evidence lays the suburban decay of Detroit squarely at the feet of poor black social organization, just as the burgeoning of AIDS can be attributed to different racial sexual practices. Coincidentally, AIDS' research has led to investigations of penis size that demonstrates that black men have large penises, mongoloid men have small ones and Caucasoid men have medium size

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49 Ibid, 156-157.
50 Ibid, 157-158.

appendages. Everything is in the genes – except the significance. While Rushton does not argue for polygenesis, or the separate origins of races, he does clock long periods of separation in the emergence of his Negroids, Caucasoids and Mongoloids. This allowed for genetic change as 'the cognitive demands of manufacturing sophisticated tools and making fires, clothing, and shelters (as well as regulating the storage of food; Miller, 1991) would have selected for higher intelligence levels than in the less cognitively demanding environment in sub–Saharan Africa'.[51]

Carnival is a site for the sinister as well as the comic.[52] According to Bakhtin, beatings and thrashings, delivered as folk humour on gluttonous, licentious clergy, figured prominently in medieval carnival. However, beatings and thrashings such as Rushton's racialist cant, while it is carnivalistic, must be read as shady acts of opportunism in a sociohistorically specific time of moveable boundaries. Who performs the beating is a particularly postmodern question, and the academy in this carnival is not presenting as a clear reversal of notions knowledge and ignorance. In this instance, it is actively engaged in producing ignorance, contradicting its own values and undoing any authority it may have by choosing not to (or being unable to) discipline its employee and successfully use Canada's hate-speech laws to contain Rushton's pseudo-scientific program.[53] In fact, Rushton currently runs an institute, the Charles Darwin Institute, promoting discrimination through an apparently legitimate authority.[54] The problem lies in distinguishing renegade institutions when they mimic the codes of mainstream institutions, appearing almost like Bakhtinian carnival doublings. This farcical use and abuse of academic authority is, of course, not simply the result of Wilson's gene/behaviour theories or a problem of how scientific authority

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51 Ibid, 229.
52 Bakhtin, *Rabelais and His World*; Russo, *The Female Grotesque*.
53 See Intelligence Report, 40 to Watch (Southern Poverty Law Centre, 2005), http://www.splcenter.org/intel/intelreport/article.jsp?pid=214#27 (accessed November 17, 2005). The Southern Poverty Law Association documents hate groups and institutionalized racism. They report the conflict that academic authorities have with writers like Rushton: 'Although the University of Western Ontario has always been careful to defend Rushton's academic freedom, officials did reprimand him twice for carrying out research on human subjects in 1988 without required prior approval. In the first incident, Rushton surveyed first-year psychology students, asking questions about penis length, distance of ejaculation, and number of sex partners. In the second, he surveyed customers at a Toronto shopping mall, paying 50 whites, 50 blacks and 50 Asians $5 apiece to answer questions about their sexual habits. Rushton crossed the political Rubicon in 1989, when he set up the Charles Darwin Research Institute in Port Huron, Mich. (apparently to avoid breaking Canadian laws on hate speech), and also presented his views on race publicly to an outraged meeting of the American Association for the Advancement of Science. Association officials called a press conference the same day to attack what the association's president called Rushton's "highly suspect" research.'
54 Philippe Rushton, Charles Darwin Research Institute, http://www.charlesdarwinresearch.org/ (accessed November 23, 2005).

is constructed. Obviously, a wider social context of inversion and subversion has opened up. Complex democratic realities, such as free speech, and complex academic realities, such as relativism and interdisciplinarity, are also ironised and exploited by people like Rushton in the carnival of ideas. This is why it is important to move through the carnival of ideas and critically and materially deal with, not only sinister opportunism such as Rushton's, but also precursive ideas like Wilson's that extend permission to Rushton through their own nostalgic, patriarchal, colonial politics. There are always snake oil pedlars at carnivals – but it is important that the audience around the snake oil pedlar is interactive. Rushton (and Wilson) needs hecklers.

In a medieval context, the fellows of the Sorbonne are portrayed as fools, men valuing intellectual wisdom in a time when conceptual meaning falls away and corporeal realities are acknowledged. What the medieval folk were not safe from were excess appetites, illness, deprivations, the passage of time and death. In the Western carnival the realm of conceptual meaning, and the realm of personal and social values are also unsafe. Wilson's patchwork discipline creates a model for Rushton to follow and use in promoting racialism, ideas which have a loaded history and the potential to materially do mass harm. Wilson may be a respected entomologist, and what he says with regard to sociobiology may have some merit, a point which will be discussed later in this chapter, but his reductionist simplification of the gene/behaviour connection, and his fathering of a composite discipline that can and does use dominant cultural norms uncritically creates a model for connecting matter and theory, disciplinary praxis and theory, and theory and theory, that needs interrogation.

The evangelist: Richard Dawkins

Beyond the representations of science as a stable knowledge field, the attribution of stable understandings of evolution within biology, and stability in gene expressions (all of which can be challenged), the construction of authority in neo-Darwinism can also be problematic when scientists intersect with popular culture and mass media. Richard Dawkins is an example of a sociobiological neo-Darwinist who walks a thin line between scientific explicator and political provocateur. A gifted and inspired writer, who over-exploits simple analogies when explaining science to non-scientists, he has played an important role in the shifting balances of arguments on gene-centred evolutionary theory.

E.O. Wilson published *Sociobiology* the year before Dawkins published his first major work, *The Selfish Gene*. Dawkins' book took George Williams' academic

rebuttal of Wynne-Edwards' idea of group selection with the 'simple' and 'austere' imperative of individual selection and completely colonized the lay understanding of Darwinism. He has gone on to write a good number of other books that are very popular, all supporting a reductive, genocentric view of life and all concentrating on the alliance of adaptation and selectionism as the only mechanism of evolution.[55] While this thinking and material may seem dated and simplistic in respect to complexified and relativistic postmodern approaches to bodies and scientific knowledge, it scores the contemporary psyche as deeply as an advertising jingle as it is iterated, reiterated and reiterated again.

Without the problematics of interdisciplinarity, Dawkins appears to offer the sociobiology and neo-Darwinist programs a lot of support.[56] This he certainly does, but his work is still open to a carnival analysis through his metaphorical language, his understanding of the big ideas of nature and evolution and his ambiguous social identity.

From the first pages of *The Selfish Gene*, Dawkins describes all living bodies, as 'survival machines – robot vehicles programmed to serve the selfish molecules known as genes'. This, together with the idea of genes swarming around inside 'gigantic lumbering robots', [57] has imprinted itself deeply on the public imagination, offending some and delighting others with its reference to that assembled techno-human body particular to the twentieth century carnival. Dawkins never really lets go of this image, revisiting the idea twenty years later in his essay in John Brockman's *Third Culture*, a collection of responses on evolution, consciousness and complexity.[58] The carnival body is originally one of appetite and communality, but Dawkins' techno-bodies are unsubtle hyperindividualistic objects that lack feeling, and suggest a rather horrific

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55 Richard Dawkins, *Climbing Mount Improbable* (New York: W.W. Norton, 1996); Richard Dawkins, *River out of Eden* (New York: Basic Books, 1995); Dawkins, *The Blind Watchmaker*; Dawkins, *The Extended Phenotype*.

56 Richard Dawkins, 'Not in our Genes: Biology, Ideology and Human Nature,' New Scientist, 24th January 1985, http://www.simonyi.ox.ac.uk/dawkins/WorldOfDawkins-archive/Dawkins/Work/Reviews/1985-01-24notinourgenes.shtml (accessed August 23, 2003). Dawkins only identified himself as a sociobiologist in 1985. It was done in this book review, and done out of exasperation with Lewontin, Rose and Kamin, authors of *Not in our Genes*. He says: 'Sociobiologists, such as myself (much as I have always disliked the name, this book finally provokes me to stand up and be counted), are in the business of trying to work out the conditions under which Darwinian theory might be applicable to behaviour. If we tried to do our Darwinian theorising without postulating genes affecting behaviour, we should get it wrong. That is why sociobiologists talk about genes so much, and that is all there is to it. The idea of "inevitability" never enters their heads.'

57 Richard Dawkins, *The Selfish Gene* (Oxford: Oxford University Press, 1976), 2.

58 Richard Dawkins, 'A Survival Machine', in *Third Culture: Beyond the Scientific Revolution* ed. John Brockman (New York: Touchstone, 1995), 74-95.

sense of possession. That is, everything they do, think or need is dictated by a completely self-serving entity that rules them completely. It is surely a carnival irony that the living body produced by rational empirical scientific discourse should have such a *frisson* of horror about it.

Changing metaphors in *The Blind Watchmaker*, the lumbering robot becomes a computer, mechanics becomes infotech and he moves even further away from the visceral body. 'If you want to understand life', Dawkins says, 'don't think about vibrant, throbbing gels and oozes, think about information technology... DNA is ROM. It can be read millions of times over, but only written to once - when it is first assembled the birth of the cell in which it resides.'[59] In *River out of Eden* the river referred to is an information river, a temporal river of DNA, similar to a river of computer code. With Dawkins' shift from the robots to the electronic, it could be argued there is a shift away from the mechanical body, the grotesque body of carnival, but the ties Dawkins creates between nature, machines and electronics are complicated and are still indicative of transformed/transformative/transgressive bodies as he plays with Cartesian dualism. In *The Blind Watchmaker* he discusses a computer program he has invented, which begins with small line drawings composed of a number of elements or 'genes'. These drawings reproduce with random changes and the program eventually produces radically altered shapes, some of them eerily reminiscent of trees, fish and other natural phenomena. The shapes are 'biomorphs', 'bodies' that represent the process of random mutation in virtual space. This is part of the late twentieth century carnival – ethereal technobodies living in a grotesquely limited intellectual imitation of biobodies – and resonating with the cyborg boundary breach of visible/invisible.[60] The biomorphs, however, seem rather cold and are insufficient for Dawkins who is nostalgic for them to 'burst out of the computer' and return to generating selectionist carnage:

> Artificial selection is relatively easy to achieve in the computer, and the biomorphs are a good example. It is my dream to simulate natural selection in the computer too. Ideally I'd like to set up the conditions for evolutionary arms races in which 'predators' and 'prey' would emerge on the screen and goad each other into progressive evolution while we sat back and watched. Unfortunately it is very difficult, for the following reason. I said that some offspring are more

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59 Dawkins, *The Blind Watchmaker*, 111-138.
60 Haraway, *Simians, Cyborgs and Women*, 153.

> likely to die, and it might seem easy enough to simulate nonrandom death. But, in order to be a good simulation of a natural death, the demise of the computer creature must result from some interesting imperfection, like having short legs which make it run more slowly than predators. [61]

The 'evolutionary arms race' is a concern Dawkins has in common with Wilson and it drives his vision of the relationship between species, leading him to label eyes, ears, brains and bat radar as high tech weaponry in animals.[62] His extended consideration of 'arming' in *The Extended Phenotype* makes it clear that manipulation and control of individuals in one's own species and members of another species are also included in this term. Again, similar to Wilson's argument this naturalises power relationships within the species and reinforces human 'dominion' over other species. Ironically, Dawkins extended references to the 'genetic arming' of an organism slip over into a rather careless non–biological speculation on arming in one interview. Dawkins claims that building certain nest shapes in birds may well be a genetically determined behavior. When asked for a similar example with regard to humans, he says:

> Well, I suppose stone arrowheads might be a possible example. It would have to be the case that if there exist two kinds of arrowhead, and when you consistently breed from individuals who have made type 'A' arrowheads, and consistently don't breed from individuals who have made arrowheads of type 'B', then after many generations of such breeding you have people being born who spontaneously produce type 'A'. Of course they will have to be given some schooling in making arrowheads generally, one's prepared to allow that ... but I don't think it's a fruitful line of enquiry. I don't believe that's what it would be like. The difference between type 'A' and type 'B' arrowheads would probably turn out to be a cultural difference.[63]

Dawkins' politics guide popular thinking on biology. His books are constantly in print. The reason this would not be a fruitful line of enquiry is because it would undermine the extreme model of evolution he promotes. His extended phenotype, the

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61 Dawkins, *Climbing Mount Improbable*, 3-37.
62 Richard Dawkins and J. R. Krebs, 'Arms Races between and within Species', *Proceedings of the Royal Society of London* 205, no. 1161 (1979), 489-511 and Dawkins, 'The Evolutionary Future of Man', 87-91.
63 The Evolutionist, 'In Conversation with Richard Dawkins' (1997), http://www.lse.ac.uk/collections/darwin/evolutionist/dawkins.htm, internet publication (accessed June 16, 2003).

biological authority given to individual notions of competitive power and manipulation would collapse. Faced with the complexities of culture, the extreme, aggression-based arguments of interhuman and interspecies relationships do get into difficulty and look like carnival extremity and clear fodder for satire.[64] It is unlikely that the above conversation would have been entertained for a moment on the genetically determined shape of cradles, yet that is a more comparative product to a nest than an arrowhead.

The empty cradle also proves problematic for competition-based biology. Contraception, for example, is a behaviour that is counterintuitive to neo–Darwinian notions of maximizing reproduction and selection, so Dawkins terms it a 'rebellion' against a genetic imperative. Cross-cultural (if not completely consistent) altruism such as taking care of the elderly and the disabled, adoption, caretaking non–humans and giving money to charity he refers to as 'misfirings' of selfish genes.[65] 'Misfiring' is another militaristic term, but is also a non–specific term used in science when genes, cells and nerves do not act as they normally would (or not as anticipated) in an investigation, in general it seems to be a term used when scientists are unsure of what mechanism is actually involved in unexpected results. Almost universal misfirings of selfish genes, therefore, sounds evasive when looking at issues that do not fit well under a competitive adaptationist/selectionist paradigm. The term 'misfirings' also comes perilously close, in metaphorical language, to the expression 'shooting blanks', often used to indicate impotence or some failure of masculinity. This distortion of evolutionary thinking through militarized, hypermasculine metaphors presents like a caricature in a carnivalised metanarrative. In fact, if Dawkins' version of biohistory is to be believed, the welfare state is an evolutionary abomination.[66]

In *The Selfish Gene*, Dawkins' concern is that lay-people understand the big idea of a gene driven universe, and that they understand the self-interested nature of the gene. He goes to great lengths to emphasise the selfishness of the gene because he is trying to address the big issue of altruism in an apparently survival oriented world. Certainly another issue with Dawkins and his language is the slippage that occurs in his discussions between selfish genes and selfish behaviours. The weak distinctions generated by Dawkins between selfish genes and selfish behaviour have generated widespread confusions, and hardened ideas of competition, in popular understandings of Darwinism. *The Selfish Gene* is Dawkins' stark view of the relentless and

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64 Some popular feminist sf texts satirise the sociobiological program. See Chapter 8 of this thesis and also Williams, 'Embodying Change: (R) Evolutionary Theories of an Alien Synthesis', 115-138.
65 The Evolutionist, 'In Conversation with Richard Dawkins' (1997).
66 Dawkins, *The Extended Phenotype*, 23.

confronting side of nature, it is his 'Pantagruel' vision, an insistence on the necessity of death/competition/ selection as being at the heart of the process of evolution. While quite dark in its focus, this book also fulfils a carnivalesque function in that it was Dawkins' first attempt to democratise science, to bring an 'exalted discourse' to ordinary people who might take pleasure in sharing that knowledge and feeling a degree of empowerment through it. [67]Dawkins' tone in future books changed until his most recent one, *The God Delusion*, which has a much more immediate sense of celebrating the fertility, bounty and pleasure of nature.[68] In this book, the cautionary tale of natural selection is still present, but it is more of a background discourse, and what is immediately apparent to the reader is the joy and pleasure the author takes in the ever renewing, 'Gargantuan' richness and complexity of the material/natural world. Of course, it has been impossible to navigate a steady path between these two extremes, and Dawkins has spent much of his career accounting for large discrepancies in his version of completely selfish, genocentric evolution. This is where he tends to make linguistic/metaphorical mistakes, satirising his own authority with excess speculation, and betraying his fidelity to certain ideas.

Dawkins' public identity has often reinforced his mechanistic, reductionist and military metaphors. Thus he can appear on occasion as the 'red-snouted Catchpole, thrashed and rewarded at the same time 'like two kings'' – Catchpole, according to Bakhtin, being at different times royalty, scholars and sacristans who come in for a beating.[69] Dawkins fills all these positions in some way. Lord of the publishing pile, he makes a good target for those frustrated with the iron grip of scientific rationalism and causality thinking in the culture. He is a highly accredited scholar, being Professor of the Public Understanding of Science at Oxford University, but his language is not conciliatory. To say he is pugnacious as a scientist, as an academic and on behalf of his own beliefs is a great understatement. Dawkins has fought with science theory critics, other scientists, the general public, specific religious figures and creationists. Much of this debate has taken place in print, in book reviews and in books dedicated to certain topics; however, it does also take place in the 'market place', in places where there are audiences and exchanges across the footlights. Dawkins talks about attending a public debate on sociobiology with John Maynard Smith. Smith reached for a 'hypothetical

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67 Ibid. 233-244. In the section on popular festive forms, Bakhtin discusses how the lampooning of famous writings of the middle Ages was a democratizing process.
68 Dawkins, *The God Delusion* (London: Bantam Press, 2006).
69 Bakhtin, *Rabelais and His World*, 199-200.

example' and selected a gene for skill in tying shoelaces. Dawkins was fully aware of the effect of this on the audience:

> Pandemonium broke loose at this rampant genetic determinism! The air was thick with the unmistakable sound of worst suspicions being gleefully confirmed.[70]

Smith's gene for the skill of tying shoelaces is clearly ethnocentric, so it was either carelessly selected, or selected for its capacity to provoke. More thought could have converted this example into a gene for manual dexterity, and that may not have raised the ire of the audience so strongly. However, Smith chose instead the example of tying a shoe lace, and many of those in the audience would have immediately registered that many cultures in the world do not have, or need, shoes, and many cannot afford shoes even if they do live in cultures where shoes are commonly worn. This random connection of human cultural activity with genes reveals one of the real excesses of sociobiological thinking. Smith might as well then argued for the positive selection of a gene for doing up Velcro. In *The Extended Phenotype*, Dawkins himself chooses a provocative example of discovering a 'gene for reading', albeit by first discovering a gene that militates *against* reading, one that 'induced a brain lesion causing specific dyslexia'.[71] It is but a small jump from there to the confusion of literacy with genes, and from there to the promulgation of class by biology. Very few gene/culture connections can be made with impunity and certainty.

While the stories of 'rebellions' and 'misfiring' help address the breakdown of a reductionist reading of culture/biology, Dawkins also negotiates the refusal of culture to bear out his heavily selectionist, survival of the fittest story by extending his particulate paradigm. In the scientific carnival of scale, his is the voice of the gene, and he advocates for it so passionately that he suggests all human knowledge must be driven, transferred and replicated by similar cultural units. These units are called memes, and work in much the same way as genetic code.[72] Memes have been picked up as a popular mechanism for extending neo-Darwinism into human processes and behaviours, but it is difficult to maintain the integrity of randomly atomized knowledge. Susan Blackmore, a British lecturer in psychiatry, exploits Dawkins' idea further.[73] Her argument is that if living creatures have been created to carry genes around and propagate them, then the brain may have been created to carry and

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70 Dawkins, *The Extended Phenotype*, 23.
71 Ibid, 23.
72 Dawkins, *The Selfish Gene*, 203-215.
73 Susan Blackmore, *The Meme Machine* (Oxford: Oxford University Press, 1999).

perpetuate memes, and a meme is every idea or act that is repeated. Selection also exists for memes, which are like behaviour viruses; that is, if something is done and not repeated then it is selected out of the culture. This reductionism of the sociocultural experience, however, demonstrates the same weakness that Dawkins shies away from in his interview on arrowheads. Both a sense of agency for individuals and the complex effects of sociocultural experience can be undone, and a spectre of meaninglessness is raised by the idea of organisms existing only to transmit invisible, virally replicating information.[74]

The alternative to meaninglessness is to invest in meaning, and this is where Dawkins presents a carnival combination of scientific rationalism and zealotry. With *The Selfish Gene*, Dawkins embraced a bleak, mechanistic, scientific materialism that saw humans and human culture governed only by self-interest. However, that particular text finishes with a plea for something different, a plea that suggests Dawkins wants to deny his own story:

> It is possible that yet another unique quality of man is a capacity for genuine, disinterested, true altruism . . . The point I am making now is that, even if we look on the dark side and assume that individual man is fundamentally selfish, our conscious foresight – our capacity to simulate the future in imagination – could save us from the worst selfish excesses of the blind replicators. We have at least the mental equipment to foster our long-term selfish interests rather than merely our short-term selfish interests. We can see the long-term benefits of participating in a `conspiracy of doves', and we can sit down together to discuss ways of making the conspiracy work. We have the power to defy the selfish genes of our birth and, if necessary, the selfish memes of our indoctrination. We can even discuss ways of deliberately cultivating and nurturing pure, disinterested altruism – something that has no place in nature, something that has never existed before in the whole history of the world. We are built as gene

74 The focus with mimetics seems to be locating memes, understanding the limits of the infosphere, the problematic links of culture with neo-Darwinian selectionism and the problematic analogy of the virus to look at meme processes too. Committed to the exploration of mimetics are Derek Gatherer, Dr Susan Blackmore, Francis Heylighen and others. See *Journal of Mimetics* at http://cfpm.org/jom-emit/ or http://www.susanblackmore.co.uk/memetics/index.htm. While this thesis does not pursue this debate, it would be interesting to know how meme scholars differentiate Darwinism and neo-Darwinism as memes worthy of study. In the light of carnival the 'science of mimetics' is completely hypothetical and relies upon other disciplines to exist. Under this analysis, it could be considered a fine 'Laputan' science, an exercise in academic satire.

> machines and cultured as meme machines, but we have the power to turn against our own creators. We, alone on earth, can rebel against the tyranny of the selfish replicators.[75]

Pages before this heartfelt finish, the 'God meme' is dismissed as a path of rescue from the selfish gene because its continuance as a belief, according to Dawkins, depends upon intimidation and threat. Hellfire ensures the generational propagation of religion,[76] but Dawkins cannot simply dismiss religion because of this. The materialist/spiritual conundrum is something that Dawkins wrestles with through a number of his popular science texts. His work evidences an explicit atheism, a baiting of those with religious beliefs, and a brilliantly satirical use of Biblical names, terminology and stories. He is a scientist obsessed with the irrationality of anyone subscribing to the existence of an omnipotent divinity. In an engaging quote he reveals the perplexity and the humorous side of this struggle with altruism in the world of the tyrannical, narcissistic gene: 'Alternatively, if there is only one Creator who made the tiger and the lamb, the cheetah and the gazelle, what is He playing at? Is he a sadist who enjoys spectator blood sports? Is he trying to avoid overpopulation in the mammals of Africa? Is he manoeuvring to maximize David Attenborough's television ratings?'[77]

Carl Jung discusses the processes of writing at some length. He says writing can be crafted intentionally or can be inspired, but that it is attributable to the creative process that moves the writer to pick up the pen, and that creative process – in turn – can be an 'alien will'. In the words of psychology, Jung describes the 'alien will' as a living thing, an *autonomous complex*. The autonomous complex 'is a split of portion of the psyche, which leads a life of its own outside the hierarchy of consciousness. Depending on its energy charge, it may appear either as a mere disturbance of conscious activities or as a supraordinate authority which can harness the ego to its purpose.'[78] In his writings, again and again, Dawkins seems to have difficulty reconciling scientific impulses and religious impulses as existing in the same world. In the same way that religion has historically fought to contain and deny science, Dawkins fights to contain and deny religion – and he is an impressive fighter. His opus is large, but it seems to work more in a moral direction than a scientific one. The personal question that he is working out in the world, tracking down the nature of

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75 Dawkins, *The Selfish Gene*, 215.
76 Ibid, 212-214.
77 Dawkins, *River Out of Eden*, 105.
78 Carl Jung, 'On the Relation of Analytical Psychology to Poetry', in *The Portable Jung*, ed. Joseph Campbell, trans. R.F.C Hull (New York: Viking Penguin, 1976), 310-313.

personal and social responsibility, and even the transcendent, begins with the most mean hypothesis of human *raison d'etre* possible and ends up with his autobiographical oxymoronic 'A Deeply Religious Non-believer'.[79] This deep contradiction is contemporary carnival, but it is also like the 'turning point' of Bakhtinian popular carnival forms. The atheistic scientist in his quest to defeat religion becomes the evangelist preaching on a limited platform to the true believers. As Robert Reid remarks about the religious fervour of the ultra-Darwinists, 'Paradigms whose popularity is underpinned by polemic, consensus and belief have a lot in common with religion', and he quotes Steven Jones from *The Third Culture*, who actually says that Dawkins is a Martin Luther figure preaching salvation (through science) by faith alone.[80] In the end, *The God Delusion* is a popular text on religion, and Dawkins offers his readers a scientist delusion because the real focus of his work is actually religious and not scientific.

With respect to Dawkins' carnival identity, special mention should also be made here of the attention paid to him by philosopher, Mary Midgely. Midgely critiques Dawkins on both genes and memes,[81] but because she cannot contain her frustration with Dawkins' reductionism, she proposes Lovelock's Gaia theory as a rival, exemplary science that seems to be both biology and culture friendly.[82] Gaia is a scale story, postulating the earth as a gigantic, self-regulating system that has kept the incredibly energy-rich mix of compounds needed for nourishing life stable throughout its long history. Midgely selects Lovelock's story for its apparent inclusivity – and sets it up against the reductionist gene story as an exemplary science story with which to work through animal/human, nature/culture and mind/body binaries. Midgely intuitively recognizes that there is something wrong with militaristic, capitalist, eugenically loaded science and something right with earth goddess scientific dreaming, but her approach actually re-hardens these categories of knowledge and perception and recreates the dualism she is trying to escape. However, in much the same way as sociobiology itself, she reveals a possible pathway as she stumbles.

Sociobiology and Gaian theory *both* contribute to non–anthropocentric science and posthuman understandings of the world. They are both implicated in an emergent

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79 Dawkins, *The God Delusion*. 'A Deeply Religious Non-believer' is the title of the first section.
80 Steve Jones, 'Why is there so much Genetic Diversity' in *Third Culture: Beyond the Scientific Revolution*, ed. John Brockman, 111-118.
81 Mary Midgely, 'Gene-Juggling', *Philosophy* 54, no. 210 (1979), 439-458; Mary Midgely, 'Why Memes', in *Alas Poor Darwin: Arguments Against Evolutionary Psychology*, ed. Hilary Rose and Steven Rose (London: Vintage, 2001), 67-84.
82 Midgely, 'Gene-Juggling', 439-458.

politics of science narratives, and they participate in terms of the grotesque body in carnival at extremes of scale. In Gaian theory the planet as a living entity is central, while in sociobiological theory microscopic genes are central. The fact that these two ideas necessarily co-exist in the construction of human science, and particularly in construction of meaning in evolution, at this time in history points to the necessity for more inclusive discourses than Midgely proposes. As Haraway says in her technoscientific version of the carnival, best praxis is to simultaneously accommodate different hypotheses, creating the authentic 'partial, locatable and critical'.[83]

The carnival model of evolutionary understanding that this thesis argues for desires multiple perspectives, interdisciplinary and – most essentially – ironic readings of authorities and scientific theories and phenomena. Then, as part of its political program, the thesis also insists on multiple agencies and subjectivities in storytelling. Thus James Lovelock speaks for the homeostasing planet, while Richard Dawkins articulates the directive voice of the gene. To situate both these theories within carnival does not eradicate the contentiousness of certain scientists or their ideas, nor does it advocate they or their theories be accepted without critique, rather, it means simply that this carnival reading of science recognizes evolutionary thinking as a significant site for undoing binarisms and rejecting totalizing discourses.

Girls in genes

Discussion of the scientific authority of sociobiology and genocentric neo-Darwinism leads to the difficulty of mapping literal, behavourial subject matter. What exactly can the subject matter of sociobiology legitimately be when there is so much contention surrounding universalising statements, the underpinning languages of biology and the genetic particularisation of groups? This is predominantly true with respect to human behaviour but, as the previous section suggests, studies of non-human behaviours have now also come into question. Sociobology has assisted in the carnivalistic collapse of boundaries with respect to any discrete animal subject in science. Haraway's cyborg exists partially in the compromised boundary between human and animal, and Barad's posthuman performativity exists partially in the compromised boundary between organic and discursive.[84] In fact, it is so difficult that something rather unusual has happened in attempts to produce the discipline of sociobiology. While its proponents have been vocally committed to re-establishing a platform of incontrovertible scientific

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83 Haraway, *Simians, Cyborgs and Women*, 191.
84 Haraway, *Simians, Cyborgs and Women*; Barad, 'Posthuman Performativity', 801-31.

truth, they have actually managed to discomfit whole other disciplines within biology and natural history studies, and they have force-fed the growth of critical studies of science. The result is that it is not only studies attempting to identify connections between genes and behaviour in humans that have been questioned with respect to their language and politics. Studies of animal behaviour are now cautious about pronouncing on behaviour-gene links, but are also often examined for conceptual and ideological loadings, particularly for problematically anthropocentric, culturally biased and/or gendered readings of any life forms and processes.

Pierroti, Anett and Hand's 'Male and Female perceptions of Pair–Bond Dynamics: Monogamy in Western Gulls' is a metastudy in this line. The paper outlines the unusual situation of three scientists, one male and two female studying territorial defense, mate-feeding and copulation in colonies of Western Gulls. The paper demonstrates how women scientists reframe a number of recorded behaviours, previously identified by Raymond Pierotti, and how the change in perceptions of gull behaviour is extensively modified by the female scientist's input.

Behaviours labeled as 'attempted rape' and 'lesbian' gulls were reformulated by the female scientists' observations. The 'attempted rape', a term originally coined by Raymond Pierotti, occurred between males from adjacent territories and nesting females when the male of the bonded pair had gone for food. Reperceived by Anett and Hand, the behaviour was re-identified as a vigorous and always successful defence of territory against large poaching males by the smaller female birds. That is, the males appeared to be attempting a territorial takeover, rather than attempting some form of illegitimate access to the body of the female gull, and the female gulls exercise uncompromised agency in holding the territory for themselves and their absent mate. The 'lesbian' pairings of female birds to bring up a clutch of eggs was also rewritten, not just linguistically but also scientifically. Originally Pierrotti saw this 'lesbianism' as aberrant sexual coupling with one female gull acting out masculinised behaviours; however, the final explanation had nothing to do with projected human patterns of sexuality in the studied birds. High levels of DDT had reduced the number of functioning male embryos in some populations, this led to female biased sex ratios that necessitated some female gulls having to support other female gulls to rear their clutches. As DDT levels fell in the environment, gull pairing returned to predominantly heterosexual combinations.[85]

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85 R. Pierotti, C. A. Annett and J. L. Hand, 'Male and Female Perceptions of Pair-bond Dynamics: Monogamy in the Western Gull', in *Feminism and Evolutionary Biology:*

The female scientists, who realized that such behaviours were complex and not just related to size or gender, further refined interpretations of dominance behaviours between the gulls. A degree of aggression certainly seemed to be the norm in male-male interactions, but in male-female interactions cooperation could be seen as the measure of success. Males who cooperated with females fared better than those who did not. Males were also no longer seen as 'forcing' females to incubate eggs for long periods. Rather, careful analysis showed that females controlled the nesting position, which was in fact the most comfortable and desirable place to sit. Males requesting a turn to sit on eggs were often refused by the female who maintained her privileged position. The female gulls were not passive, and neither, for that matter, were the chicks. In this new, less-than-patriarchal, carnivalised gull family, chicks that left the nest were no longer seen as victims of potential siblicide dominance behaviours; rather, they were seen as behaving with agency because they packed their bags and left to find foster parents who offered better quality food!

This particular project is immensely revealing of the mapping of white, middle-class American family values into studies of animal behaviour; however, the scientists who authored the paper seem unaware of the carnival ironies that attend their opening up of the gull family story: if the original story was found wanting due to its ignorance of feminist understanding, might not this story too be found wanting on the grounds of yet 'other' understandings? For example, one narrative in this article is about a one legged, male gull that successfully rears a clutch of eggs with a female partner despite the fact that he could not copulate due to his injury. This inclusion of a 'grotesque' body was framed simply as a 'reproductive strategy', but it is sometimes difficult to know exactly what 'reproductive strategy' means. The female pairings during the shortage of male gulls was a 'reproductive strategy' in response to environmental pressure, but the 'reproductive strategy' of the one-legged gull seems a different kind of narrative. What if this unusual narrative is retold as a 'disability' or 'surrogacy' story? What kind of values are transported into the stories, and conversely, what kind of values are re–exported back into human stories of reproduction? How does the unintentionally amusing tale of the one legged, impotent, step-parent gull fit within sociobiological concepts of altruism and fitness? Why would an animal in the wild select such a reproductively disadvantaged mate? What kind of ingenuity was exercised to overcome the serious problem of sexual incapacity? How did an

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Boundaries, Intersections and Frontiers, ed. Patricia Adair Gowaty (New York: Chapman and Hall, 1996), 261-276.

'agreement' occur that allowed the damaged bird to maintain the full status of reproductive partner when the eggs in the nest were not his? And, of course, it was very civilised of him not to kill offspring he plainly had not sired. Beyond these questions is the issue of environmental agency on the behaviour of the birds over a fairly short space of time. In this posthuman agential model of carnival, the sinister molecules of pesticide play a role that overrides even genes and leads back to an interspecies affect that demands further political analyses. Following this line of interrogation, it is possible to see how challenging a sociobiological story can lead to highly productive multidisciplinary ecofeminist readings of biological science.

Earlier sociobiological stories yield similar problematic language, with its accompanying problematic logics, to the gull study. Ruth Bleier documents field studies on the 'rape' of flowers, the 'adultery' and 'prostitution' of birds, and even the 'homosexual rape' of parasitic worms. This is language that colours and compromises scientific research with its unrestrained anthropomorphism, but it only becomes apparent through feminist critique. Bleier also sees a problem in the selectivity of sociobiological arguments. Where, she asks, are the stories of male Rhea birds that patiently incubate eggs, or the female South American Jacana bird who keeps a 'harem' of male birds, or the Emperor Penguin father who stands nearly immobile for two months to incubate the egg produced by the male and female? Why does sociobiology so insistently prefer stories of female monogamy and male promiscuity?[86] Interventions in sociobiology, such as Bleier's, opens a carnival possibility of body/behaviour that insists on supporting a rich potential of subversion, inversion and difference in body and behaviour, and draws attention to the discriminatory dimensions of scientific story telling.

In the same decade that Bleier was asking her questions about the sociobiology project, Donna Haraway published *Primate Visions: Gender, Race, and Nature in the World of Modern Science.* This text moves deeply into the layered and complex stories of an entire discipline. Her exposé of primatology reveals linguistic prejudices, gendered practice, academic influences and genealogies; the local, global and historical context of the studies; political transferences; the impact of the women's movement on both female participation in, and the material focus of the discipline; and a multifocal, multidisciplinary analysis informed by a carnival of speaking positions and theory. *Primate Visions* is a confrontational lesson in the heteroglossic and endlessly dialogic nature of intersections of the material/natural world, ideology, history, personality,

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86 Bleier, *Science and Gender*, 31-34.

science and storytelling. Haraway's complex accounts of primate knowledge put the scientific and academic worlds on notice that its authority is under scrutiny and non-reflexive versions of natural stories are no longer sufficient. For her, it is vital to understand the observer's world in all its complexity as an inseparable adjunct to scientific activity, and to understand that observation is never neutral or disinterested but is socially produced. This is a particularly important message in primatology, a field ripe for 'resolutely adaptationist' sociobiological interpretation,[87] and Haraway works to undo that possibility in a way that foreshadows Barad's multiagential posthuman performativity.

Haraway presents the collection as 'non-innocent' cultural studies: a feminist and a scientist, she turns a compound critical eye on primatology, the most poachable scientific discipline for sociobiology, stripping it of a capacity to nourish only particular stories of human prehistory. This does not mean she fails to recognise that sociobiology had already left its mark on primatology. For example, the politically ambiguous primatologist Sarah Blaffer Hrdy combines feminism and sociobiology in her investigations of reproductive choice and parenting behaviours in primates and human cultures.[88] Haraway reads Hrdy as sociobiological in her choice of academic mentors (Irven de Vore, Robert Trivers and E.O.Wilson) and favouring selectionism as the primary evolutionary force.[89] However, she also sees Hrdy as contributing to stories of female agency in 'self – and species forming dimensions' by elaborating on female reproductive fitness and making it contingent with 'female choice of mate, female elucidation of male support and protection, competition with other females for resources, cooperation with other females, and female ergonomic efficiency'.[90]

Hrdy, as an early feminist sociobiologist, is a carnival figure. Part of her carnival identity is found in the ambiguous and unusual political position she occupies. Debates about gender issues have regularly flagged an incompatibility between sociobiology and feminism, and Hrdy has certainly had feminist critics as well as being tokenistically appropriated by male sociobiologists.[91] Part of her ambiguity has

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87 Haraway, *Primate Visions*, 213.
88 Sarah Blaffer Hrdy, *The Langurs of Abu: Female and Male Strategies of Reproduction* (Cambridge, Mass.: Harvard University Press, 1977); Sarah Blaffer Hrdy, *The Woman that Never Evolved: with a new preface and bibliographical updates* (Cambridge, Mass.: Harvard University Press, 1999); Sarah Blaffer Hrdy, *Mother Nature* (London: Vintage, 2000).
89 Haraway, *Simians, Cyborgs and Women*, 99-101.
90 Haraway, *Primate Visions*, 365.
91 Michael Ruse, *Darwinism Defended: A Guide to the Evolution Controversies* (Reading, Mass.: Addison Wesley, 1998), 121. Ruse co-opts Blaffer Hrdy to argue that Darwin is both feminist and sexist. See also Linda Marie Fedigan, *Primate Paradigms: Sex, Roles and Social Bonds* (Chicago: The University of Chicago Press, 1992); Fedigan rebukes Blaffer Hrdy for her

depended on her holding to feminist argument, but also insisting on utilizing the sociobiological model to explore gendered investments. Other parts of her carnival identity depend on what Bakhtin calls 'market place' language, and her academic focus on the lower stratum of the body, the reproductive function.

Much of carnival is about male/male competition, sometimes in the shape of battles between opposing groups and sometimes in the shape of personal drubbings. So is sociobiology – recall the importance of the aggression gene and the focus on dominance in animals. Much of carnival is also about the 'lower stratum', the animal body. Sociobiology tends not to focus on excretion, but does concentrates on access to food and reproduction, frequently linking human and primate reproductive behaviour and practices. Over three decades Hrdy discusses what can be understood as the grotesque and transgressive – female sexual pleasure, male/male violence, male/female violence, and male and female infanticidal practices.[92] Her preoccupations within sociobiology are survival in terms of resources, social hierarchies, competition and sexual behaviours – all the literal content of carnival life, albeit changed through the tone of the discussion. Her 'market place' language is not the one Bakhtin describes for carnival. Gone are the vulgarity and curses, but the language is one of barter, the language of buyers and sellers in the market place. Haraway speaks to the underpinning of biology and sociobiology with capitalist and patriarchal discourses, from Yerkes' idea of 'nature and society as managed capital' to Wilson's 'rationalised altruism in a competitive world'.[93] She points this out as something militating against developing a socialist-feminist life, but Hrdy co-opts this language and reinscribes masculinist economics with feminine choice and power. Is she subversive? It would appear so. Does she collaborate with discourses that feminism frequently identifies as unfriendly? It would seem so. Hrdy is both feminist *and* sociobiologist and a large part of her success lies in being academically multilingual and her capacity to directly address life and death choices around the creative force of reproduction.

In *Mother Nature*, Hrdy uses a special sociobiological speech constructed from anthropology (her undergraduate major), Bowlby's theory of attachment (psychology) and the language of economics (as co-opted by sociobiology) applied to a curious mix of primatology, history, ethnology and Western fiction. Her examination of primate differences, foraging human cultures in Africa and more modern European history is

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goal directed interpretation of primate behaviour. Also see Haraway, *Simians, Cyborgs and Women*, 90-108 for a discussion of Blaffer Hrdy's politics in the infanticide stories.

92 Hrdy, *The Langurs of Abu*, and Hrdy, *Mother Nature*.

93 Haraway, *Simians, Cyborgs and Women*, 45.

completely underpinned by a commitment to capitalism and the application of capitalist principles to sociobiological resources, together with a carnival lack of inhibition on the grotesque and fecund body. Consider the gorilla mother eating a placenta 'like a pizza',[94] the chimpanzee mother who is nervous about other chimps 'snacking on her new born baby',[95] and human breast milk as a pharmacopoeia that can not only nourish infants but also prevent nappy rash and act as antibiotic eye drops.[96] With images like these, Hrdy evokes the lower stratum as surely as Rabelais. Bakhtin also reads the pregnant hag as the ultimate birth/death mandala in the medieval carnival, for Hrdy this mandala is seen in the patterns and practices of reproduction and infanticide. The death of one child can mean life for another, the possibility of food for all or correct gender structure in a family needing certain concomitant benefits. This is not to say that Hrdy tells the good carnival story and Wilson/Dawkins the bad one. Rather, it is to say that her story shares the Medieval thematics of carnival with them, and that she recognizes by the force and particularity of her language the fragility of the contemporary systems of knowledge she works with. While Wilson and Dawkins both readily allow patriarchal and colonialist expressions centrality in scientific discussion, Hrdy uses complex, interdisciplinary language to identify those exact threads of power and to counter them. To use carnival metaphors and aesthetic, the sociobiology/ neo-Darwinist camp bear leads unstable monsters created from uncritiqued social science and science stories into the science carnival. These monsters are animated by nostalgic politics, and in some cases downright misogynistic and racist politics. Hrdy on the other hand, constructs her interdisciplinarity with more care and political awareness. They lead monsters into the carnival, but Hrdy is more like a female organ grinder accompanied by a dancing female primate.

As a writer, Hrdy is careful around the traps that sociobiology sets, but it is difficult to avoid them. She insists she works with phenotypes, not genotypes, genes being only codes for proteins not behaviour, but occasionally she becomes problematically hypothetical (for example) when speculating on genes for female modesty.[97] Her emphasis is also relentlessly neo-Darwinian with her phenotypes, but she does balance the survival challenges of the Pantagruel vision with the rich, reproductivity of the Gargantuan world. In terms of science, Haraway explores the apparent impasse created by the combination of Hrdy's feminist politics and her patriarchal, sociobiological

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94 Ibid, 167.
95 Hrdy, *Mother Nature*, 161.
96 Ibid, 136.
97 Ibid, 259-265.

training. In the end, she reads her as deeply ironic in her confrontational 'female genetic investment strategies'.[98] This does reflect the nature of her project. Hrdy's deliberately politicized interdisciplinary answer to masculinised sociobiology is to remind her fellow scientists that reproduction is central territory of evolution territory, and even in pre-contraceptive history and in the jungle, females make many of the most subtle yet significant decisions about that process.

Carnival and sociobiology: new directions, possible conclusions

Bakhtin says that carnival is relevant to science and that in times of carnival, science will also be implicated in the loss of boundaries. While alternative readings of certain stories have emerged in the cultural studies of science, particularly in feminism, carnival has not really been utilized as a theoretical tool to situate scientific stories.[99] Carnival clearly runs against the very structure of science with its category crises and collapse of the rule of authority, but there are definitely links between neo-Darwinism and sociobiology and carnival, both within the general context of science and with regard to the specifics mentioned in this chapter. Sociobiology is science politicized to the point of caricature in its own extremity, and it problematically suggests that a new scientific narrative can magically appear from the tired genres of reductionism and scientific positivism. Sociobiology, however, is not just politically reactionary. As a discipline, it sign posts epistemological change, working on the dissolution of some of the most potent boundaries we think with – cultural dualisms like nature/culture, human/animal and mind/body. Sociobiology also suggests from its extreme political tendencies what a post-carnival or post neo-Darwinist politics of science cannot be.

Problems have been identified in this chapter with respect to constructions of interdisciplinarity and the way politics guides the sensibilities of pot-pourri science. Behind the problematic interdisciplinarity of sociobiology lies that invisible scapegoat, the gene, the foundation of neo-Darwinist reductionism that does not and cannot work as the governing unit of living activity. It cannot work because the life stories of evolutionary subjects are immensely complicated and, as Haraway says, no single

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98 Haraway, *Primate Visions*, 349-367.

99 Carnival theory has not previously been specifically used as a theoretical approach in studying science; however, it should be noted there are significant intersections between carnival and cyborg theory, which is foundational to Haraway's feminist/ecofeminist critiques of science. See Bakhtin, *Rabelais and His World* 26-27: 'The unfinished and open body (dying, bringing forth and being born) is not separated from the world by clearly defined boundaries; it is blended with the world, with animals, with objects.'

'agent-unit' be it gene or species, meme or entire culture can bear the burden of directing all evolution:

> No bounded body seems able to resist limitless fragmentation to become at last the luminous unit–agent acting strategically to stay in the game. Who is playing?
>
> Has the evolutionary play in the ecological theatre become a video game on an automated battlefield? No element of structure and function can unify all the narratives of biological meaning. Species, population, social group, organism, cell, gene: all of these units turn into powder under the explanatory burdens they must bear. No unit, least of all the individual, sexually reproducing organism, is a whole, classically reasonable, potentially rights–bearing subject in the realm of nature. The organism is in constant danger of resolving into nothing but a proximate means for the strategic ends of its own genes. [100]

Reductionism cannot hold at this point in history, but it is helpful in the overblown disorder of carnival to understand that a discipline that seeks to reinstate a univocal resolution to complexity is actually in itself complex. Claiming stability does not produce stability, and no shifting authority, such as the ones examined in this chapter, can ever hope to clarify social, political and cultural ambiguities through science. Everything is compromised: witness arch conservative Wilson's claims to be 'liberal'; witness Dawkins morally driven autonomous complex about science; witness Pierotti and Hands' pesticide contaminated lesbian gulls; witness Rushton's gene justified resuscitation of phrenological 'science'; witness feminist Hrdy's genic economy of motherhood. Never a faithful story of origins and development, sociobiology's greatest significance lies in its power to unravel itself and other biological stories and its positive non-dualist contribution to potential science discourses. As scientist Peter T. Saunders suggests, there is often a 'misplaced concreteness' in sociobiology,[101] and as scientist David Hull, suggests it is important not to work only from current systems because that will inevitably lead to a perpetuation of errors and clichés. For himself and many others, Hull sums up the abundant carnival of nature and the scientific distortion of neo–Darwinism in this lovely quote:

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100 Haraway, *Primate Visions*, 353-354.
101 Saunders, 'Sociobiology: A House Built on Sand?' in *Evolutionary Processes and Metaphors*, ed. Ho and Fox, 286.

The paradigm of an organism is an adult vertebrate, preferably a mammal. Unfortunately, these paradigmatic organisms are at the tail end of several important distributions. The vast majority of organisms that have ever lived have been small unicellular, and asexual. According to recent estimates, systematists have described nearly 1.7 million species of organisms. Of these, about 751,000 are insects, 250,000are flowering plants, and only 47,000 are vertebrates. But nearly all verterbrate species have been described, while most species of insects remain undescribed. According to one estimate, 30 million insect species are probably extant. But even that number shows a bias because it includes only extant organisms when easily 99 percent of the species that have ever lived are extinct. Roughly 3.5 billion years ago, life evolved here on Earth. Not until 1.3 billion years ago did eukaryotes evolve. None of these were large multicellular organisms, not did they reproduce sexually. Multicellularity and sexuality evolved only 650 million years ago, during the Precambrian era. Hence it seems strange to pick even insects as the paradigmatic organism, let alone verterbrates. The most common organisms that ever existed are blue–green algae.

None of this would matter to science if similar biases did not influence how evolutionary biologists think of biological evolution. When we think of evolution, we tend to think of fruit flies, flour beetles, deer, and humans. We do not think of slime molds, corals, dandelions, and blue–green algae, but if evolutionary theory is to be truly adequate it must apply to all sorts of organisms, not just to those organisms most like us. Multicellularity and sexuality are rare, peculiar, aberrant, deviant, yet nearly all the literature of evolutionary biology concerns large, multicellular organisms that reproduce sexually, and almost none of it deals with the vast majority of organisms. Critics complain of those biologists who want to generalise from the evolution of ordinary phenotypic traits of most of the organisms that have lived. If we are not sure whether our current understanding of biological evolution applies unproblematically to reproduction in blue–green algae, perhaps we should be a bit

> cautious about generalizing to the social organization of African hunting dogs or Yãnomamo Indians. To put this cautionary note differently: One should not dismiss the cultural or conceptual evolution as aberrant on the basis of such peculiar phenomena as the transmission of eye colour in fruit flies. Perhaps a theory of evolution that would be adequate to handle the entire range of organisms that have functioned in this process might also be adequate to handle cultural and conceptual evolution. [102]

Hull is a carnivalistic thinker, positively predisposed to sociobiology, an inclusive rather than exclusive theorist. His demand for sociobiology to account for the peculiar favouritism of nature for blue green algae at the end of this chapters discussion is both humorous and appropriate as questions on the 'subject' 'matter' of the discipline multiply.[103] He writes a very broad based, sensitized evolutionary script for planetary life, so he can also have a final word on the construction of scientific authority. According to Hull, Kuhn did not go far enough on the subject of scientific communities. He believes that, while there may be cooperation, there is rarely true consensus in the community of scientists. Instead, Hull argues for a sort of eternal intragroup and intergroup dissonance, one where no individual thinks exactly the same way about an issue as any other individual, and every individual will likely subscribe to different beliefs and ideas at different stages in their professional life. It is a position that sounds close to Harding's 'standpoint science', but it also resonates with Bakhtin's carnival notion of a 'gay relativity of prevailing truths'.[104] The end result is that sociobiology presents many problems and it has been appropriated by individuals wanting to argue their political conservatism through science, but it also contributes to the ecofeminist possibility of post neo-Darwinist science. It is doubtless one of the tools that is both accidentally and willingly assisting to dismantle the dualisms of the father's house.

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102 David L. Hull, 'Interactors Versus Vehicles', in *The Role of Behaviour in Evolution*, ed. H. C. Plotkin (Bradford: Bradford Book, 1988), 220-221.
103 Barad, 'Posthuman Performativity', 801-831.
104 Bakhtin, *Rabelais and His World*, 11.

Chapter Four
Just Add Water

Most studies ascribe the formative cause of evolution to natural selection, while the organisms for the most part are regarded as the inert material cause. This is clearly wrong, for the organisms are themselves the originators of the forms (morphological, physiological and biochemical) on which natural selection can act. Thus, both material cause and a large part of the formative cause reside properly within the organism themselves.

Mae-Wan Ho[1]

This idea of 'Ecological and Evolutionary Cascades' (EEC's) is not entirely speculative. For example, the dietary shift by the Koshima troop of Japanese macaques to digging for peanuts buried on the beach, led to juveniles bathing, swimming and even diving for seaweed. One individual swam to a nearby island.... By a small extension in dietary habits the troop had grated [sic] an additional way of life on to their previous mode. They were on the borderline of becoming partially marine organisms. Not only would this open up a whole new set of ecological opportunities it would also expose the troop to a new series of physical pressures (i.e. the different mechanical requirements of swimming).

Russell D. Gray[2]

I shall always be grateful for the things my mother taught me. Though she soon decided that war was for the future, she was the first to recognize the possibilities, and the problems. She knew that if we went down the evolutionary path to war, the boys would take to beating up the neighbors, but she could think the whole thing through. She knew that once they got the knack of it, they'd soon take to beating us.

Murder and Mayhem are thoughtless, uncivilized, backward-activities, leading one way only, back to the trees, said Mother. She stuck to the peace, although she knew the threat of war.

Instead of warfare, Mother substituted cricket.

'See that thighbone of giraffe?' Mother asked my sister Giselle. 'I want you to go and get it for me.'

'What, go down into the valley with all those *Homo habilis* yoicks?'

'Now. This minute.'

Rosaleen Love[3]

Introduction

The prehistoric human body is a carnival site within the field of evolutionary theory. Primate bodies and behaviour, and pre-hominid bones, bodies and behaviour, generate debates claiming to depict ancient truths but those narratives and bodies are deeply inflected with perceptions and ideas underpinned by contemporary politics, religion and science. Feminist speculative fiction author Rosaleen Love satirises science stories collected around human evolutionary theory in her anthology, *Evolution Annie*. 'The Palace of the Soul' is about the 1912 Piltdown Hoax, where the brain case of a modern human was teamed with an Orangutan jawbone and used to fool paleontologists. Her

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1 Ho, 'Beyond neo-Darwinism', 581.

2 Russell D. Gray, 'Metaphors and Methods: Behaviourial Ecology, Panbiogeography and the Evolving Synthesis,' in *Evolutionary Processes and Metaphors*, eds. Mae-Wan Ho and Sidney W. Fox (London: John Wiley and Sons, 1988), 229.

3 Rosaleen Love, *Evolution Annie and Other Stories* (London: The Women's Press, 1993), 10.

conclusion is that, while the perpetrator of the hoax was an educated professional in the field, it may be the skull itself that is the trickster. The story implies that, while material phenomena like fossilised bone can appear to hold a stable scientific meaning, very different stories can be told about the same piece of bone. In the title story Love speaks to gendered bias in human evolutionary science stories. A pre-hominid woman narrates life in the Pleistocene. With her mother and sisters, she stays in camp accomplishing the real business of accruing culture, mostly by capitalizing on accidents like fire, while the post-simian men and boys are off on 'what they like to call hunting, but I like to call mucking around in the bush'.[4] Love's writing is funny and pointed. She reminds the reader that stories about early humans *are* stories. Her message is that no one can ever really know what happened so far back in time, and our own current cultural preconceptions and biases will deeply affect any story we tell.

The Aquatic Ape Theory (AAT) is another kind of destabilizing feminist challenge to the andocentric bias and preconceptions in evolutionary story telling. In some respects it is also fictocritical, weaving captivating stories of possible pre-hominid experience and using scientific theory and information in a speculative way. Originating as a hypothesis with distinguished marine biologist, Alister Hardy, the AAT has been predominantly developed by popular science writer Elaine Morgan into a complex, multidisciplinary challenge to male-centred stories of human emergence. The AAT is a democratically open narrative underpinned by radical feminist politics. It focuses on humans as the aberrant primate, rather than the heroic primate, and it presents as a carnival story that subverts and ironises scientific narrative and process in a number of ways.

Hardy's original article, published in 1960 in *New Scientist*, was entitled 'Was Man More Aquatic in the Past?'. His thesis was that 'a branch of ... primitive ape-stock was forced by competition from life in the trees to feed on the sea-shores and to hunt for food, shellfish, sea urchins etc., in the shallow waters of the coast.'[5] His arguments for assuming a sub-aquatic detour in human prehistory included man's grace and endurance when swimming, his hairlessness, his upright posture – which Hardy believed could have come from wading, the unusual layer of subcutaneous fat found in humans,[6] and the realistic potential for tool use which may have occurred when the

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4 Ibid, 5.
5 Sir Alister Hardy, 'Was Man More Aquatic in the Past?', *New Scientist* (1960), 642-643.
6 F. Wood Jones, *Man's Place Among the Animals* (London: Edward Arnold, 1929). This observation of the extra layer of subcutaneous fat on humans originally came from Jones, a comparative anatomist, who also drew attention to human hair loss patterns and likened both features to aquatic mammals.

proposed human ancestors needed to access water line food sources such as oysters and crabs.

Ten years later, his idea was taken up and developed by Elaine Morgan who has since published five popular books on the subject. Her approach is sociobiological and interdisciplinary, argued through functional morphology and social anthropology, which she supplements with paleogeography and with analyses of convergent aquatic features in humans. In *Descent of the Child* she summarises her development of Hardy's thesis, with its concentration on physiology:

> The strongest evidence in support of the AAT is anatomical. A list can be drawn up of all the physical features distinguishing humans from apes – such features as the loss of body hair, subcutaneous fat, face to face copulation, the shedding of tears, the hymen, volitional breath control, the diminution of the apocrine glands, the migration of the vagina to a sheltered site within the body wall, and the descended larynx. None of these features is found in savannah mammals. But examples of all of them can be found among those species of mammals which have adapted to aquatic or semi-aquatic life, such as whales and dolphins, seals and sea lions, manatees, hippopotamuses, otters and beavers.
>
> In the context of this book the question is whether a semi-aquatic stage in the evolution of humans would offer a possible explanation for some of the anomalous features of our offspring, before and after birth – the vernix caseosa, the shedding of the lanugo, the fat layer, bipedalism, speech and brain growth.[7]

Beyond addressing the physical curiosities of the modern human body, Morgan takes a speculative evolutionary argument and rewrites it in significantly subversive ways. Her argument is that females, children and the environment drive human evolution at least as much as male dominance, territoriality and reproductive urges.

This chapter will initially look at Morgan's rescripting of human evolutionary stories. She will be contextualized in the light of other feminist interventions in that area, examined for her unusual academic genealogy, for the open model of science she promotes, for her complex relationships with sociobiology, orthodox Darwinian science and the post neo-Darwinian stories of this thesis, and for her

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7 Elaine Morgan, *The Descent of the Child: Human Evolution from a New Perspective* (London: Souvenir Press, 1994), 158-159.

carnival/ecofeminist politics. While the AAT is implicated in sociobiological story telling, and is supported by adaptationist/selectionist orthodoxy, it also challenges that orthodoxy through its radical feminist politics. The focus of the AAT theory on the vulnerable members of the human community and the openness and oddly democratized growth of the AAT as a cultural site, has led to popular interest and contribution and an interdisciplinary involvement from geologists, microbiologists and paleontologists prepared to identify themselves with the narrative.

As well as subverting popular human evolutionary stories and most paleoanthropological stories, the AAT contains within its disruptive construction connections to 'post neo-Darwinist' stories. These are stories that challenge the metanarrative of Darwinian and neo-Darwinian change. Darwinism and neo-Darwinism depend upon random mutation, gradualism, competition and selectionism as primary evolutionary forces. Post neo-Darwinian stories acknowledge these stories as significant, but a post neo-Darwinian perspective also support notions of rapid change, organism/environment feedback loops, cooperative development within and between species, multi-dimensional panbiogeography and interdisciplinary studies of life. Much of the latter is not overt within the Aquatic Ape Theory itself, but becomes apparent when the theory is critically reviewed.

As well as authoring direct and embedded subversive science stories, this chapter argues that the AAT lends itself to a carnival reading due to its focus on irregular, non-classical bodies and its oddly material/discursive and dialogic construction. The AAT focuses on the scientific production of the 'grotesque' bodies of prehominid women and infants, but incorporates multiple narratives about bodies demonstrating 'intra-relationships' of human, viral, continental and sociocultural bodies.[8] The vulnerability of the human body in its environment is perceived through the carnival traditions of thrashings and beatings. This is a seamed, unauthorized story that challenges both the integrity of the dominant, classical, closed, masculinised body and the rule of prevailing truths and authorities. In conclusion, however, it is argued that there is a potential new unity within this complex story; that is, an ecofeminist politic that drives the theory and prompts the man-the-hunter narratives to recognize and incorporate the occluded bodies of the female and the child into a multi-agential story of environment and evolution.

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8 Barad, 'Posthuman Performativity', 821: 'Meaning is not a property of individual words or groups of words but an ongoing performance of the world in its differential intelligibility. In its causal intra-activity, "part" of the world becomes determinately bounded and propertied in its emergent intelligibility to another "part" of the world. Discursive practices are boundary making practices that have no finality in the ongoing dynamics of agential intra-activity.'

Scripting the AAT

Anthropological extrapolation from human fossils originated with Raymond Dart. Dart found the fossilised skull of the Taung child in South Africa in 1925.[9] The skull was significant because it had a larger brain than any known primate and the foramen magnum, the hole in the skull for the spinal cord, indicated the child walked upright. Dart's enthusiasm led him to propose in his original paper that this was a species that had come out of the jungle to the savannah, to an environment that 'sharpened the wits, and quickened the higher manifestations of intellect in direct response to keen competition and the swiftness and stealth' of prey and predators.[10] In the 1930s, following *Australopithecine* cave finds that were fossilised together with many cracked and broken gazelle bones, Dart became convinced this was evidence of man as 'killer ape', prehistoric man the predator, and he wrote journal articles to that effect. Dart's story telling was not well received by some scientists, but it clearly made a deep impression on the field and in the culture.[11]

According to Adrienne Zihlman, the killer ape stories dominated for some time and social group formation and potential cultural developments in protohominids, including mention of females and offspring, did not enter Paleolithic stories until the early 1950s. According to Zihlman, by the mid-sixties, ethnographic information and popular texts had both 'formalised the concept of "man the hunter" and simultaneously provided a means to challenge it'.[12] Donna Haraway includes Robert Ardrey, Desmond Morris, Lionel Tiger, Robin Fox, Konrad Lorenz, Steven Goldberg and Irven deVore among those that promoted the hunting hypotheses, but lists only Jane Goodall, Evelyn Reed and Elaine Morgan as writers with a different vision. The women primarily argued in the public forum that the hunting hypothesis gave primacy to aggression, xenophobia and territoriality in humans and there were alternative readings to human prehistory and culture.[13]

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9 Ian Tattersall, *The Fossil Trail* (Oxford: Oxford University Press, 1995).
10 Ibid, 57.
11 Roger Lewin, *Bones of Contention: Controversies in the Search for Human Origins* (New York: Simon and Schuster, 1987). Lewin discusses the politics of the field around the time of Dart's discovery and how the British group of paleontologists rejected Dart's fossil as an ape and were more committed to the 'Piltdown Man', which turned out to be an elaborate hoax. Later there was acceptance of the Taung child as an *Australopithicene* but the controversy then shifted to whether *Australopithicenes* were actually part of the human ancestral tree. The Leakey's have never accepted them, while Donald Johanson has founded his reputation and scholarship on his discovery of 'Lucy' as the earliest *Australopithicene* human ancestor.
12 Zihlman, 'The Paleolithic Glass Ceiling', 92-96.
13 Haraway, *Primate Visions*, 298-299.

In her deconstruction of masculinised evolutionary stories, Haraway pursues the academic genealogies of a number of women primatologists, 'daughters of man-the-hunter', tracing the social and cultural construction of their intellectual ideas,[14] but she does not further investigate Elaine Morgan. Haraway's critical frame of reference is the social and cultural construction of science stories, with an emphasis on feminist responses and resistances to patriarchal training within the academy, and Morgan does not fit those criteria. Morgan is a renegade, a patently odd mix in her qualifications, motivations, authorial processes and success. Crossing disciplinary and genre boundaries in significant ways, her first work was a blatant feminist polemic, but she moved on to effect thinking about evolution in mainstream science in unexpected ways. Part of her carnival identity then lies with the contrast she presents to Haraway's 'daughters of man-the-hunter'.

Morgan was born into a poor Welsh mining community, but excelled academically. At Oxford University she developed a strong interest in socialism and married a returned soldier who had fought in Spain against Franco's dictatorship. She began writing when the mother of young children, and had a long relationship as a scriptwriter with the BBC.[15] *The Descent of Woman* was produced because Morgan was 'fearfully cross' with masculine-centred stories of evolution.[16] Sir Alister Hardy was her academic progenitor, but he gave her no formal tuition. In fact, in an upset of conventional pedagogical authority, Morgan claims she approached Hardy and simply told him that, with or without his permission, she was going to explore his ideas further. Although he was initially 'shocked' at the idea, he encouraged her.[17] He even wrote the forward in 1982 for *The Aquatic Ape: A Theory of Human Evolution.* Morgan's position with regard to Alister Hardy is very different from Haraway's 'daughters of man-the-hunter'. Haraway speaks to the influence of Sherman Washburn, primatologist, on a generation of American educated women. Washburn was not an isolated force of cultural production in the training of that generation of American female primatologists, but he fostered his 'daughters' through his own protégés and from his training in physical anthropology, Professorial positions at

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14 Haraway, *Simians, Cyborgs and Women*; Haraway, *Primate Visions.*

15 See snailrind, *Elaine Morgan: Housewife, Screenwriter, Scientist and Author*, http://www.bbc.co.uk/dna/h2g2/A5316860 (2005) (accessed December 12, 2005); Internet Movie Database http://www.imdb.com/name/nm0604634/ (2005) (accessed December 7, 2005).

16 Libby Brooks, 'Come on in - the water's lovely,' *Guardian Unlimited* (on line), May 1, 2003. http://www.guardian.co.uk/life/interview/story/0,12982,946539,00.html (accessed December 11, 2005).

17 Elaine Morgan, 'The Origins of a Theory', in *The Aquatic Ape: Fact or Fiction?* eds. Machteld Roede et al (London: Souvenir Press, 1991), 5.

Columbia and UCLA, his grants from the Wenner-Gren Foundation and he drew on post-war archetypes that synthesized stories of early human bodies and behaviour for over thirty years.

Washburn's contributions to both primatology and the production of feminist resistances in primatology were timely.[18] Hardy's aquatic ape contribution, on the other hand, was not timely. Occurring to him much earlier in his career, he did not formally present the hypothesis until he had achieved his goals of Professorship at Oxford and Fellow of the Royal Society. Morgan contends he was advised against advancing the idea and, when he did present it, it was viewed as a late career eccentricity rather than a viable research topic.[19] According to Haraway, Washburn's hunter was more closely related to Dart's killer ape. That is, the killer ape still had blood on his hands, but in Washburn's story he was creating carnage because he had a family at home to support, which legitimated his actions. According to Haraway, Washburn's hunter played to values that were core to the white, western nuclear family in an unsafe white, western nuclear culture. Hardy's ideas just didn't have the same cachet. Hardy had the atomic ape bronzing up at the seaside, running into water to escape predators and living a fairly peaceful life while the entire extended tribe democratically scavenged easily obtainable, nutritional food on the shoreline.

With their vastly different reception and relevance, the two stories inevitably led to different feminist responses, practices and discourses. Washburn's coterie of feminist resistance formed a significant disciplinary group and began unraveling patriarchal assumptions and beliefs in primatology from within the academy[20] through postgraduate field research and academic publications, while Morgan occupied the lonely and ironic position of 'Hardy's bulldog', with no science background, excellent popular communication skills and little academic discipline. Her first book, published seventeen years prior to Haraway's *Primate Visions*, prepared the general science reader to understand that stories from ethology, biology, primatology and evolution are myth making activities and they contain unexpected bias.[21] For example, she used Christian origin stories in popular science writing well before Dawkins did, and her particular origin story was potent and disruptive.

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18 Haraway, *Primate Visions*, 186-230.
19 Morgan, 'The Origins of a Theory', 3.
20 Haraway, *Primate Visions*, 332-333.
21 Lewin, *Bones of Contention*, 30, talks about Misia Landau's identification of human evolution stories as hero myths that generate explanations of technology, morals and society.

Positioning Darwin next to Genesis in her introduction to *The Descent of Woman*, she warns that both stories ratify male dominance and superiority.[22] In a few short words, she defuses the polarity of the creationism/science argument and puts her readers on notice about a third option for human evolution that focuses on the culturally, socially and environmentally repressed. She lards her text with the language of fairy tales, flagging the ficto-critical dimension of her work. 'Once upon a time ... But which time?' and 'Long, long ago ... back in the mild Miocene, there was a generalized vegetarian prehominid hairy ape.'[23] When Morgan proceeds to attach the female pronoun to this public story about a pre-hominid ancestor, she challenges all previous stories and all stories yet to be told in a way that the 'daughters of man-the-hunter' do not. While Washburn's trainees present to Haraway a positive feminist pathway in science, they inevitably retain investment in their own patriarchal context. They do offer 'fruitfully contradictory and multiple possibilities for new links between knowledge and power'[24] but they cannot do what the un/disciplined, carnivalised Morgan and her aquatic ape do. Although the feminist primatology contingent question preconceptions in human evolutionary thinking with their own stories of sexuality, reproduction, provisioning and so on, it is not in their interests to completely unravel work accomplished through the academy and contemplate studying a watery origin for modern humans. In Kuhnian terms, Washburn's students deliberately expose anomalies and the politics of 'normal' science but stay within recognized paradigms, whereas Morgan is an 'outsider' who comes into a discipline, perceives the field in a very different way from the trained practitioner, and offers that rare 'switch in visual gestalt'.[25] Thus the scripting of this particular evolutionary story is differentiated in its origins from the scripting of scientific stories produced by feminist practitioners within newly politicized but traditional disciplinary boundaries.

Presenting a contrast to academic models of field review and careful development of resistant ideas, Morgan's story is a funny, eclectic, disruptive polemic. On analysis, her non-scientific approach borrows in an unauthorized way from the 'socialist science process', proposed by the October 29th Group from Wisconsin University. A feminist science project, the proposed ideal science model included, among other things, veracity above the pressure to publish, a democratic and communal social structure in science, community participation, and thoughtful rather than fashionable choices of

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22 Elaine Morgan, *The Descent of Woman* (London: Corgi, 1974), 7.
23 Ibid, 21.
24 Haraway, *Primate Visions*, 286.
25 Kuhn, *The Structure of Scientific Revolutions*, 85-86.

research topics.[26] This open model is close to Morgan's praxis, which actually carnivalises the science space. The AAT is particularly democratic and, in carnival fashion, demonstrates a loss of the divide between performers and audience, particularly between scientist and non-scientist.

Through the AAT, institutionalised certification is made ambiguous as a privileged marker of knowledge with regard to sociobiology, popular science and even evolutionary theory.[27] While the AAT has been developed and championed by Elaine Morgan, and she is significantly identified with the discourse, this theory is one that perplexes western notions of ownership of ideas and structured pathways of knowledge. The AAT is a highly interactive site on the Internet with 161,000 English pages listed under AAT discussion forums alone.[28] Morgan's email address is on the net as she contributes to the forums and she posts pages giving specific answers to specific critics or critiques.[29] This is carnival, a place where stage and footlights disappear and the performers and the spectators become indistinguishable in the process. Just as Morgan complicates and genders the liminality between land and ocean, so she complicates and genders the liminality between professionals and amateurs in human evolution. She does not displace culturally dominant methods of telling such stories, but she engages in academic exchange when professionals are willing to engage her and she contributes directly to the library of popular science publications. In turn, she is also a significant reader and contributor to the hoi polloi exchanges of cyber argument. Her activity in discussion forums is another aspect of Morgan's carnival intervention in the field. That she does not defer to the usual barriers between scientist/non-scientist, specialist/generalist or writer/reader marks her as a carnival figure with respect to authority and genre boundaries. She sees herself as a contender in an academic field, but also she sees those who correspond with her as legitimate contributors to the growth of the theory.

The pattern of response to the AAT from scientists has been ambiguous. A very few individual scientists have embraced her, a few have actively spoken against her, but the majority have simply ignored both the theory and the questions it raises. Those directly supporting the AAT include Derek Ellis of the University of Victoria in British

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26 Patricia L. Witt et al, 'The October 29th Group', 253-259.
27 As argued in Chapter Three, and later in this chapter, professionals and scientists can transfer out of their original disciplines to become 'recognised' experts in socio-biology.
28 Google search for 'AAT discussion forums' (Accessed October 10, 2006).
29 Elaine Morgan, *Re: AAT*. http://unauthorised.org/anthropology/sci.anthropology.paleo/july-1995/0067.html, sci.anthropology.paleo archive discussion forum (1995) (Accessed October 10, 2006) and Elaine Morgan, http://www.riverapes.com/AAH/Arguments/ElainesResponse.htm (Accessed October 10, 2006).

Columbia. Ellis is a specialist in arctic underwater environmental studies and salmon but has published a small number of general articles on the AAT.[30] Marc Verhaegen is a Belgian general practitioner who has also published a number of articles on the AAT and Algis Kuliukas is a postgraduate student at the University of Western Australia who is investigating aquatic 'side to side' walking in wading primates. Kuliukas and Verhaegen follow Morgan's open model of debate, participating extensively on the Internet forum sci.anthropology.paleo, and, in the way of carnival, often end up brawling with each other as well as their critics.[31] While the other supporters publish in minor journals and Verhaegen engages in public debate, Kuliukas is a more interesting figure for feminist analysis. He is completing a doctorate on the AAT but is having difficulty getting published.[32] He readily acknowledges his debt to Morgan's work, but his own redirects attention from the AAT to his own nomenclature for a sub-aquatic pre-hominid of 'river ape'.[33] On some levels this could be read as masculinist appropriation of the theory, but a feminist politic links Kuliukas' academic interest to his lived experience and a carnival politic drives his scientific story of subversion and he has also authored a fictional story of different bodies. Kuliukas writes that his wife gave birth to their fourth child in water and that prompted his research into aquatic origins, as it has also prompted him to conceive of a series of fictional children's books, the first one is on his website and has a female interspecies protagonist, 'Upe' the 'chimpanzilla'.[34] This 'story telling' across genre boundaries produces a carnival dialogue and shifts him closer to Morgan's original model, though he maintains the split between the fictional and scientific narrative more strongly than she does.

Scientists who have spoken directly against the theory are John Langdon, Adrienne Zihlman and some of those who contributed to the 1987 Valkenberg conference on the AAT. Zihlman has mentioned the AAT a number of times and has moved from ridicule to acknowledging legitimate feminist criticisms Morgan raises about

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30 Derek V. Ellis, 'Proboscis Monkey and Aquatic Ape', *Sarawak Museum Journal* 36 no.57 (1986), 251-262; Ellis, Derek Ellis, 'Is an Aquatic Ape Viable in Terms of Marine Ecology and Primate Behaviour?', in *The Aquatic Ape: Fact or Fiction?* ed. Machteld Roede, J.M. Patrick Wind, and V. Reynolds (London: Souvenir Press, 1991) 37-74; Derek Ellis, 'Wetlands or Aquatic Ape? Availability of Food Resources', *Nutrition and Health* 9 (1993), 205-217; Derek Ellis, 'Human Ancestors in Wetland Ecosystems', *ReVision* 18 no.2 (1995), 8-12.
31 Jim Moore, *Aquatic Ape Theory: Sink or Swim*, http://www.aquaticape.org/index.htm (Accessed March 30, 2007). Moore is a strong critic of the AAT seeing the theory as dangerously unscientific and he watches the forums carefully. Kuliukas argues that Moore often takes quotes out of context.
32 Personal communication, February 8, 2008.
33 Algis Kuliukas, *River Apes: A Different Story about Evolution*, http:www.riverapes.com/ (2007) (Accessed March 1, 2007).
34 Ibid.

representations of women in human evolution.[35] Langdon performs an overall critique, including scientific reservations, but he largely rejects the story because of its lay appeal, forcing a recreation of the boundary between performer and audience through an attitude of professional elitism and misreading Morgan's feminism as 'embittered and victimized'.[36] His misreading of the tone and content of Morgan's work highlights the problem of how Morgan's material hybridizes genre to a point of confusion for some readers. The Valkenberg papers, collected in *The Aquatic Ape: Fact or Fiction?* evidence a similar deep polarization on the part of the participants who clearly want the story to resolve into a more comfortable scientific narrative. The bottom line is that Morgan plunders stable scientific stories and destabilizes them in the process and her approach to science is irreverent. This is entirely in keeping for a carnivalistic tale that wickedly parodies current authorities, parades the grotesque and irregular body for public inspection, actively demonstrates that no discourse manages to completely contain or map the experience or history of the grotesque body, and simultaneously suggests alternative political directions in its unruly representations.

In her writing, Elaine Morgan privileges humour and colourful description over more careful and constrained scientific or academic expression, and she can be scathing – much more so of poorly thought out ideas than of opponents. Satire is a major tool for her as a writer, and this is part of why her ideas are so reader friendly. Politically, theoretically and linguistically she is confrontational and funny in her reinterpretations of human biology, evolution and sociobiology.

Although parody is less apparent in her later books, which seek to engage more formally with science, the original narrative of the AAT in *The Descent of Woman* repeatedly ruptures self-satisfied dialogues on human evolution with satirical passages that aim to expose the fragile reasoning that stands behind assumptions in human evolutionary ideas. Her use of masculine and feminine pronouns is non-innocent and deeply ironic. She assigns the female pronoun to the 'generalised, vegetarian prehominid hairy ape', the survivor of the Miocene, and the masculine pronoun to

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35 Jerold M. Lowenstein and Adrienne Zihlman, 'The Wading Ape: A Watered-Down Version of Human Evolution', *L.S.B. Leakey Foundation News* 18, Winter (1980). Zihlman is particularly irritated among feminist scientists with the aquatic ape story. Her initial response was to ridicule Morgan, saying a similar theory would be the evolution of an ape in the air, something akin to the Von Daniken story. Later, she acknowledged Morgan's role in dismantling some of the more unrealistic ideas about women in evolution, particularly with regard to the hunting model; see Adrienne Zihlman, 'Gathering Stories for Hunting Human Nature', *Feminist Studies* 11 no.2 (1985), 367-368. She has, however, never conceded scientific worth to the theory; see Zihlman, 'The Paleolithic Glass Ceiling', 104.

36 John H. Langdon, 'Umbrella Hypotheses and Parsimony in Human Evolution: A Critique of the Aquatic Ape Hypothesis', *Journal of Human Evolution* 33 (1997), 479-494.

'man-the-hunter'. Her expectations for man-the-hunter are not high. He is unable to run very fast in the new mode of locomotion that he has only recently adopted and he is very clumsy with the weapons he has just designed and placed in his newly freed forelimbs. Morgan says, rather than living on to create civilization as we know it today, he is more likely to be leopard dinner and his whole species is going to become extinct.[37] Morgan focuses in precisely those areas where dominant cultural stories seamlessly accommodate inconvenient details, such as physical vulnerability and environmental difference, and she then unpicks them. She relentlessly mocks popular writers like Robert Ardrey, Desmond Morris and Michael Chance. Giving quotes on the aggressive nature of man, she says:

> Try a bit of fieldwork. Go out of your front door and try to spot some live specimens of Homo *sapiens* in his natural habitat. It shouldn't be difficult because the species is protected by law and in no immediate danger of extinction. Observe closely the behaviour and interactions of the first twenty you encounter at random. Then, next time you are reading a sonorous statement about man, try mentally replacing the collective noun by the image with one of those twenty faces.
>
> "That window cleaner is one of the most sophisticated predators the world has ever seen."
>
> "The weapon is my grocer's principal means of expression and his only means of resolving differences."
>
> "The postman's aggressive drive has acquired a paranoid potential because his young remain dependent for a long period."[38]

While Morgan's collision of the twentieth century and the prehistoric can be dismissed as scientifically unsophisticated, it does work to illuminate assumptions that have been inherent in many scientifically imagined, presented and authorized prehistoric scripts. Her point, unrefined and funny as it may be in expression, is potent. Her parodies eloquently expose the investment late capitalist (sub)urban based science has in domination stories of prehistory, and the ironic contrasts those stories present to the 'evolved' culture that produces them. The AAT is carnival by being anti-heroic. It is not a competitive genetic success story as such; rather, it is a non-dominating, environmentally and gender responsive story of organism.

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37 Morgan, *The Descent of Woman*, 25.
38 Morgan, *Descent of Woman* 67.

Morgan uses laughter as antidote and criticism. What is interesting is that Morgan's carnival narrative works more effectively than academic debate when the rules of debate are not what they appear to be. In 1994 the popular right leaning, intellectual publication, *The New Republic*, carried a piece entitled, 'Feminists, meet Mr. Darwin'. The author, Robert Wright, is not a scientist or an academic. He is a journalist, who now writes evolutionary psychology texts. This article reiterates degraded versions of dominance biology to justify a range of gender inequalities from sexual harassment to unbalanced employment figures.[39] Anne Fausto-Sterling, Patricia Adair Gowaty and Marlene Zuk, science professionals specializing in evolutionary biology, attempted to engage with Wright. In 1997, they finally published a review essay in *Feminist Studies* expressing their frustration with Wright's 'extraordinary media access' and their own difficulty in publishing a reply to his material. In three years of trying, they had not succeeded in being acknowledged, and clearly felt ghettoised. The kind of dialogue they sought, however, assumed equal access and the potential for reasonable and informed debate – an open forum where they could just point out to Wright how he has misread Darwin. Such an approach relies on the kind of reason learned at the academy; however, carnival distorts reason and rules of engagement become distorted. What Wright primarily paraded in his work was his political extremism not his scientific knowledge, and that was what caught the public attention. In Bakhtinian carnival, dissonance is located between worldly authorities and the powers of nature as they affect and dictate the human condition, while in the postmodern carnival there is often dissonance between the languages of educated discourse and the power of prejudice. Wright is unlikely to have a road-to-Damascus revelation by reading an informed response to his article in the journal *Feminist Studies*, and his followers will choose to remain blissfully ignorant. This is territory that Morgan navigates by actively using carnival codes. She knows that successful forms of address in such contemporary exchanges can demand that appeals must be specifically to carnival politics not to information alone.

Morgan scripts the repressed – women, children, the environment – the very things that are customarily marginalised into numerous discourses, partly because of the way that she handles information and thinks about information. She is educated, but she is not a feminist who was groomed by postgraduate study in the academy. Rather, she moved from general arts to writing genre TV shows and then she moved into evolutionary science. *The Descent of Woman* and *The Descent of the Child* are

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39 Robert Wright, 'Feminists, Meet Mr. Darwin', *The New Republic*, November 28 (1994), 34.

separated by twenty-two years and the nature of Morgan's exchanges with the establishment changed during that period, but her politics changed little. Both titles extend Darwin's *Descent of Man*, and their subject matter forces a re-evaluation of excluded catalysts of human evolutionary change in sociobiological stories.[40] Rather than the male body, strong, carnivorous, clever, athletic, being the driver of evolution and leading humans inevitably to the official 'high' culture of civilization as we know it today, Morgan scripts the discomfited, protruding, secreting female body, and the oddly proportioned, dependent, energy intensive body of the child, as the forces historically and currently at work on both biological and social transformation.[41] In this she stands alone. Some of her protégés have taken up her challenges but her odd combination of sharp populism and eclectic information gathering are not something that can be emulated effectively. She remains quite autonomous with respect to those who dislike her work, despite borrowing extensively from their discourses and models.

Sociobiology, the AAT and carnival

The AAT in its original incarnation, *The Descent of Woman*, was simultaneously an answer to, and a collusion with, the sociobiological stories that had currency in popular science in the 60s and 70s. They were stories of origins and cross species relationships that accepted or promoted genetic selectionism as a powerful, significantly deterministic, way of shaping bodies and social behaviour. Morgan is sociobiological in that she uses natural selection as the mechanism for change in her stories of human evolution and she consistently ties biology and behaviour together. However, where Morgan extrapolates for an aquatic or subaquatic feature she does not argue for what Stephen Jay Gould and Richard Lewontin call the Panglossian paradigm, perfect genetic design. Rather she debunks sociobiological 'just-so' stories of human evolution, and scorns the notion that every detail of evolved life is to be explained as a selected response by the organism to new demands. To do so, she says, would be to ignore the many disadvantages that are built into the human frame and to treat biological change as an unlimited celestial mail-order catalogue:

> Dear Sir,
>
> Am returning fur coat as I have no use for it after all; kindly exchange for one pair of earlobes and 14 lbs of subcutaneous fat. The corrugator muscles arrived safely and are satisfactory, but both the

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40 J. Bronowski's famous BBC series *The Ascent of Man* went to air the year after the publication of Morgan's book.
41 Russo, *The Female Grotesque*, 8.

brain and the penis are 3 sizes too small for present needs, please replace. I could also use a nose, if you have any in stock.

And oblige, Yrs., N.Ape [42]

Her simultaneous disrespect for the sociobiological model and recognition of its authority is a marker of carnival. In a time of carnival, authority often occupies two contradictory positions simultaneously: the position of power it holds in a non-carnival space and time (so it is recognisable) and its carnival position of ambiguous, ironised, disempowered subject.

Utilising a selectionist paradigm for behaviour, Morgan argues – like Hrdy was to do some years later – for female sexual selectivity and female sexual pleasure. Unlike Hrdy, however, she does not argue through primate research, rather she debunks phallocentric readings of sexual attraction as the adaptationist driver that shaped emergent humans, and she does it in a popular science format. The identification of 'secondary sexual characteristics', such as enlarged female breasts, as enticement for the hunter to pair bond more strongly and stay at home more to help with the offspring is unacceptable to Morgan as an evolutionary mechanism.[43] Morgan strongly criticises the idea that male desire (whether it is for immediate sexual gratification or aroused by the promise of future fecundity) prompted the physical development of the human female form. She claims rather, that a streamlining of human physiology came from the demands aquatic or semi-aquatic living made on the prehominid primate. Reasoning through the AAT she suggests that, beyond generalised buoyancy, that the increase of fat deposits around human women's breasts finds an equivalent in the enlarged mammary glands of sirenians, or sea cows. In these species, a group that includes the manatee, the dugong and the now extinct Stellar's sea cow, nurturing of the young is done with one well-developed pair of pectoral breasts. The nursing in these species is often done in water and thus it is easier for females to float on their backs and pups to access their food supply. The expansion of the hips and increased fat

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42 Morgan, *The Descent of Woman*, 109-110.

43 Ibid, 17. See also Desmond Morris, *The Naked Ape* (London: Corgi Books, 1969), 58-69; Morris summarises thoughts of the time regarding human female secondary sexual characteristics, including the breasts enlarging to replicate the buttocks to attract males as the primary sexual position shifted from rear entry to ventro-ventral sex. Some of his other ideas include the roundness of the breasts emphasising the colour of the nipples to enhance sexual attraction and he comments that unfortunately the 'darker races' missed out on this particular stimulation. Human female breast development to encourage pair bonding is argued by Roger Short, 'The Evolution of Human Reproduction', *Proceedings of the Royal Society of London* 195 (1976), 3-24; J. Cant, 'Hypothesis for the Evolution of Human Breasts and Buttocks', *American Naturalist* 117 (1981), 199-204; C. Owen Lovejoy, 'The Origins of Man', *Science* 211 (1981), 341-350; F.S. Szalay and R.K. Costello, 'Evolution of Permanent Estrus Displays in Hominids', *Journal of Human Evolution* 20 (1991), 439-464.

deposits on the buttocks, according to Morgan, could have helped with buoyancy and heat regulation in the water, but also could have provided a comfortable cushion for a primate mother nursing a dependent infant for long periods on a sandy beach or sitting in a muddy mangrove. The penis became longer as the vagina became more inaccessible due to bipedalism and streamlining of the body, and estrus, overt signs of female receptivity at times of fertility, disappeared and the establishment of menstruation reflected a 'lunar biorhythm', commonest in marine creatures.[44] Her argument is highly speculative, but seeks material cause for material change in the environment and from the entire reproductive process, with a focus on infant survival, as opposed to seeing the primary driver for the changing female pre-hominid body as masculine sexual or reproductive desire.

Where she does explore sexuality, she tells a startling story that comes out of the period of time in which she writes, but one that is very complicated in cultural and scientific story telling. Three years prior to the publication of Susan Brownmiller's *Against our Will*, a feminist account of the sociopolitical power of rape, Morgan offers a biopolitical explanation of rape. According to her, the first rape was committed by a pre-hominid whose 'aggression brake' failed and this also happened to be the first example of ventro-ventral, face-to-face, sex. The early aquatic ape found herself being 'attacked' while on her back in the submissive position, and, according to Morgan, it simply shouldn't have happened:

> So nothing had prepared our aquatic anthropoid for what was happening to her now, being flung down on the shingle on her soft, wet hairless back and mounted the wrong way up....This one was emitting piercing shrieks. It was a natural reaction. She thought he had gone berserk and was aiming to disembowel her. "Shut up!" he explained, clobbering her a bit and trying to straighten out her knees, which she had locked into a panic-stricken foetal crouch. He was still convinced that once she understood what he was getting at, she would melt into his arms and cooperate with her usual enthusiasm.
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> But she didn't understand. Dizzy with terror, she was only aware that at the hands of this absolute beginner, her viscera were being squashed and the air compressed out of her lungs – and *that* had never

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44 Elaine Morgan, *The Aquatic Ape Hypothesis* (London: Souvenir Press, 1997), 152.

> happened in an amatory context to any quadruped, reptile or mammal, since the world began.[45]

According to Morgan, rape then became an entrenched species behaviour as all other surrounding males tried it too. Eventually the more aggressive males became more successful and produced more progeny. Although not articulated in this text, this results in an argument similar to the one made seven years later by Hrdy with regard to the infanticidal Langurs of Abu; that is, females cannot afford to avoid the aggressive genes of infanticidal males that will give their own offspring a reproductive benefit in the next generation.[46] Although Morgan's contentions clearly came out of early sociobiological thinking, they also came more from the raised awareness of gender violence issues in the 1960s and they left the water around the aquatic ape quite muddy.

With her particular rendition of prehistoric rape, Morgan actually establishes a tradition that went on to be supported by sociobiologists like Richard Dawkins. Dawkins countenances stories where genetic reproductive potential is maximised, but when the two writers are examined together they prove to be problematic to each other and to sociobiology. Dawkins names altruistic behaviours like care of the aged and contraception as genetic 'misfirings',[47] while Morgan identifies rape as a 'misfiring'. So, are both altruistic and aggressive behaviours genetic misfirings? An affirmative answer to that question would imply that sociobiological theory works around a genetically programmed but obviously mysterious 'norm', while a negative answer evidences a slippery slope to the story telling aspect of science. A likely scientific response might be dismissal of Morgan because of her lack of specific scientific credentials in the field, but Morgan is actually telling the *same* story of biologically inevitable, genetically selected sexual violence told by 'qualified' evolutionary theorists like Roger Short and Malcolm Potts, Randy Thornhill and Craig Palmer, and Richard Wrangham and Dale Peterson.[48]

These writers believe there is a high degree of genetic programming to violent behaviours like rape and they predominantly consider it from the masculine viewpoint. The key to understanding how a radical feminist text holds its politics while it is telling

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45 Morgan, *The Descent of Woman*, 78.
46 Hrdy, *The Langurs of Abu.*
47 The Evolutionist, 'In Conversation with Richard Dawkins' (1997).
48 Malcolm Potts and Roger Short, *Ever Since Adam and Eve: The Evolution of Human Sexuality* (Cambridge: Cambridge University Press, 1999); Randy Palmer and Craig T. Thornhill, *A Natural History of Rape: Biological Bases of Sexual Coercion* (Cambridge, Mass.: MIT Press, 2001); Richard Peterson and Richard Wrangham, *Demonic Males: Apes and the Origins of Human Violence* (New York: Houghton Mifflin Company, 1996).

a similar story to the politically nostalgic late twentieth century new right sciences such as evolutionary psychology lies in carnival thinking. Part of the answer is that the story is a public 'thrashing': a physical beating, usually funny within the context of carnival, but not always. Bakhtin comments on the generalized danger of carnival, while Russo comments on the specific dangers of carnival for women, and how women are in danger when they are both out of control and in control. This thrashing, however, is not just part of the physical spectacle of evolutionary theory, it is a politicized thrashing in that it confronts the authority of science with its own gendered understandings of extremity. As Russo says of feminist carnival, it suggests 'a redeployment or counter-production of culture, knowledge and pleasure'.[49] Over several decades in the late twentieth century, the story of this thrashing of the prehistoric ape-girl assists in ironising an oddly recognizable division in culturally based science stories. On one hand, professionals argue this ape-girl's beating is a product of continuing biological destiny, they naturalise it and write about it as a phenomenon to do with mammalian behaviour patterns.[50] On the other hand, while science naturalises the ape-girl's thrashing and rape, it treats with reverence the skeleton of the Pliocene ape-girl, Lucy.[51]

Lucy's bones are respected like holy relics by the culture generally and by the faithful patriarchs of paleontology particularly, and these bones do the job of preserving femininity in an elusive form that exists just beyond Latour's 'purified' human boundary. Further exaggerating this attitudinal split, and bringing the two ape women ever closer to the polarized Madonna/whore dichotomies is the phenomenon of the 'Dikika baby', a recently discovered fossilized child from the same family as Lucy. In paleontological articles, the Dikika baby is now known as 'Lucy's child' and has been connected to her in the popular press as if they form a parent-child dyad.[52] That the two fossils exist so far apart in time, the baby being tens of thousands of years older than Lucy, lets us know this is a carnival pairing. It is an immaculate conception that is ridiculous rather than miraculous, and that stands in starkly stereotypical

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49 Russo, *The Female Grotesque*, 213-218.
50 Potts and Short, *Ever Since Adam and Eve*; Palmer and Thornhill, *A Natural History of Rape*; Peterson and Wrangham, *Demonic Males*.
51 'Lucy' was discovered two years after *The Descent of Woman* was published. Lucy is a fossilised specimen of *Australopithecus afarensis*, a chimpanzee-like prehominid that walked upright. The most remarkable thing about Lucy was the extensive recovery of the skeleton.
52 James Owen, *'Lucy's Baby' - World's Oldest Child - Found by Fossil Hunters* (National Geographic News, 2006) http://news.nationalgeographic.com/news/2006/09/060920-lucys-baby.html?fs=www9.nationalgeographic.com (Accessed September 30, 2006).

contrast to Morgan's raped ape girl.[53] The preparedness to pronounce sexual violence as inevitable because it is gene driven, on the one hand, and sanctify Lucy's bones on the other, is part of what Russo describes as the difficult and complex 'discontinuous geographies' of sex in carnival.[54] The split of the patriarchal perception of the feminine is not immediately apparent. Lucy only becomes the venerated and respected mother in the light of Morgan's sexually available ape girl.

One of the ways Morgan carnivalises sex in evolution is by her direct address of the act and her refusal of the more scientifically neutral terms 'reproductive process'. The rape of the ape-girl is not seen as 'reproductive strategy' resulting in 'reproductive success' but as a 'clobbering'. Nor is it seen as a scientifically distanced geographical or historical incident. It is given imaginative immediacy and is imaginatively reconstructed and situated in the generally sought out familiar and modern environment of a beach. As an anecdote, the story is presented as farce to the reader, which then allows Morgan to extend it in an interesting way. That failure of the aggression brake was:

> The first step along the tortuous road that led to the sex war, to sado-masochism, and ultimately to the whole contemporary snarl-up, to prostitution, prudery, Casanova, John Knox, Marie Stopes, white slavery, women's liberation, *Playboy* magazine, *crimes passionels*, censorship, strip clubs, alimony, pornography, and a dozen different brands of mania.

Sex cannot simply be a 'reproductive' story to a carnival writer; it is rather a story of violence, licentiousness, fetishism and social complication. *The Descent of Woman* is an early story to emerge from the feminist consciousness raising in the 1960s, and as such it foreshadows a number of directions feminism would take with respect to rape, pornography, sociobiology and even the science wars.[55]

Infants and children, as well as women, are players in Morgan's AAT carnival, but by the time she published *The Descent of the Child* in 1990, she had adopted a less confrontational style with science and scientific thinking. Still strongly Darwinian, she speaks through the authority of Dawkins' selfish gene, Trivers' notions of

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53 This recent advent of prehistoric Madonna and child can also join the list of religious iconology transported into evolutionary studies; see Chapter 1.
54 See Russo, *The Female Grotesque*, 93-94.
55 Morgan published four years before Susan Brownmiller's *Against Our Will* (New York: Bantam, 1976), and in her quote here she anticipates the pornography/feminism debates that began at the end of the 1970s, involving Andrea Dworkin and Catherine McKinnon. Although she is in a different tradition, Morgan's work may also be considered a proto-feminist critique of science.

parent/offspring conflict, Bowlby's attachment theories and she anticipates Blaffer Hrdy's constructions of children as social/biological capital.[56] However, she does not critically engage with any of these writers, and her creative thinking occurs mostly at the border of accepted scientific paradigms and the AAT. Despite being openly pro-choice, wary of sociobiological constructions of the nuclear family (she argues the only relationship that is certain in any biological sense is the mother/child dyad) and dismissive of criticisms of reproductive technologies, her feminist politics are heavily carnivalised. The child receives its first beating at birth:

> Now they [contractions] become more frequent, more regular and much more forceful. The formerly hospitable walls surrounding it contract in a strenuous effort to diminish the size of the uterine cavity and its contents. The contents, being non-compressible, are shoved downwards towards the neck of the womb, which initially bears no resemblance whatever to an exit. It has to be forced open; and the only available battering ram to bring this about is the baby's head. This is Stage One, and if it is a first baby the process continues for something between 13 and 24 hours ... by the end of this time the baby's head has entered the neck of the womb and, if the amniotic sac has not ruptured before, it does so now and the waters leak away.
>
> This has the effect of causing the mother to increase the force being applied to the child's buttocks. The involuntary contractions of the uterus are now augmented by powerful contractions of the abdominal muscles. This is State [sic] Two. It can be a painful business for the mother and it is impossible to believe that it is not painful for the baby also. The contractions are liable to be accompanied by kicking and spasmodic movements of its arms. The increased pressure on its buttocks is transmitted up its spinal column to the base of its skull, and this forces the head forward until the chin is touching the breastbone.
>
> In this position it is propelled onwards until it encounters the bony pelvis, and the slope of the pelvic floor twists its head until it has rotated 90 per cent and is, as it were, looking over its shoulder. A little lower down, because its mother is a biped, it finds the vagina has a kink in it, and it has to negotiate a 90 degree turn. The exigencies of

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56 Morgan, *The Descent of the Child*, 186-190.

> this new hazard force its chin farther and farther away from its breastbone; its head is now bent backward as extremely as it was formerly bent forward, and it is leading with its chin.[57]

This difficult process, with its final pugilistic metaphor, is consistent with the carnival world. In Rabelais' original carnival text, the birth of the main characters is violent. Gargantua chooses to deliver himself through Gargamelle's ear canal rather than in the regular way, and Gargantua's son Pantagruel is so large he kills his mother during his birth. Morgan's rendition of the child's birth emphasizes vulnerability and the difficulty of its entry to the world, but the story is not just one of danger. It is also one of difference and hidden strength.

Looking at adaptive features, Morgan argues that the vernix and the lanugo are responses to an aquatic environment. The lanugo, a thick layer of hair, begins to grow on the fetus at around the third month of gestation then is shed in utero by the thirty sixth week of pregnancy and the result is an apparently hairless baby (the follicles are still present, but the covering of actual hair is negligible). The vernix, an oily secretion from the sebaceous glands, appears after the lanugo and human infants are often born smeared with vernix. Thus the differences that distinguish human infants from other primate babies are their apparent hairlessness, their coating of oil and their large deposits of fat. Morgan's contention is that the human baby has not appeared in a form that will ultimately help it survive as an adult, but in a form that is maximally adapted for its survival at that point of its existence. Being buoyant, hairless and waterproof is helpful if a baby is going to live in a semi-aquatic environment, but seem to have little intrinsic value if a baby is going to live in a forest or savannah. A more speculative point is the pairing of the finger-curling reflex of newborn humans with long hair in women. The scenario Morgan imagines is that long hair would have been useful for very small, dependent babies to hold onto in the water.

The infant body is grotesque and inevitably connects carnival and evolutionary thinking. The baby and young child is an undeniable confrontation with the 'lower stratum' being, in essence, the mouth, the anus and the genitals. It is bodily appetite and excretory function incarnate, and it is also the confrontationally unfinished body, the becoming body: the body that *must* be, through its 'convexities and orifices', connected to the world and to other bodies.[58] The infant can never be absorbed into what Russo identifies as the oppositional to the grotesque, the 'high culture' of

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57 Ibid, 69.
58 Bakhtin, *Rabelais and His World*, 317.

bourgeois rationalism and individualism, the culture of the classical, closed, self-contained body.[59] Man-the-hunter represents that classical body in prehistory, and the hunter cannot absorb the child's body any more than a modern banker. Thus, the infant's body is a continual reminder of the grotesque, but it also is a strong marker of time and human perceptions of time, which are key to both carnival and evolutionary stories.

Bakhtin speaks specifically to a cyclic sense of time in carnival, particularly when he is examining metaphors like the birth of Pantagruel, which is overlaid by death by thirst during a great drought, or the pregnant hag, where death and birth are combined in an iconic embodiment of carnival. His medieval model of folk carnival focuses on the seasons that directly affect the lives of all people and reflect the cycle of human birth, fecundity, aging and death. Because of this, it is tempting to only situate the infant in a cyclical model of time, and see it as the renewing link. Bakhtin, however, does not actually permit temporal closure in any of his systems – even time in carnival. The infant's body, according to him, is part of a continuous process of death, renewal and fertility, a link in an 'endless chain of bodily life' and a product of the endlessly becoming 'ancestral body'.[60] The infant's body is then not only connected to its forebears, but to any life, so its body is part of the body of the community it lives within, however that may be defined, and also the earth supporting that community. This is the ongoing and layered story of evolution seen through a child's grotesque, open, needy, renewing and continuing body. It is also an analysis that clearly exposes the potential ecofeminist politics of both carnival and evolution.

Considering the body as 'dismembered', as well as grotesque, allows us to see more of the unusual political focus that Morgan has on the human body and the human body in evolution. Bakhtin says that dismemberment exaggerates a body part in carnival, hiding the normal members of the body, changing our metaphorical understandings of body.[61] In *The Descent of the Child*, dismemberment occurs when attention centres on the infant larynx. The larynx is positioned high in the throat in most animals and in the human infant. Part of its task is to separate breathing and swallowing in this position, but during the first year of life it moves down the throat of a human baby and leaves the oesophagus and trachea lying next to each other in the throat. It then becomes essential in the production of sound and speech.[62] Using this information, Morgan tells

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59 Russo, *The Female Grotesque*, 8.
60 Bakhtin, *Rabelais and His World*, 24-29.
61 Ibid, 328.
62 Morgan, *The Descent of the Child*, 165.

a revised evolutionary story of change that evidences both anxiety and power. In her story, the larynx becomes symbolic of the vulnerability of the child. In her story because of the susceptibility of the child to choking and because she believes this movement of the larynx may be a cause of cot death. Cot death is a species-specific risk for humans under six months of age, a statistically demonstrated killer of infants.[63] A source of vulnerability and anxiety, the larynx is also, however, a site that actively defines humanity and separates it from all other primates. The larynx allows human speech, and according to Morgan, the infant larynx is the generator and controller of the enormous powerhouse that is human language. She considers the child has an extraordinary capacity to communicate and initiate interactive access to culture, and she argues that it was necessary to evolve language to support the most vulnerable members of the human community.

Morgan's reasons for working backwards to simultaneously positioning the most vulnerable and the most needy members of the pre-hominid community as the most powerful are counterintuitive yet commonsensical in the way of carnival, because the focus is brought to bear upon physical ability not social concepts of responsibility. Children learn language easier and more fluently than adults; their sound repertoires in any primate group are more extensive than adult sound vocabularies; older people face enormous difficulty when trying to learn a second language and the problems of adults learning a first language late in life for the first time are almost insurmountable. Addressing the gendered issues of language skills, she says, 'girls learn to speak sooner and more fluently than boys. This seems to suggest, ancestrally, that vocal communication was more important within the mother/infant relationship than it was in the case of other social relationships'.[64] For Morgan, then, the impetus for language came not from man naming the world and thereby claiming dominion over it, or from the necessity to organize the hunt, but from children who had a need to manipulate the adults around them – particularly their mothers – so they could get what they wanted during their long period of dependence. This is carnival and the politics of carnival, with inversion and subversion governing and renegotiating perceptions of social and 'natural' power, thereby moving the registers of evolution from competitive child/parent relationships into something more complex and subtle.

Morgan's relationship with sociobiology is conflicted and undeveloped in a scientific sense, but – as with much of sociobiology – her ideas are essentially political

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63 Ibid, 97-98.
64 Ibid, 135.

not scientific. She is simply the openly subversive voice that points out the unlikelihood of the full grown hunter suddenly being able to direct his best mate to speedily attend to the left back leg of the charging bison. The apparently dominant group, in Morgan's story, is *not* the one in charge of the most powerful tool of human evolution – the weakest and most vulnerable are. Morgan uses sociobiological discourses of adaptation and selectionism as mechanisms of evolution, while deliberately undermining its favoured stories. She is more inspired than systematic in her use of evidence, but her work is intriguing and provocative. Her authorities are the most conventional and conservative scientists in the sociobiology discourse, yet she uses them to tell the most radical stories of human evolution, bringing women, children and the environment out of the margins as agents of evolution and change.

Oddly enough, but in keeping with Morgan's carnivalised identity, while her stories unsettle the reception of patriarchal human evolutionary sociobiology in the market place, she completely fails to link with feminist science theorising, particularly feminist sociobiology or feminist critiques of sociobiology. Donna Haraway mentions her as a pop science writer, lumped in with Desmond Morris,[65] and Adrienne Zihlman sees her as unscientific and annoying.[66] Otherwise feminists who have investments in this field ignore her. Partly this is because Morgan offers no critique of the highly masculinised and contentious models of sociobiology she uses, she simply rejects their androcentric perception while viewing the methodology itself as unproblematic. Her genre is popular story telling more than scientific narrative, and her appeal is definitely marketplace, not scientific. However, her interdisciplinary crossovers mark her yet again as a significant carnival figure, because when the dialogue she craves with the science establishment turns up, it is often in unexpected ways. Her arguments are sociobiological, but that is not where she ultimately makes an impression scientifically. Ironically, Elaine Morgan's marginalized ideas connect in unexpected ways with mainstream research as components of her hypothesis see her unexpectedly adopted by one of the fathers of paleoanthropology, and being supported by recent scientific information from the field of biochemistry. In some ways, Morgan's theories map better on non-sociobiological science than on sociobiology – although she inevitably carnivalises these intersections of knowledge too.

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65 Haraway, *Primate Visions*, 127.
66 Zihlman, 'The Paleolithic Glass Ceiling', 104.

The AAT and mainstream science

Breakthroughs from the marginalized AAT into mainstream science are of intrinsic interest to both students of human evolution for their radical revisionism, and as an example of Kuhnian paradigm change. Developed as an interpretive theory, the AAT takes steps to solve a 'gathering of anomalies' in the savannah and hunting hypotheses of early human evolution. It also places 'normal science' on notice that its stories cannot keep eliding the role of women, children and the complexities of environment in stories of the formation and continuation of the human species. The responses of 'normal science' to these various issues have been historically and culturally piecemeal. They include denying that the 'savannah theory' ever existed;[67] incursions by women scientists into male dominated/male dominance stories that traditionally ignore the social and physical contribution of females in human development;[68] and revisions of early environmental models of the African rift valley, from savanna to 'woodland' or 'mosaic', meaning reaches of dry grassland are replaced in evolutionary thinking with patches of forest interspersed with open lands and large bodies of water.

Little of this has been due to open scientific debate on the actual topic of the AAT, as few scientists publicly own interest in the hypothesis. However, one conference was held on the topic in 1987, and conference proceedings were published under the title, *The Aquatic Ape: Fact or Fiction?*[69] The title alone suggests the polarization of participants, the possibility of a definitive record of human evolution and – simultaneously – its story telling processes and potentiality. Even the demarcation of the second section of the book, entitled 'Reaction to the Aquatic Ape Theory: for and against' (the first section was on the theory itself) suggests a much neater divide of ideas than is possible when considering a complex hypothesis that refers to fields as diverse as geology, paleontology, paleoanthropology, comparative zoology, morphology and evolutionary biology.

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67 The 'savannah theory' is a theory concerned with the niche adaptation and selection pressures that gave rise to bipedalism. It suggests that prehominids left forests and went on to the savannah where they became bipedal and tool using *as* hunters. Raymond Dart's work certainly proposes the savannah theory and teams it with hunting. See also Richard Lee and Irven de Vore, eds. *Man the Hunter* (Chicago: Aldine, 1968). The papers in *Man the Hunter* focus almost solely on the open plains hunting process and the central part it played in prehistoric food provisioning, but this collection is also a pivotal text where other food sources begin to be mentioned and women's contribution to the economy of the group begins to be addressed.

68 Women writers who challenged the male bias of the 'hunting culture' or the 'savannah hypothesis' in the 1970s were Sally Slocum, Adrienne Zihlman and Nancy Tanner.

69 Roede et al. eds., *The Aquatic Ape: Fact or Fiction?*.

If the editors of the proceedings wish to convey a sense of resolution to the aquatic ape story, they are defeated by a narrative that remains persistently open. Most of the scientists in the collection are sceptical of the AAT, but taken collectively the articles neither confirm nor destroy the theory, rather they bring more information to bear upon it and complicate issues. For example, Marc Verhaegen claims that humans would have necessarily developed in a situation where water was abundant and permanently available for cooling to allow their bodies to be so profligate with water. On the other hand, Peter Wheeler says that constant exposure to water would have required humans to develop more efficient ways of producing heat to prevent their vulnerability to hypothermia, so humans are maladapted for an aquatic or semi-aquatic existence.[70] While offering essentially interpretive stories, the authors of each article strike a pose on one side of the divide or the other, claiming that the hypothesis they support – be it savannah or aquatic - is the most defensible. This binarism supports Kuhn's notions of crisis and resistance in the scientific community as paradigms change; however, it also reveals the deeper scientific processes he talks about when he says 'explicit recognitions of breakdown are rare, but the effects of crisis do not entirely depend on its conscious recognition.'[71] Scientists involved in this level of debate do not necessarily argue from the singular perception of an entire paradigm shift, rather they contest details and elements of paradigms within the context of their disciplines and their institutions.

Such exchanges reflect a larger safe/unsafe framework of professional ideas and attitudes. For example, Roede et al clearly find it difficult to accord any credibility to Elaine Morgan at all, despite her writing two papers for the book. They ungenerously state in the introduction that they are dealing with Hardy's proposition only, and they barely acknowledging her in the conclusion. They fail to document anywhere in the collection how she has developed Hardy's idea beyond the original, generating multidisciplinary interest in the theory, and they fail to acknowledge that a conference attracting practicing scientists and academics, and their own professional publication ride upon a 'Welsh housewife's' unscientific ideas.

One of the ways in which the AAT has moved into mainstream science is over the issue of diet. Meat is traditionally central to paleoanthropological stories. Raymond Dart's original hunting hypothesis contended that the brain developed as an aid to

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70 Peter E. Wheeler, 'Body Hair Reductions and Tract Orientation in Man: Hydrodynamics or Thermoregulatory Dynamics', in *The Aquatic Ape: Fact or Fiction?*, eds. Roede et al, 221-326; Marc Verhaegen 'Human Regulation of Body Temperature and Water Balance', in *The Aquatic Ape: Fact or Fiction?*, eds. Roede et al, 182-92.
71 Kuhn, *The Structure of Scientific Revolutions*, 84.

hunting patterns, an idea reinforced by emphasizing the nutritional value of meat and its social value.[72] Dart's 'killer ape' captured the postwar imagination, but that story started to unravel during the 1970s as female scholars like Sally Slocum, Nancy Tanner and Adrienne Zihlman argued that the hunting hypothesis neglected other food sources, particularly those provided by foraging women, which included nuts, seeds, grains and even seafood. Research with living, nomadic communities led Slocum and Tanner to generate the idea of a hunter-gatherer economy, as opposed to a hunting economy only. Hunter-gatherer economies were mixed and depended on a generalized, rather than gender specific, division of labour.[73] In some respects, the struggle over including women in food provisioning activities became a series of carnival moments, including repeated gender inversions and determined political distortions of information that were themselves comparable in tone and invention to the aquatic ape story.

By the early 1980s, evidence suggested the fossilized 'killer ape' heroes of Raymond Dart's stories were not predators but prey. C.K. Brain fitted leopard teeth into the holes of the Swartkrans *Paranthropus* skull and brought the mighty hunter low by placing him on the same footing as neighboring gazelle bones.[74] The year Brain published, other researchers who had been working with the nomadic Agta of the Philippines also published on women hunters.[75] Not only did women hunt, they hunted while pregnant. This democratization of hunting was then extended from the modern Agta to the prehominids of the Pleistocene, using the chimpanzee model of food provision, which illustrates other factors such as age are more important than gender in hunting.[76] These ethnographic and primate studies, combined with Brain's palaentological detective work, considerably modified the figure of the hunter, but certain scientists would not allow it to diminish the figures of either the prehistorical patriarch or modern scientific man. Determination that Paleolithic families receive their daily allowance of animal protein, turned arguments from hunting for meat to

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72 Tattersall, *The Fossil Trail*, 204-208. Tattersall talks about teeth difference in fossils reflecting diet with the larger, stronger teeth reflecting the 'committed herbivore'. Also see Gretchen Vogel, 'Paleoanthropology: Did Early African Hominids Eat Meat?' *Science*, 283 no.5400, January 15 (1999), 303-304. Vogel talks about chemical analysis of teeth to identify diet.

73 Zihlman, 'The Paleolithic Glass Ceiling', 95.

74 C.K. Brain, *The Hunters or the Hunted? An Introduction to the African Cave Taphonomy* (Chicago: University of Chicago Press, 1981).

75 Estioko-Griffin and Griffin, 'Woman the Hunter: The Agta', 121-51.

76 Agnes A. Estioko-Griffin and P. Bion Griffin, 'Women Hunters: The Implications for Pleistocene Prehistory and Contemporary Ethnography', in *Women in Asia and the Pacific: Toward an East-West Dialogue*, ed. Madeleine J. Goodman (Honolulu: University of Hawaii, 1984), 61-81.

scavenging for meat as the central food provisioning practice of ancient culture. Marks found on bones indicated early cutting tools were used to butcher meat, so all the arguments that had supported the hunter were transferred directly across to scavenging. Men did the butchering of pre-preyed carcasses, and the meat was taken back to a central camp area where families waited to share the rewards. Men had to cooperate with each other to locate and retrieve meat, and to travel back to camp with it, and – as with hunting – that may have been the source of language development.[77] Scavenging restored the gender balance that had nearly been lost with the undermining of the hunting story. In 1981, Owen Lovejoy reinforced the male-as-provisioner argument in an article entitled 'The Origin of Man' by also appropriating gathering as a specifically masculine activity and claiming the central social unit was a breeding male and female, and the male returned to camp with all food for dependents.[78] This picture of disciplinary debate is politically disturbing in terms of gender, but also almost comical in respect of the determination of some participants to reconstruct prehistory in the image of the late capitalist masculine, pay cheque-centred experience. In fact, this concern with the mutual reflections of prehistoric experience and modern identity finds echoes in scientists pronouncing the *Paranthropus* from Swartkrans a related, but 'dead end' species, not connected to the *Homo* line at all.[79]

That the meat eating, 'killer ape' is accepted into the human lineage and the vegetarian who was consumed by a leopard is not[80] – particularly when the two stories are mapped onto the same body – is emblematic of carnival's confrontation with the 'devoured and devouring world'.[81] Science seeks to contain, particularize and control the natural world, but has difficulty with the inverted value that the world ultimately limits human life and experience – sometimes violently and unexpectedly. That C.K.

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77 P. Shipman, 'Scavenging or Hunting in Early Hominids: Theoretical Framework and Tests', *American Anthropologist* 88 (1986), 27-43 for an early consideration of scavenging, and Ann Gibbons, 'American Association of Physical Anthropologists Meeting: Humans' Head Start: New Views of Brain Evolution', *Science* 296, no. 5569 (2002), 835-837 for a more recent treatment.

78 Lovejoy, 'The Origins of Man', 341-350.

79 Randall L. Susman, 'Who Made the Oldowan Tools? Fossil Evidence for Tool Behavior in Plio-Pleistocene Hominids', *Journal of Anthropological Research* 47, no. 2 (1991), 129-151; Bernard Wood and David Strait, 'Patterns of Resource Use in early *Homo* and *Paranthropus*', *Journal of Human Evolution* 46 (2004), 119-162. Susman proposed looking at hand bones rather than skulls with respect to fossilised pre-hominids and argued that *Paranthropus* was more clearly a toolmaker than *Australopithecus afarensis*. This reopened the debate of *P.* as a dead end species.

80 In a strange coincidence, nearly a decade earlier, Morgan had actually consigned the original hunting ape to the fate of being 'leopard dinner'! See Morgan, *The Descent of Woman*, 25.

81 Bakhtin, *Rabelais and His World*, 221.

Brain's *Paranthropus* was consumed by the earth, and by time, is orderly and acceptable: however, that these bones have been doubly devoured by both a predator and by the earth/time brings up more complex structures embedded in, and even oppositional to, scientific anthropocentric narratives. Being doubly devoured by the carnival world, *Paranthropus* is shown as weak and vulnerable, so his bones are no longer from a heroic/genetic survivor, they are from a victim and could not/should not have fathered modern man. *Paranthropus* is also twice born, once as a mammal and once as a fossil, and twice eaten, once as leopard prey and once by the sedimentation of the earth. *Paranthropus* then becomes a religious pun as well as a more complicated story of the grotesque, regurgitated body that challenges scientific discourses of killer apes and survivor genes.

Struggles over food and the male figure of the hunter, in both the arguments of paleoanthropology and the AAT, are attempts to keep the classical body intact, and coherent with scientific rationalism. As Bakhtin says: 'the basis of the image is the individual, strictly limited mass, the impenetrable façade. The opaque surface and the body's 'valley's' acquire an essential meaning as the border of a closed individuality that does not merge with other bodies and with the world.' Also he says that fecundation, pregnancy and childbirth are all prohibited in the new bodily canon.[82] If we consider this, the hunter is clearly not just feeding himself and his pair bonded mate and children, he is extending the idea of individuality and a problematic, separatist sort of relationship with nature back to the dawn of humankind. Eating fish, rock limpets, turtle eggs and so on produces a far less admirable and iconic ancestor than spears and fire do. Shoreline grazing opens up the prehistoric vista to include the females, pregnant females, infants, juveniles and aging/aged bodies. The semi-aquatic ape is a more democratized creature than the hunter with his cohorts, the water ape's generalized and grotesque bodies merging 'with various natural phenomena, mountains, rivers, seas, islands, and continents' rather than seeking to conquer them.[83]

Keeping these distinctions and broad disciplinary struggles in mind, it is deeply ironic to consider that the scientific stories supporting the AAT and its shoreline diet are probably the least hypothetical and the most informationally resilient in human evolutionary science at this point. Robert Martin claims that growing large brains is very energy intensive and requires an abundant, non-seasonal diet for the primate

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82 Ibid, 320.
83 Ibid, 318.

mother so her infant can develop most of its brain size prior to birth.[84] Michael Crawford contends that the specifics of a seashore diet does in fact provide the consistent balance of Omega-3 and Omega-6 polyunsaturated fatty acids needed to build the human brain, noting that Omega-3 is scarce on land but is common in the marine food chain.[85] Putting these ideas together makes a forceful argument for a period of dependence in human history on a semi-aquatic environment, be it oceanic, estuarine, mangrove or riverine. Crawford's seafood diet idea emerged due to an engagement with the AAT, and impacts on the gender locked diet arguments of man-the-hunter-and-provider. Fixing address at a molecular level incidentally reinforces feminist politics in paleoanthroplogy *and* the AAT, and carnivalises the field further. Michel Odent connects a *lack* of Omega-3 long-chain polyunsaturated fatty acids to preeclampsia, which he calls the 'primary human disease'. Preeclampsia affects women and unborn children, is linked to many later adulthood diseases and is found more commonly in areas where there is reduced access to the sea.[86] This biochemical information does not actually confirm the AAT, but it supports its readings of the prehistoric human body and environment. The seafood argument complexifies the scientific narrative field of early human evolution by providing a check for the extremities of hunting debates and by prodding institutionalized complacency regarding anomalies in accepted food provisioning stories, and encouraging further research.

In medieval carnival, Bakhtin tends to concentrate on the subversion of orthodoxy as being the core value challenges of medieval carnival, but postmodern carnival inclines more to a multiplicity, complexity, and synthesis of information that is inclusive of subversion and orthodoxy. Michael Crawford's story of how big brains are connected to a shoreline diet is biochemical, but Morgan moves from the molecular to the social by teasing out the gendered politics of this apparently value free knowledge. Crawford believes that two particular fatty acids are needed to build neurons. Both fatty acids form slowly in the body and DHA is particularly rare in the food supply of

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84 R.D. Martin, *Human Brain Evolution in an Ecological Context* (New York: Museum of Natural History, 1981).

85 Michael Crawford and David Marsh, *The Driving Force: Food, Evolution, and the Future* (New York: Harper & Row, 1989).

86 Michael Odent, 'The Primary Human Disease', *ReVision* 18, no. 2 (1995), 19-21. The diseases that preeclampsia is linked to includes, coronary heart disease, essential hypertension, non-insulin-dependent diabetes, high cholesterol levels, obesity in adulthood, recurrent miscarriages, cerebral palsy, and schizophrenia. Areas with a sufficient intake of omega-3 polyunsaturates are Japan and Greenland, areas with deficiencies are places like Heilongjiang province in China, which is completely land locked and Quito, Ecuador, an inland city situated at a very high altitude.

large, savannah dwelling mammals. The only place, in fact, where DHA is common is in oceans, lakes and rivers.[87] Crawford and Sinclair provide the chemistry – Morgan provides the theatre in which the chemistry works.

It would be possible to imagine an AAT reconstruction of events, based on the perception that human females appear to be better water-adapted than males. Their bodies are simultaneously more hairless and more thickly lined with fat, a combination characteristic of many aquatic mammals. They can survive immersion in cold water for longer and one athletic sport at which they can outdo males is long-distance swimming. Conceivably they could have been the first to become habituated to the water. In an environment which combined trees and water (a flooded forest or an offshore island dwindling as the sea level rose) the more dominant males would have had first call on the diminished reserves of their traditional food source and would have continued to confine themselves to it. In any society, long-established dominance tends to lead to conservatism. The hungrier females could have been driven to seek for less familiar things to eat and would have found them in the water.[88]

The fatty acid molecules lend credibility to the feminist aquatic ape story and the feminist aquatic ape story constructs a meaningful context for the fatty acid molecules. Neither subject fully contains the other, leaving room for scientific and paleoanthropological speculation but potentially connecting the finessed studies of molecular composition with the broader brush strokes of imagined evolutionary origins. This loose reciprocity between information and story telling is common in fields that deal with human evolution, as witnessed by repairs to the status of the AAT by prominent paleontologist, Philip Tobias. Tobias, once strongly committed to the savanna theory, realised from fossilised pollen studies and the remains of Liana vines that current areas of grassland in the African rift valley were once woodland, and that all fossil sites were in close proximity to water. Late in his career, this information persuaded him to endorse Morgan's theory.

Tobias' conversion touches on scientific issues connected to the AAT, which he recommends be relabeled the Aquatic Ape Hypothesis.[89] However, Tobias may only be acknowledging what has become difficult to deny and his endorsement is problematic. For example, it has long been known that fossil sites show nearness to water and many fossils are necessarily sedimented in what was once wet ground. Morgan had already

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87 Kate Douglas, 'Eve's Watery Origins: How the Sea Shore Made us Human', *New Scientist*, November 25 (2000), 32.
88 Morgan, *The Aquatic Ape Hypothesis*, 100.
89 Philip V. Tobias, *Water and Human Evolution* (Dispatches Human Evolution, 1998), http://allserv.rug.ac.be/~mvaneech/outthere.htm (Accessed November 7, 2003).

pointed out that famous Australopithecine fossils, such as Lucy, 'were found eroding from sand which also contained the remains of crocodile eggs and turtle eggs and crab claws'.[90] This was a obviously a likely food source, but was not read in this way at the time of discovery as it did not conform with the hunting paradigm. A little like the original progenitor of the theory, Sir Alister Hardy, Tobias has come out in support of the idea of semi-aquatic ancestry late in his professional life. This means that what may appear to be professional risk is more likely to be viewed by the still resistant scientific community as eccentricity and will do no harm to Tobias' reputation. Once again, he and his ideas must be contextualized. In the complex conjunction of politics, society, culture and individuality, Tobias is constructed as a member of an old guard in a discipline that is being colonized by other disciplines, such as the contemporary and relevant biomolecular studies. His ideas have weight and will possibly move acceptance of the AAT closer to mainstream science, but they will probably have less impact than Crawford and Sinclair's conclusions about aquatic diet.

All evolutionary paradigms exist in an open, heteroglossic space that attempts to simultaneously accommodate eons and decades, cells and planets, and institutional and organic bodies. While not experiencing the acrimonious exchange that have occurred between other contingents of evolutionary thinkers, such as those between creationists and evolutionists, or even those between individuals such as Richard Dawkins and Stephen Jay Gould on genocentric sociobiology, the idea of aquatic/semi-aquatic ancestry for humans has been a popular theory resisted by scientists. Part of the reason for this involves the history of the Aquatic Ape Theory, and choices Elaine Morgan made in developing it and promoting it. In *Descent of Woman*, the tone was antagonistic to current evolutionary science, but that changed as the status of the theory itself developed from mocking feminist polemic to serious contender.

In terms of developing a direct relationship to science, the AAT is a story of guarded mutual concessions and problematic instability. For Morgan it is clearly more of a dialogue than it has been for most of the members of the scientific establishment that have intersected with her and her ideas. Morgan has now changed the status of her argument from 'theory' to 'hypothesis' in line with Tobias'suggestion, and includes references in her most recent writings.[91] In the preface of *The Aquatic Ape Hypothesis*, she says that twenty-five years of disputing with scientists is long enough and she is selecting to follow disciplinary convention. Following the Valkenburg conference and

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90 Morgan, *The Aquatic Ape Hypothesis*, 23.
91 Morgan, *The Descent of the Child* and *The Aquatic Ape Hypothesis*. See also Elaine Morgan, 'The Rise and Fall of the Savannah Theory,' *ReVision* 18, no. 2 (1995), 4-8.

other relevant research, she also makes concessions on some of her claims. The idea that tears function as an excretory mechanism to dispose of excess salt is recanted because, while evidence indicates that marine birds and reptiles shed tears to balance salt, the kidneys of marine mammals such as seals are actually sufficient with regard to this function and tears do not seem to play a part in salt balancing in marine mammals.[92] The sweating idea is also modified because claims that only humans have extensive bodily eccrine glands, the kind of sweat glands which excrete salt water that are normally found only on the hands and feet of primates, have proved inaccurate. Patas monkeys, a savannah dwelling species, also have extensive eccrine glands that result in the loss of a great deal of body moisture, apparently in the interests of thermoregulation. Morgan had assumed, as had her academic sources up to that point, that hairless humans were the only primates with extensive eccrine gland distribution on their bodies – other primates supposedly having widely distributed apocrine glands, glands exuding a more oily, coat lubricating substance generally found on hairy mammals. Speaking to the new information that unravels that part of her theory, however, she maintains her subversive style:

> Researchers began peering very much more closely at the other primates. Traces of 'cutaneous moisture' were detected on the skin of the baboon. Also, the rhesus monkey. And the Macaque. And the chimpanzee. I received a (doubtless subjective) impression that a large number of primate species which had remained cool and dry throughout the first half of the twentieth century had suddenly begun sweating like stevedores.[93]

As if playing a hand of poker, Morgan counters eccrine gland research with bony swellings found in fossilised ear canals – evidence of early swimmers. Thus the dialogue continues. She and her aquatic ape woman shadow the heavily gendered figures of the scientist and the hunter in the complex power discourses of late twentieth century human origins stories. The scientist's rationalized, reductionist and certificated stories are compromised by the open, hyperbolic, illegitimate tales from the Welsh housewife and scriptwriter. The wily hunter stands sentinel staring into the distant grasslands, his hands firmly clenching weapons of domination and destruction, while unnoticed his partner seeks safety in the water where she nourishes her pregnant self and her offspring on all manner of scavenged waterline food.

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92 Morgan, *The Aquatic Ape Hypothesis*, 107.
93 Ibid, 116.

These are important pictures to contemplate, not only for their contrasts but also for the instability of the boundaries dividing them. Knowledge is inevitably political and gendered and these various players are carnivalistic, not just because of difference, but also because, as scientific stories, they compromise each other in surprising ways – dominant players and repressed players, or as Bakhtin might describe it, the representatives of 'official' and 'unofficial' culture.[94] A level of osmotic exchange of information has not yet led to open and full dialogue - and it may never - but the important point is that it has led to a shift in the status of both stories. Now they are, respectively, *less* dominant and *less* repressed. Boundary movement is part of carnival, but the evolutionary carnival does not have temporal boundaries like medieval religious holidays, nor is it geographically restricted, like a Mardi gras to the streets of cities and towns. At the moment neither the hunter story nor the aquatic ape story are sufficient within themselves and the struggle for stability of their prehistoric narrative is being enacted in laboratories and universities, in bookshops and on the internet, on best seller lists and in academic publications, and in public and private debates throughout the western world.

The AAT and post neo-Darwinian evolutionary theories

There is a further aspect to the aquatic ape story that extends its complex and carnivalistic relationship to science. That is, although it has its roots in sociobiological Darwinism, it also demonstrates the currency of a number of other models of evolutionary theory that open and expand Darwinism. These models are not overtly referred to or used within the AAT, rather they are embedded within the heteroglossic text, the text that structurally and informationally resonates to stories well beyond its apparent boundaries. Such acts of incorporation are not only heteroglossic, they are also markers of carnival, which is always structurally rebellious and challenges the boundaries between what is 'law' and what is 'not law'.

Punctuated equilibrium, the modified form of Darwinism discussed in chapter two of this thesis, is the first alternative theory that can be mapped on to the AAT to expose its deep splits from orthodox sociobiological theory. Mainstream sociobiology is necessarily invested in gradualism, Darwin's story of random mutations being positively selected over long periods of time. Genetic stories have a high degree of stability and consistency, the near perfect replication processes of genes making them a centrepiece of current understandings of species. Incorporated into sociobiology,

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94 Morris, *The Bakhtin Reader*.

gradualism is an important structural element of building coherent pictures of organisms, part of their biological rationality that can explain their history and their present. Good, stable genes guarantee survival and quality of life for humans, hence the first world concentration on gene therapies, preemptive genetic diagnoses, genetic counseling, mapping the human genome and more. Control of genes could see endangered animals recoup their numbers, prize livestock could be cloned and patents on diagnostic genes could provide a cash bonanza for the pharmacomedical industry. The reliability of the gene is central to many, many hopeful western stories of biology, medicine and agribusiness and it currently reigns supreme in human reproductive tales. Morgan uses this strong sociobiological foundational thinking, but paradoxically advocates a more chaotic genetic story. The AAT is not a rational genetic tale of species development, because in it she postulates a plastic and somewhat indecisive organism, one that almost opted for existence in the water, but then retreated and went back to terrestrial living.

Specifically, in terms of punctuated equilibrium, the development of aquatic features requires an appropriate prehistoric window in which the pre-hominid was confined to a specific kind of environment. Pressure must have been put upon the organism to make sense of two radically different environments within certain time frames and change rapidly to accommodate them. Elisabeth Vrba does not in any way examine or support Morgan's hypothesis of human evolution but she does support punctuated equilibrium. She considers the central puzzles of abrupt species change, noting (as most scientists do) that traditional Mendelianism is clearly inadequate in explaining macroevolution. Vrba contends that a degree of intrinsically directed evolution, that is epigenetic organisation and function, as well as genomic self-organisation, needs to be recognised as part of the master plans of species creation, something genetic reductionism resists. In Vrba's summary hominids are noted as diverging into several distinct groups at about the same time as 'sudden appearances' of other bovid species in African prehistory, and that sudden climatic change is connected to this phenomenon.[95] This seems congruent with Morgan's hypothesis as she tries to understand the strange 'parcel' of developments that sets early humans apart from other primates in such a dramatic way. Vrba is unlikely to support a specific application of her climate pulse theory to the AAT, but Morgan is at least speculatively

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95 E. Vrba, 'Patterns and Processes in the Fossil Record', in *Beyond Neo-Darwinism*, eds. Ho and Saunders, 126-134.

in line with Vrba and others who argue rapid speciation as a probable result of environmental change and stress upon the organism.

Punctuated equilibrium does not, of course, ultimately support or disprove Morgan's theory, but the AAT and punctuated equilibrium do have the interesting effect of lending each other credibility. The AAT demands rapid directed morphological changes in pre-hominids in response to geographic isolation and a changed environment, while punctuated equilibrium supports the idea that an organism can evolve quickly, particularly under duress, and that species can suddenly appear in the fossil record, having apparently activated sleeping packages of DNA. This is a tenuous alliance of a number of unsubstantiated ideas at this point, but when examined closely it does not appear, in its internal logic, much more tenuous than the alliance of gradualism and the savannah theory. Indeed, the strength of the defense of gradualism and the savannah theory in the separate controversies of punctuated equilibrium and the AAT does not provide resolution but rather raises further questions about material interpretations of science, sensitivities to scientific challenge, and cultural investment in orthodoxy.

Three other evolutionary models that hold little relevance for die-hard sociobiology or the general contemporary state of dialogue over the AAT are convergent evolution, panbiogeography, and the positing of a neo-Lamarckian, environmental/organism feedback loop. While all three of these ideas will be discussed in more depth in the next chapter, a brief detour to look at their relationship with the AAT serves to conclude this section. With respect to convergent evolution, Morgan follows the pop evolutionary method in her search for environmentally related, transpecific similarities to support her hypothesis of early humans and their possible sub-aquatic period. Some of her most challenging ideas involve comparisons with aquatic or sub-aquatic mammals like pinnipeds (seals), sirenians (stellar sea cows, manatees and dugongs) and cetaeceans (whales and dolphins). An example is the development of vocalisation. Whales and dolphins are historically and anatomically very different from humans, yet Morgan proposes that our diminishing sense of smell and our increase of vocalisation may resonate with the cetacean adaptation from a terrestrial environment to an aquatic environment. Comparing features across taxonomically unrelated animal species is not an approach favoured by many biologists, but it is a live issue for scientists trying to construct some sort of measurable relationship between genotype, phenotype and environment. Jack Hailman, for example, says cross species information cannot be ignored, as it is based on 'operational' as opposed to 'optimal' features. Optimality

reasoning perceives any variable in an animal form as optimal simply because it is the one that developed (the one that was selected for), but this may not be what has happened. Hailman's approach is to avoid assessing biological form on optimality, which is ultimately tautological, and assessing it for its operationalism. He does this by comparing species and environments, and looking for measurable differences and similarities. To determine a convergence, he states that what is required is a high correlation between measurable characteristics of organisms and measurable aspects of the environment they live in. The advantage of this hypothesis, according to Hailman, is that it measures convergence as a falsifiable hypothesis should new evidence arise which does not support the correlation. Conversely, the hypothesis can be strengthened if new groups are found in which the correlation continues to hold. His example is that sea turtles, penguins and pinnipeds all have oar like appendages and are aquatic feeders; therefore, their appendages can be considered a convergent characteristic.[96] This empirical method suggests new relationships between groups previously considered unconnected, and as post neo-Darwinian thinking it offers multiple agency that may involve environment, gene clusters, new expressions of genes and/or what Gould and Vrba refer to as exaptive change.[97] This does not confirm Morgan's speculative comments on the convergence of vocalization in cetaceans and humans, but it demonstrates her thinking is in line with a problem occupying biologists searching for an empirically based model for cross species comparisons of phenotypical traits.

Leon La Lumiere's Danakil Island story argues for an isolated group of early Australopithecines stranded on the Danakil Alps when the Red Sea flooded the Afar Gulf. According to him, the castaways then made it back to the mainland via a volcanic rock bridge.[98] The geological information is not controversial, but the idea of prehominids being isolated on islands and forming a foundation population for modern humans is. Counter arguments and related hypotheses place the prehominids on the savannah, in mangroves, on beaches and even in rivers, but fossils have not yet

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96 Jack Hailman, 'Operationalism, Optimality and Optimism: Suitabilities versus Adaptations of Organisms', in *Evolutionary Processes and Metaphors*, eds. Mae-Wan Ho and Sidney W. Fox (Chichester: John Wiley and Sons, 1988), 85-115.

97 Stephen Jay Gould and Elisabeth S. Vrba, 'Exaptation – a Missing Term in the Science of Form', *Paleobiology* 8, no.1 (1982), 4-15; Gould and Lewontin, 'The Spandrels of San Marco and the Panglossian Paradigm', 139-153. These articles discuss 'exaptive', as opposed to 'adaptive', change: where features in organisms can arise as the consequences of other developments, and may not in themselves be utilitarian.

98 L. P. La Lumiere, 'Evolution of Human Bipedalism: A Hypothesis About Where it Happened', *Philosophical Transactions of the Royal Society of London. Series B* 292, no. 1057 (1981), 103-107.

indicated a conclusive habitat preference or a definitive point of origin – place is contentious. La Lumiere's support of the AAT via the story of the stranded Danakil Island apes is essentially panbiogeography. Panbiogeography refuses to separate biology and geography, and tracks both historically, seeing all three elements of space, time and morphology as crucial in following pathways of speciation. Leon Croizat developed a mapping process designed to try and accommodate the complexities of tracking life and geological change together.[99] Also, though the axes of the major values shift, depending on the specifics of a study, space is the privileged dimension/agent in panbiogeography and is used as the framework to track ancestral species through to their descendants via geological and geomorphological events.[100] La Lumiere and Morgan stress the importance of the history and geography of the Afar triangle and the African rift valley in the development of a semi-aquatic or aquatic ancestor.[101]

Faced with the problem that the aquatic phase apparently predated Lucy (only 2.5 million years old), Morgan extends her possible scenario. Was it Lucy's ancestors who were stranded on the Danakil Mountains when they became islands? Did Lucy's more recent forebears then migrate back down the chain of great lakes that formed much of the rift valley, making sure they stayed close to water? If they did, then a lot of their development into modern humans had to be done in that location. This raises questions for both the aquatic and savannah theories. For humans to have experienced their crucial development in the rift valley, the lipid profile of freshwater fish in the large lakes must work at least in a similar way to marine fish in relation to brain development. It does, so Morgan is able to contend that Lucy and her band were still relying on aquatic food sources, but from the inland Rift Valley lakes rather than the ocean.[102] The plasticity of this kind of research, in the end, does not detract from the AAT or any other hypothesis. Rather, it shifts both the aquatic theory and the savannah

99 Croizat, *Space, Time, Form.*

100 Leon Croizat, *Panbiogeography: or, An Introductory Synthesis of Zoogeography, Phytogeography, and Geology, with notes on Evolution, Systematics, Ecology, Anthropology etc.* (Caracas: published by the author, 1958); Croizat, *Space, Time, Form.* See also Gareth Nelson and Norman Platnick, *Systematics and Biogeography: Cladistics and Vicariance* (New York: Columbia University Press, 1981); Robin C. Craw, John R. Grehan, and Michael J. Heads, *Panbiogeography: Tracking the History of Life* (Oxford: Oxford University Press, 1999).

101 La Lumiere, 'Evolution of Human Bipedalism', 103-107; Morgan, *The Aquatic Ape Hypothesis*, 171-175.

102 C.L. Broadhurst et al, 'Brain Specific Lipids from Marine, Lacustrine, or Terrestrial Food Resources: Potential Impact on Early African *Homo sapiens*', *Comparative Biochemistry* 131 (2002), 653-673; C.L. Broadhurst, Stephan C. Cunnane, and Michael A. Crawford, 'Rift Valley Lake Fish and Shellfish Provided Brain-specific Nutrition for Early *Homo*', *British Journal of Nutrition* 79 (1998), 3-21.

theory closer together and allows scholars like Tobias to embrace a more textured story of human origin.

Articles on the 'C' type endogenous baboon virus by Benveniste, Todaro and Sherr are also used in the AAT by Morgan to reinforce the Danakil scenario and support the idea of separation of pre-hominid populations from the African mainland. Benveniste and Todaro's argument is that an endogenous baboon retrovirus crossed the species barrier and ravaged all primate populations in Africa at the time, and survivors ended up with a copy of the retrovirus integrated into the DNA of their genome.[103] This copy was inherited by offspring and became fixed in all primate gene pools, except for seventeen species of orangutans and gibbons, none of African origin, and *Homo sapiens*.[104] Morgan uses this information to support Lumiere's hypothesis of prehominids stranded on the Danakil mountains in the flooded Afar triangle, Benveniste et al use it to argue that man had an Asian rather than African origin.[105] Whether or not the endogenous baboon retrovirus supports either of these stories (it appears to support both) is immaterial to the post neo-Darwinian frame being considered here: what is of relevance in this understanding of Morgan's argument is that the science being read and being used is disruptive as well as conformative.

Paleontology is unenthusiastic about Benveniste's origin story, mainly because of the presence of early fossils in the African Rift Valley. The Asian origin theory also requires a primate species to migrate to Java and China, and then return again to Africa very early in its evolution. While science does not take the AAT seriously and finds the Danakil story insufficient in other ways, it would seem a walk back to the Rift Valley from the Danakil Alps is more plausible. These competing stories illustrate the complex relationship in scientific discourse that exists between information and information, and information and speculation about information. In just a few words, the 'baboon marker' yields multiple meanings and possibilities, marking an invisible separation between primate groups yet supporting quite different origins stories. The two stories are ambiguous, not only for their different extrapolation of information, but also in the way they lock into cultural renditions of power relationships – one is a feminist story and one is a race story. As Haraway says: 'Scientific discourses are

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103 George J. Todaro, Charles J. Sherr, and Raoul E. Beneviste, 'Baboons and their close relatives are unusual among primates in their ability to release nondefective endogenous type C viruses', *Virology* 72 (1976), 278-282.
104 Raoul E. Benveniste and George J. Todaro, 'Evolution of type C viral genes: evidence for an Asian origin of man', *Nature* 261 (1976), 101-108.
105 Ibid.

"lumpy"; they contain and enact condensed contestations for meanings and practices'.[106]

That primate DNA was altered by the 'baboon marker' in a heritable manner within a short time (possibly a generation), in a non-mutational framework, is also neo-Larmarckian. Lamarckian and neo-Lamarckian stories continually search for the environment/gene connection that random mutation and selection denies. The complex mutability of DNA invites this consideration of neo-Lamarckianism when a change in DNA can act, as it can in this case, as phylogenetic information on species formation. According to Johnson and Coffin, conversion events such as the baboon retrovirus can be marked with a high degree of accuracy in old world primates, even providing an estimate of gene distances between species.[107] This resonates with the work that Ted Steele and other Australian scientists are doing on the human immune system, looking at it as a site where heritable change occurs and the Weismann barrier is challenged.[108] This is not traditional Lamarckianism in that it does not offer larger somatic features of an organism changing within a generation or two, but it does foreground a significant shift in scientific vision, reading incremental, biochemical steps as undoing a problematic master narrative of genic selectionism and determinism. This shift disallows absolutist boundaries between the body and the gene and the body and the environment. To undo these boundaries is to challenge genocentric neo-Darwinism, but it also implicitly threatens the whole of the Darwinian edifice of biological science. Traffic between the soma, the body, and the germline, the reproductive cells, and between the germline and the environment, compromises not so much contemporary science, but the underpinnings of contemporary science. The transfer of RNA codings into DNA codings led to progeny, and ultimately *species* with a 'biased immune repertoire encoded in their germline genes'.[109]

These stories and their accompanying philosophical and scientific issues are not readily accessible when reading the primary material on the Aquatic Ape Theory, such as Morgan's books or academic articles. The ideas mentioned in this section are embedded stories, stories that reflect underlying processes that set the theory in a

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106 Haraway, *Simians, Cyborgs and Women*, 204.
107 Welkin E. Johnson and John M. Coffin, 'Constructing Primate Phylogenies from Ancient Retrovirus Sequences', *Proceedings of the National Academy of the Sciences* 96, no. 18 (1999), 10254-10260.
108 Edward J. Steele, Robyn A. Lindley, and Robert V. Blanden, *Lamarck's Signature: How Retrogenes are Changing Darwin's Natural Selection Paradigm* (Sydney: Allen and Unwin, 1998).
109 J.W. Pollard, 'Is Weissman's Barrier Absolute?' in *Beyond Neo-Darwinism*, eds. Ho and Saunders, 292 –293.

newer framework, as opposed to positioning it as a fringe theory or a non-standard interpretation of existing ideas. Like a Japanese puzzle box, pieces of the theory move around to open and expose another layer or perception of the complexities of twentieth century modernist readings of natural history and deep time possibility. Rapid revisions of scientific information and the development of sociology of science theories have led to questioning of the normative values of modernist science, but this process is not orderly or logical. It is a carnivalistic dance through carnivalised texts, following carnivalised authorities. Superficially, an oppositional, gendered sociobiological narrative, using conventional Darwinist selectionism, the Aquatic Ape Theory complicates the hero narrative of pre-hominid change by contextualizing Australopithecines in the micro and macro environments of immune systems and the ancient geography of the African rift valley. The boundary of the organism changes, and – more importantly – the perceptions of multiplicity and agency change. The 'missing link', that creature of phallocentric scientific desire, dissolves into a site of multiple and partial stories, and is reintegrated via the multiple systems from which it is constituted – albeit, the sutures are clumsy and their carnival nature is exposed.

Conclusion

In some respects, the AAT needs to be critically viewed in the same way as Wilson's grand design story of *Sociobiology* and even Rushton's composite race story in chapter three. The AAT is a 'monstrous theory', a difficult, Frankenstein-like product, patched together from selected pieces of information and leaking at the seams. However, there are significant differences in political tenor. While Wilson's theory seeks the restoration of a colonial, patriarchal order in the biosocial world, and uses selectionism as the first commandment in the service of an all powerful gene, Morgan's AAT subverts colonial and patriarchal orders. If sociobiology is a father's story, reinforcing paternalistic authorities and actively working to reabsorb its own feminist deconstructions, Morgan's story comes from a disowned, illegitimate daughter, a source that acknowledges the father but cannot in turn be acknowledged. Using their own rhetoric, the AAT challenges the fathers to see the occluded aquatic environment and the occluded members of the human family.

This chapter has looked at the contribution of the Aquatic Ape Theory to human evolutionary thinking by appreciating its carnival rewriting of the human ancestral body and its subversion of early and contemporary scientific notions of pre-hominid development.

The carnival aspects of the theory draw attention to the anomalies of the human body versus the standard primate body in the context of an aquatic or sub-aquatic environment. In a story that is designed to focus on difference, the theory draws attention to the vulnerabilities of the human body, such as its slowness in running, other disadvantages with bipedality, its nakedness, its sweatiness, the extreme dependence, fragility and over vocalisation of human infants. The AAT presents a carnival body – anomalous as a primate, curiously built in terms of survival. As an organism, it is nearly impossible to protect individually in a culturally unmediated natural environment, and as a species it simply doesn't make a great deal of sense in terms of its own family tree or its historical emergence. The aquatic ape body is primarily the open, secreting, irregular, reproductive body of the female pre-hominid, including its dependent infants and children, and the aquatic ape story gives reproductive females, infants and children pre-eminence in selection and survival over the classically closed, monumental body of the hunter and provider. In seeking to identify the shaping forces at work on the species, and which bodies are being shaped according to whose needs, this theory challenges the notion of the human body as dominating the environment and argues rather that the environment has, in fact, been instrumental in producing our idiosyncratic species. This theory revises pre-historic emergences in a manner close to the notion of 'material posthuman performativity': that is, the pre-hominid body (and eventually the hominid body) are products of mutual physical agencies in bodies and environment, as *well as* historical and cultural discursiveness.[110] Examples of this material posthuman performativity are found in the 'intra-active' stories of long chain fatty acids that came from estuarine or riverine waters to shape the human brain, and in the historically complex biogeography of the African Rift Valley.

Leaving the multiply mapped grotesque body, it is important to recognize that the Aquatic Ape Theory also has carnival connections with science in a number of ways, as demonstrated through this chapter. Firstly the theory has a profoundly ironic connection with the conservative discipline of sociobiology. Morgan cheerfully

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110 Barad, 'Posthuman Performativity', 809; Barad raises the issue of the body's material historicity and change. 'To what degree does the matter of bodies have its own historicity? Are social forces the only ones susceptible to change? Are not biological forces in some sense always already historical ones? Could it be that there is some important sense in which historical forces are always already biological? What would it mean to even ask such a question given the strong social constructivist undercurrent in certain interdisciplinary circles in the early twenty-first century? For all of Foucault's emphasis on the political anatomy of disciplinary power, he too fails to offer an account of the body's historicity in which its very materiality plays an active role in the workings of power.' These questions are germane to evolutionary studies and ecofeminist thinking on evolution.

plunders writers in this area to produce the framework of her own story, but then she subverts conventional sociobiological arguments of male dominance and male reproductive strategies and replaces them with female-centred and environment-centred stories of prehistory. Henry Gee talks about the problems of telling 'deep-time' narratives through a reliance on fossils by comparing it to sifting through a box of inherited photographs from an aged relative. With no context, it is impossible to sort the pictures accurately beyond a certain point. Gee's argument is pro-cladistics and he is not a fan of the AAT; however, his writing of the difficulties of situating material evolutionary snapshots does highlight the gaps in knowledge that a theory like the AAT can exploit. That Morgan's story fits with a certain way of hypothesizing human origins works to open understanding in two ways through sociobiology. Firstly, it assists in demonstrating the shortcomings of the sociobiological model and the shortcomings of existing sociobiological stories, and secondly, the confusion it brings to those stories allows new scientific and sociocultural questions to be posed and investigated.

The identification of the importance of long chain fatty acids in building the human brain, and the identification of those fatty acids as coming from a prehistoric aquatic food source are an example of the reciprocal feedback, or perhaps lopsided dialogue, that has been set up between a disruptive carnival idea and conventional scientific knowledge. The same applies to Philip Tobias' revisions of the 'little foot' fossil and his ratification of the importance of an aquatic element to the environment of the original human forbears. Thus the AAT is not just subversive and challenging in its stories about the human body, it opens the boundaries of the scientific understandings of human evolution to generate a degree of uncertainty that goes beyond specific disciplinary debates such as, for example, the paleoanthropology tussle over hunters and gatherers. A further interesting aspect to the carnivalisation of current science is that the AAT started as a gendered story in the challenges it posed to science, but the information that is impacting on stories of human emergence is often no longer so noticeably gendered. Elaine Morgan may be correct that females and infants were left to graze along estuarine shorelines while males dominated the few trees in the mangroves, but that is not where the current scientific unraveling occurs. It occurs in places of immediate interest to modern science – primarily in molecular science, and secondarily in the ecology.

The opening of standardised science narratives to admit complexifying, unresolvable ideas is a carnival process, but it also holds within its challenges and

changes the seeds of what will follow should other parts or all of the existing narratives collapse. The AAT subverts sociobiology, challenges current science and anticipates post neo-Darwinism in its feminist and eco-feminist politics. The theory messes with currently constructed boundaries by its focus on interspecies convergence, its multidisciplinary approach, its acknowledgement of its own partial perspective and its unexpected, embedded expressions of change that read the organism and the environment in ambiguous ways with respect to the neo-Darwinist, sociobiological adaptationist paradigm. The AAT uses both sociobiology and neo-Darwinism, but it uses them to challenge current constructions of gender, science, animality, environment and history. A curiosity of the carnival, an inhabitant of side show alley, this theory is surprisingly relevant to the contemporary scientific and cultural revisions of evolutionary understandings of humans, their history and their world.

Chapter Five
Darwin meets Pandora

The present intellectual 'uprising'...is unique. It springs simultaneously and independently out of diverse disciplines: from chemists contemplating the origin of life to developmental psychologists preoccupied with the origin of human nature. At first glance, they seem to have little in common save a dissatisfaction with the neo-Darwinian framework. A closer inspection reveals the connecting threads which converge on those fundamental issues of evolution left largely untouched by Darwin and his followers. Problems such as determinism and direction in evolution, global patterns of speciation and extinction, and the origin of biological form and function, have been regarded by neo-Darwinists either as irrelevant – because they are outside the scope of the theory – or as explicable by natural selection in combination with other *ad hoc* assumptions. To us, on the other hand, these problems are primary to evolution, and hence epistemologically prior to natural selection. Our common goal is to explain evolution everywhere by necessity and mechanism with the least possible appeal to the contingent and the teleological.

Mae-Wan Ho and Peter T. Saunders[1]

Patterns of descent, branching, and hybridisation are space – and time –dependent processes.

Robin C. Craw et al[2]

Introduction

A central concern of this thesis is to consider the carnivalisation of knowledge in the field of evolutionary theory and investigate how it can be mapped on to the carnivalised genre of feminist science fiction. To do this meaningfully it is important to understand subversive stories of scientific authority and organic extremity and explore a broad spectrum of alternatives that might suggest new unities and affiliations between scientific disciplines and science and literature. Part of the methodology used in this chapter is a feminist critique of science stories, because such critique is useful in detecting some of the biases of scientific discourse and practice that have led to heavily masculinised research projects, and it is a good position from which to identify yet 'other' skewing of science.[3] The focus of the chapter will be a cluster of stories that constellate around evolutionary thinking but are not usually considered central to its genocentric metanarrative. Using both Haraway's politics and her story telling approach, sociocultural inflections will be read from the various disciplinary accounts of change. Through this process, a 'new unity' will then be suggested using an ecofeminist framework, a framework that can include – but does not centralise – evolutionary stories of reductionist and competitive stories of selection and genes. Gathered and specifically analysed as feminist/ecofeminist, these 'other' narratives

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1 Mae-Wan Ho and Peter T. Saunders, 'Pluralism and Convergence in Evolutionary Theory' in, *Beyond Neo-Darwinism*, ed. Ho and Saunders, 5.
2 Craw et al, *Panbiogeography*, 89.
3 Harding, *Is Science Multicultural?*

present a surprisingly unified developmental avenue for evolutionary thinking that stresses the necessity of an interdisciplinary approach in this scientific arena.

These stories come partially from articles in two collections, both co-edited by the British geneticist Mae-Wan Ho. In *Beyond Neo-Darwinism: An Introduction to the New Evolutionary Paradigm* and *Evolutionary Processes and Metaphor*, Ho demonstrates a frustration with the impediment that strict Darwinian and neo-Darwinian thinking pose to a possible new pluralistic approach to evolutionary thought. She includes samples in both volumes from sympathetic scientists who speak on protobiogenesis, morphology, panbiogeography, convergent evolution, complexity in evolution, neo-Lamarckianism and artificial intelligence. This scientific bricolage is further supported in this thesis and/or this chapter by theories from outside these collections. Gould and Eldredge's punctuated equilibrium has already been considered at some length in Chapter Two of this thesis. While it could have been included with the 'post neo-Darwinian' stories in this chapter, it was considered separately because of the extent of the challenge it presents to non-genocentric Darwinian thinking. It is not the only 'unravelling discourse' with respect to Darwinism, but it is significant. Kimura's Neutral Theory – that DNA works in a population on the basis of random drift as opposed to active genetic selectionism – also challenges Darwinism and the new synthesis, but that will be considered in this chapter because its case has not been as widely discussed yet and its institutional affiliations are different and more specific. Lynn Margulis' Serial Endosymbiosis Theory, a story that constructs a cooperative model of macroevolutionary change from studies of the eukaryotic cell, is also considered with Ho's collection of stories as a 'post neo-Darwinian' theory because it offers a cooperative strategy for change, as is the Gaia Theory that she has helped James Lovelock to develop. Gaia suggests that the earth is a gigantic, single organism, capable of balancing its own needs by a form of homeostasis. Considered together with the more disruptive aspects of sociobiology, discussed in chapter three, and the problematic specifics of human evolutionary discourse, discussed in chapter four, these disparate ideas – like the subversive and odd individual participants of carnival – move the focus of evolutionary science away from the orthodoxies of natural selectionism, competition and random mutation, and support a new force within evolutionary thinking of 'pluralism and convergence'.[4] They also multiply ideological and

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4 Ho and Saunders, 'Pluralism and Convergence in Evolutionary Theory', in *Beyond Neo-Darwinism,* ed. Ho and Saunders, 3-10.

biological hybridities and normalise a polyvocal science, particularly with their overlapping representations of time and scale.

My particular argument in this chapter reads change in evolutionary theory as following that hopeful, combinatory, polyvocal science constructed from interdisciplinary, multiple and partial perspectives, and founded on assumptions that closed, androcentric models of knowledge can no longer be sustained as central and overly privileged. Such an approach, however, does not exclude androcentric evolutionary discourses from what is essentially an ecofeminist model of diversity in evolutionary understanding. Rather, it aims to recognise the androcentric voice without conceding dominion. Operationally, an ecofeminist model, in this context, would refuse dualisms, investigate biocentrically rather than anthropocentrically, and reintegrate organism and environment. Such a polyvocal model would also appreciate the complexities of a plethora of organic and environmental agencies and position the metatheory of evolutionary change and history as an open, socially reflexive discourse. This may sound idealistic; however, what is being proposed is not so much a utopian model of knowledge as an extremely elastic and inclusive one. An example of its praxis was demonstrated in Chapter Three where the problematically gendered and racialised aspects of sociobiology and genetic reductionism were identified but sociobiology was then simultaneously credited as a significant bridging discourse, shifting western science away from cartesian dualism and anthropocentricity. Richard Dawkins was discussed as a didactically conservative writer, but was also given credence as a legitimate voice of the gene in the carnival of evolutionary theory. Using carnival analysis in this way means resistance to a theory does not necessarily create binary, oppositional thinking, but instead shifts both idea and resistance to an idea into a larger and more complex field of signifiers that, read wholistically, intimate a new politics for the field. Embracing complexity means the tiered landscape of evolutionary theory can then be reconceived as ecofeminist – bodies are mutable, agency is distributed, non-human subjectivity is recognised, organisms and environments are indivisible and interdisciplinary accounts of the world are essential for operational and intellectual understanding.

Two biological histories: prebiotics and Serial Endosymbiosis Theory (SET)

The vital question, when looking at evolution in this way, is whether seemingly piecemeal approaches like carnival theory and ecofeminism can effect a real change in the support for Darwinism and neo-Darwinism? Particularly, what chance do they have

of deflecting allegiance away from reductionist paradigms and introducing new, more wholistic and effective models of change to both public and scientific thinking on this subject? Even discounting Dawkins' broken record technique of writing the gene into the centre of the evolutionary universe, we currently have a strong cultural focus on DNA. A reverence for genetic code infiltrates almost every aspect of the way the western world conducts business in the twenty-first century. As noted in the previous chapter, the gene is central to many hopeful stories in Western biology, medicine and agriculture, but it has led to, among other things, to the growth of biosurveillance, biocommerce, biocrime and bioart. Issues of genetic identity and privacy have caused, and still are causing, enormous problems for the legal system, and the poaching and patenting of living materials has become common.[5]

Clearly the gene story is central and significant to who and what we are at the moment, clearly it is also not a closed biological story. As with any complex narrative, there are culturally central and culturally marginalised stories that contribute to understanding the gene. The gene, in turn, contributes affirming and disruptive stories to the grand narrative of evolution. Neo-Darwinism claims the most environmentally successful genetic options win when nature casts the dice, and each throw gives the species yet another unqualified chance to improve or lose in the game of life through the gene. This is a concept that is comfortingly simple and offers a prefabricated genetic justification for any observed outcome, but it is only telling – at most – one part of a very complicated tale that ignores important constraints that exist both within and without the organism. Acontextual DNA, for example, while offering large insights into the replicative story of life must still answer questions of even more primitive origins, because DNA, of course, did not materialise out of the primordial air. First came chemistry.

The search for the chemical origins of life, prebiotics, has focused on the synthesis of amino acids when combined with heat and water as it has long been suspected that the initial chemical reactions that generated life on earth occurred in hot springs and geysers. Laboratory experiments modelling this process using water, heat and amino acids yield considerable information, some of which promotes an alternative to the

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5 Lori Andrews and Dorothy Nelkin, *Body Bazaar: The Market for Human Tissue* (New York: Crown Publishers, 2001); this perspective of human and other bodies is carnival and directly challenges the classical body in science. Andrews and Nelkin provide dozens of anecdotes in *Body Bazaar*: stolen DNA creating fortunes for researchers; Thomas Jefferson's reproductive link to one of his slaves; children challenging their own paternity; canny individuals selling their own specialised genes; unscrupulous laboratory work ruining lives; problematic ownership of artistic DNA when artists use their own or others bodily products in their work, and more.

Darwinist/neo-Darwinist gradualist, random mutation and environmental selection paradigm. Experiments undertaken by Sidney W. Fox, a researcher in this area and contributor to the Ho volumes, found that protocells or large macromolecules, for example, formed very easily when it had been anticipated that prebiotic evolution would necessarily be a lengthy and difficult process. Protocells were created in huge numbers rather than in small, isolated populations, and the laboratory protocells showed tendencies to associate and communicate chemically, so environment quickly became significant. Chemical activity was also found in all protocells, which had unexpectedly good life spans, and protein appeared to predate DNA as a mechanism of inheritance in cells.[6] Further qualities of the cells that Fox lists include more specific chemical properties and activities. The cells were found to be esterolytic, phosphatatic, decarboxylatic, peroxidatic, synthetic, photodecarboxylatic, Protophysiological, electrostactic, protometabolic (Catalytic), protomobile, osmotic, permselective, fissive, protoreproductive, conjugative, protocommunicative and excitable.[7]

Fox extrapolates from a career of intensively studying prebiotics, to claim the field offers a significant empirical, experimental basis for evolution. He says that macroevolution can now be reconsidered on the basis of this replicable leap, as it indicates other large evolutionary steps are not only possible, but likely.[8] His research leads him to reject randomness in both its open and more specific statistical meanings and to embrace notions of 'self assembly' or 'self-organisation' within the organism. He critiques current evolutionary theory for its backward interpolations (reverse engineering) of evolution, in terms of the surprising results of his own experiments, as he believes this is never going to accurately demonstrate the emergence and development of life. He also contends that study of the modern cell cannot reveal primordial process because protocells emerged without having any or all of the functions of the modern cell and modern proteins do not work the way that proteinoids work in forming cell-like structures. Fox believes his experiments underscore the unpredictability of evolutionary impetus and the need for more focus on construction

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6 Fox, 'Proteinoid Experiments and Evolutionary Theory', in *Beyond Neo-Darwinism,* ed. Ho and Saunders, 15-60.
7 Fox, 'My Scientific Discussions of Evolution for the Pope and his Scientists', *The Harbinger* (Mobile) May 27, 1997, 15.
8 Fox, 'Proteinoid Experiments and Evolutionary Theory', in *Beyond Neo-Darwinism,* ed. Ho and Saunders, 47.

and synthesis in evolutionary thinking, as opposed to analysis and reductive and deductive reasoning.[9]

Like Gould and Eldredge with their 'footprint of theory' and Henry Gee with his 'search images', Fox is aware that science is culturally and historically informed. He cautions against preconceived notions in scientific stories, and tries to support experimental process and documentation of what happens. However, no science – not even the study of chemicals – can avoid narrative loading and, in this case, a specifically gendered loading. The thermal protein that generates life is referred to by Fox as 'mother substance', and he uses his piece in Ho's collection to purposefully reject the heavily patriarchal Darwinist/neo-Darwinist gene stories. He is also keenly aware of the importance of genesis narratives in the culture as he documents three summonses with other scientists to the Vatican to explain his findings to Pope John Paul II and his scientific advisors. This explanation was done in the context of evolutionary knowledge and, according to Fox, met with a generalised response of the impossibility of full knowledge in the area. [10] So Fox uses the 'maternal substrate' of prebiotic protein to instruct one of the most significant patriarchs of western culture in an alternative origin story, one that supposedly contradicts the primal text given to the papal father by the ultimate father. Consultation on this issue between a scientist and the most eminent prelate in the Catholic Church sends mixed signals on authority as significant patriarchal structures adjust to each other.

Read on one level, Fox's dedication to prebiotics appears to ratify Keller's psychoanalytic perception of masculinist science's obsession with origins and the replication of 'life'. Just as paleontology can be understood as an investigation of the contents of the earth/womb to identify the primal moment of conception,[11] so too prebiotics can be seen as an attempt to recreate the moment of conception when life emerged from the primal soup on an ancient earth. However, beyond that particularised psychoanalytic reading, Sidney W. Fox's work can also be viewed as an oxymoronic expression of carnival gender and authority. He genders the substrate for his revolutionary ideas as feminine and purposefully uses it to oppose reductionist, masculinist evolutionary discourse with it. However, Fox is still bound by, and dependent upon the authority of masculinized empirical traditions. He tries to escape

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9 Sidney W. Fox, 'Evolution Outward and Forward', in *Evolutionary Processes and Metaphors*, ed. Mae-Wan Ho and Sidney W. Fox (Chichester: John Wiley and Sons, 1988), 17-29.

10 Sidney W. Fox, 'Biopoesis', http://www.holysmoke.org/fox.htm (accessed June 20, 2004); Fox, 'My Scientific Discussions of Evolution for the Pope and his Scientists'.

11 See Chapter Two.

them, by remarking on not visiting the work with preconceptions but rather allowing his experiments to 'talk' to him, and thereby practicing better science.[12] This framing of experimentation as a dialogue with the 'protolife' is a significant revisioning of scientific process and concepts of agency, but Fox's claim to 'better' (i.e. more value free) science still revisits a traditional sense of objectivity as a marker of distinction, rather than moving into a space where it is possible to fully embrace the ramifications of complexity and relativity that his comments on dialogue imply about experiment and experimenter. As a bottom line, the dialogue between Fox and his proteinoids can hardly be described as a conversation between equals.

Both Fox and Koichiro Matsuno, another protobiologist, challenge the Darwinist/neo-Darwinist notion of randomness through the production and behaviour of protocells. Traditionally, for example, in the population genetics model of evolution, random variation has been the base upon which selection operates: as organisms manifest favourable traits, they are positively selected, as they manifest unfavourable traits, so their survival or sexual viability is challenged. However, randomness is a concept that has different applications in different disciplines. Fox, Matsuno, Ho and Saunders all argue that neither the more conventional statistical model of randomness nor an open idea of randomness works in the biological framework. For example, out of the existing twenty amino acids it should be assumed that all conceivable random sequences would be likely to occur in Fox and Matsuno's experiments, but in fact 'the probability space of prebiotic proteins is much more restricted' than simple number crunching would imply, and only certain combinations manifest.[13] This causes these writers to defect from the term 'random' in life and protolife studies, to the terms 'self-organisation' or 'self-assembly', suggesting a sense of agency at work at a chemical level. Pursuing Fox's work on self-organising protocells, Matsuno seeks a possible regulative principle in self-generated biotic (as opposed to abiotic) open systems. The question, according to Matsuno, is whether there is a generative principle that acts as a precursor to the DNA transcriptive mechanism because, once DNA appears, the system is no longer as open or as random, but is subject to constraint. So, both Fox and Matsuno's reasoning is as follows: any regulatory principle that acts on the prebiotic will inevitably function with the biotic too. That is, 'The regulative principle underlies both the origin and the evolution of the DNA apparatus'. [14]

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12 Fox, 'Biopoesis'.
13 Matsuno,'Open Systems and the Origin of Protoreproductive Units', in *Beyond Neo-Darwinism,* ed. Ho and Saunders, 61-88.
14 Ibid, 63.

In the search for the regulative principle, Matsuno critiques any division of organism and biosphere as 'arbitrary' and 'anthropomorphic', saying that such a division carries with it the baggage of Cartesian dualism and doesn't make sense.[15] Due to this artificial separation of life and environment, Matsuno sees adaptation and selectionism as inadequate explanations of biological change, as he contends that the evolving organism cannot itself assume the role of regulative principle as it is in a state of flux. In fact, he points out that non-random variation, as opposed to random variation, is the most probable mechanism for change in biosystems. That is, changes are not random, rather they are generated from within the protocells because the environment is affecting the responsive protocells in a predictable way, and 'the sharp separation between reproductive units and the environment ... dissolves'. The dismissal of the boundary between organism and environment is a crucial marker of both carnival and ecofeminism. The loss of boundary reflects the loss of footlights in Bakhtinian carnival.[16] For Bakhtin, there is no distinction in medieval carnival between the performer and the spectator, between the world and the individual. Put it in a more contemporary and ecofeminist framework, Karen Barad dissolves boundaries in what she calls 'posthuman performativity'. That is, Barad proposes an all inclusive system that sees no 'inter-relationship' between discrete entities, but rather 'intra-relationship' between open subjects participating in a muti-agential, posthuman performance.[17]

For Matsuno the organism is an active agent, but it is not a 'free agent'. Arguing the inseparableness of organism and environment, Matsuno inevitably supports reciprocal narratives of epigenesis and punctuated equilibrium through his own story of material flow equilibration. Seeking the boundaries of the model, he uses the second law of thermodynamics and looks to the equilibration of matter in the open system where his protocells aggregate and disassociate on a regular basis. Matsuno searches for a regulative principle that can move across both the micro and macro fields of evolutionary thinking.[18] The question is not only will what he seeks be found. It is also whether such a regulative principle would take biology in a new, more open direction or would it be appropriated to reinforce reductionist stories? Many complicated and

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15 Ibid, 63.
16 Bakhtin, *Rabelais and His World*, 7.
17 Barad, 'Posthuman Performativity', 801-831.
18 The second law of thermodynamics is that heat will always flow 'downhill', i.e, from an object having a higher temperature to one having a lower temperature; thus it is impossible for heat to flow spontaneously from an object with a lower temperature to one with a higher temperature, and work must be done to transfer heat energy from a lower temperature to a higher temperature. *The New York Public Library Science Desk Reference* (New York: The Stonesong Press, 1995), 283.

complicating narratives are concealed behind replicative gene stories. Even the macrocells are but one prebiotic chemical story. Beyond prebiotics are tales of enzymes and proteins, of microfossils and organisms from hydrothermal vents, of prions and pathogenic organisms. Ironically, however, while these tiny carnival entities disturb the dominant narrative of reductionism, the simplicity of the gene story ensures they can be swallowed by it too – unless they do what this thesis proposes and ally themselves with other stories of resistance and alternative mechanisms of change to reveal very different common denominators in perspectives of organisms, environments and the relationships between them.

Another history of the cell and, by extrapolation, a history of the multicellular organism belongs in this chapter section of the rewriting of early evolution as carnival. Serial Endosymbiosis Theory (SET) offers a resistance to the molecular biology narrative of nucleated genes as the origin and meaning of life and seeks to explore life prior to the nucleated cell and examine its contribution to what we understand as life today. Put in simple terms, Serial Endosymbiosis Theory views the emergence of life thus:

> Bacteria evolved first. They diversified by branching. Then, through bacterial symbiogenesis, branches of protoctists emerged. From a rich ancestral stock some protoctists evolved into fungi, others into animals or plants.[19]

This outlines the basis of Lynn Margulis' five kingdom model of life in which protoctists, diverse unicellular organisms, form the basis of all life by creating themselves anew through profoundly cooperative strategies.[20] According to Margulis, bacteria (also known as monerons or prokaryotes) have been around for over 2000 million years and are non-nucleated cells with free floating DNA. Predicated on the bacteria are protoctists. These include slime moulds, algae, ciliates and other organisms that are more complex than bacteria and have been formed, at some stage in their history, by the crucial process of symbiogenesis, literally a joining. Animals (life forms that develop from embryos), fungi (life forms that develop from spores), and plants (life forms that can develop from both spores and sexually produced embryos) form the other more readily recognised kingdoms. Using her five kingdom model, Margulis then contends bacteria and protoctists provided the most significant evolutionary leaps, via symbiogenesis, in the development of life on the planet.

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19 Lynn Margulis, *The Symbiotic Planet: A New Look at Evolution* (London: Phoenix, 1998), 7.
20 Ibid, 67.

Symbiosis, a more familiar term, means the living together of different kinds of organisms, while symbiogenesis means that in some cases of symbiosis, or cohabitation, new bodies, new organs or new species are formed. Margulis, like many female scientists, followed the lead of a male scientific progenitor in constructing her theory.[21] Around the turn of the century Konstantin Merezhkovsky proposed the original idea of new organs and organisms being formed by symbiotic mergers. Margulis makes Merezhkovsky's idea more specific, arguing that incorporation and body fusion explains the origin of all plant and animal cells.[22] She says, the process began when an archaebacterium, an ancient bacteria that likes sulphur and heat, merged with a swimming bacterium. Together they formed the precursor of a nucleated cell, ancestor to the basic substance of fungal, plant and animal cells. This merger yielded an anaerobic swimmer that inhabited rich muds and pools, away from oxygenated environments. The protist divided and multiplied, and when that process was stabilised, it absorbed an oxygen breathing bacterium. This complex entity that enjoyed acid, heat, oxygen and swimming became capable of engulfing and metabolising particulate food matter. It then absorbed another bacterium, a tough walled, bright green photosynthetic bacterium. The large, complex cell could not digest the green bacterium and it became a chloroplast. Thus the stage was set for the development of complex animal and plant cells and those organelles or mitochondria, small bodies found within cells, began to take on specific functions inside the microbial beings they inhabited.

Margulis also argues for a further incorporation along that early boundary organization of bacteria/protoctist, but her fourth argument has not become accepted science to this point. It is indisputable that the original bacterial mergers occurred. Cell organelles remain the same size as bacteria and they retain their own depleted stores of DNA that reproduce differently and at different times from the nucleus. Also, the particular kind of DNA found in the mitochondria, intracellular bodies, still resembles that of independent oxygen breathing bacteria, and Margulis says that the DNA of

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21 Haraway, *Primate Visions*; Haraway, *Simians, Cyborgs and Women*. Haraway identifies the inevitability of female scientists acquiring knowledge and training under patriarchal figures and systems in their disciplines.

22 Lynn Margulis, *Origin of Eukaryotic Cells* (New Haven: Yale University Press, 1970). Margulis gives a historical list of those who contributed to the symbiotic theory of the eukaryotic cell. See also Lynn Margulis and Mark McMenamin, 'Marriage of Convenience', in *Slanted Truths* ed. Lynn Margulis and Dorian Sagan (New York: Springer Verlag, 1997), 35-46, and Lynn Margulis and Michael F. Dolan, 'Swimming Against the Current', in *Slanted Truths*, 47-58. Primary credit for the early development of the theory is given to Merezhkovsky, but Margulis also acknowledges Ivan Wallin, who independently published on symbiogenesis in 1927.

chloroplasts was found, in 1970, to more closely resemble that of free-living cyanobacteria than the DNA found in the nucleus of the cell containing the plastid.[23] The fourth incorporation, as yet unproven, that she argues for, is the absorption of ciliate organelles. These cells would have brought motility to early symbiotic partnerships and then could have evolved to cilia and villi in more complex organisms. Margulis also believes the ciliate organelles would have occurred early in the partnership as she believes they could have contributed centriole-kinetosomes, bodies crucial to cell movement and cell division. Margulis actually argues for this as the primary symbiosis – wriggling, hungry and desperate spirochetes invading archaeobacteria, then forming a truce whereby both life forms could subsist together.[24] Its primal nature, if Margulis is correct, could be what makes this particular fusion so difficult to detect.

Lynn Margulis is creative and eclectic in her ideas – a carnivalised figure of a scientist narrating a carnivalised story of origins. Loyal to Darwin, she pictures the early 'highly integrated protoctist clones' as evolving, via selection, into larger, more complex creatures. This leads to Margulis arguing for selection as the primary process in the development of complex, multicellular organisms and maintaining the language of competition in the narrative of protoctists. The anastomosis (joining) of the organisms is depicted by her as a savage conflict, resulting in one organism consuming the other but being unable to digest it. When she describes the process, Margulis uses language like 'cannibalism', 'battle' and 'truce'.[25] In this respect she maintains a Darwinian reading of nature, a competitive story of nature red in tooth and claw. However, this is only one dimension of what she writes, and witnesses only to the trauma that can underpin creation and life. She is also, however reluctantly, describing a profound cooperation that is imbued with a sense of organisation, aggregation, community and communication:

> We are especially concerned with these microbes' behavior, rich social lives, and interaction with sediments as they form persistent community structures ... 'Speaking' the language of chemistry, the [original] bacteria diversified and talked to each other on a global scale.[26]

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23 Margulis and McMenamin, 'Marriage of Convenience' in *Slanted Truths*, ed. Margulis and Sagan. 37.
24 Margulis and Dolan, 'Swimming Against the Current', in *Slanted Truths*, ed. Margulis and Sagan. 47-58.
25 Margulis, *The Symbiotic Planet*, 48.
26 Ibid, 108.

As in Fox's work, there is the democratising notion of dialogue with the object/subject of study. However, Margulis focuses more on the way early bacteria communicated chemically with each other, while Fox has a more traditional patriarchal perception of the protocells speaking to him, the figure of the scientist who counsels religious leaders. Thus the scientist in Fox's model becomes translator and gatekeeper to truths revealed by protocells, while Margulis is more of an ethnographer and advocate of the bacterial community. An emphasis on dialogue guides both models, but there is a significant political difference in way the dialogue is framed and what is says about the shifts of constructions of authority as part of traditional scientific process.

Margulis also recognises the dilemma it puts her in to argue a competitive model when her main theory is a symbiogenetic joining. There is a double think to her work because, while she adheres to a Darwinian truth of competition and selection, she castigates neo-Darwinism.[27] Her contrast is between what she refers to as 'mechanistic neo-Darwinism' and 'autopoiesis'. Her critique alleges that neo-Darwinism is incurably mechanistic because it depends on a mathematics/physics/chemistry/biology hierarchy of knowledge and that, as long as biology remains subservient to more apparently value-neutral disciplines there will be no progress in understanding life and organisms within their environments. Opposing hypercompetitive, mechanistic neo-Darwinism, Margulis emphasises autopoiesis, the ability of living entities to balance themselves and to respond to changes at internal and external levels. Autopoiesis, she says, is a characteristic of single celled bacteria, but is also a characteristic of multicellular organisms in general, and is even a quality of the planet. As a professional, she anathematises cultural patterns that fund scientists to work out mathematical formulae for sociobiological perceptions of kin relationships while refusing resources that would allow biology students to be taken out into the field to study plants and animals within their original environments.[28]

Both Fox's protobiology and Margulis' Serial Endosymbiosis Theory are essential to constructing a fuller picture of evolution. They address invisible baselines of creation and imagine the deepest possible histories of life. Entering the story at different points, both scientific narratives challenge competition, random mutation and selection as dominant modes of existence in primitive forms, whether they be macromolecules or early bacteria and protoctists; however, as is the way in the

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27 Margulis, 'Big Trouble in Biology: Physiological Autopoiesis versus Mechanistic Neo-Darwinism', in *Slanted Truths: Essays on Gaia, Symbiosis, and Evolution,* ed. Lynn Margulis and Dorion Sagan (New York: Springer Verlag, 1997), 265-282.
28 Ibid.

knowledge carnival, they do it inconsistently and offer no sense of a unified resistance to dominance politics in biology. Fox and Matsuno consciously and deliberately frame their work as moving beyond Darwinism and neo-Darwinism into a hopeful new synthesis. Margulis, on the other hand, situates herself differently to Fox, Matsuno and Ho. She refuses to take issue with Darwinism, saying it is likely that selection played a significant role in the survival and development of multicellular organisms, but she does unequivocally reject neo-Darwinism as a mechanistic, hierarchy driven discourse that is disconnected from studies of life. Combined and separately, the Fox, Matsuno and Margulis stories offer possible, plausible accounts of origins and, despite Margulis' Darwinian readings of her own work, neither fits comfortably with the current prevailing stories of change found in evolutionary discourse.

Something else that should be noted is that permeable boundaries are a common element to both the prebiotic and the SET stories, and an examination of them is revealing. Microspheres are basically undifferentiated but they share one important and necessary feature with bacterial cells – a membrane. The thin film of proteinoids that confine the elements of the microsphere may be structurally different from the much more complex and well ordered phospholipids and amino acids that contain cytoplasm, nucleic DNA and assorted organelles, but both are important in contemporary narratives of symbiosis/cooperation and can be considered through carnival theory. They are important because the permeability of boundaries is central to both the microscopic logic of existence and the current political topos of science and society. While competition is the dominant narrative of contemporary evolutionary biology, neither protocells nor early bacteria can be perceived as closed or possessing the strong sense of individuality usually attributed to competitive organisms. Protocells freely aggregate and communicate chemically with their environment and with each other, while the early archaeobacteria created unusual relationships with their food, forming intracellular cooperatives with it and creating complex, mutant and multiple bodies in the process. While current representations of chemistry as numbers and lines make it difficult to imagine the prebiotic protocells as grotesque and carnivalistic, their instability and permeability move them away from closed, classical notions of bodily integrity. They are also subversive and unruly under the reverse engineering expectations of Darwinism and clearly obey their own rules of construction and connection. The same can be said of the early bacteria. Early bacteria did not evolve DNA step by step, they ate it. Their consumption of organelles indicates a carnival appetite, a lower stratum activity, and their failure to digest forms/formed the

grotesque, open, secreting, multiple body of life. They cannot conform to classical or modernist concepts of closed bodies and must be rewritten in a more adventurous, more open framework, such as Karen Barad's posthuman performativity. Barad's posthumanist notion of performativity reflects the complexity of the cellular and precellular entities discussed here and endows them with politics as their performativity 'incorporates important material and discursive, social and scientific, human and non-human, and natural and cultural factors'.[29]

The identification, nature and function of such primal boundaries is bound to be particularly contentious in a time when margins are being questioned. This is evidenced by Margulis' ambiguous reaction to her own theory as she reads through the hopeful inclusivity of symbiogenesis to the violence of rupture necessary for joining. Fox is happy to present his proteinoids to Pope John Paul II and face down Darwin with Ho, but Margulis wrestles more intimately with scientific patriarchy and the basic conundrum of understanding competition and cooperation simultaneously. Binary thinking is not just a theoretical tale, it lies at the heart of matter. Boundaries are about bodily and social integrity, safety and control, whereas breaches are about change, disruption and threat. The question in radical evolutionary thinking is how to honour the boundary, the breach and the science at the same time. The answer is never going to be simple. Ruth Bleier argues for better gender representation in the science professions, Sandra Harding's solution is promoting standpoint theory in the Science Wars, Keller's is psychologised western anxiety as institutional foundation, Haraway's is unpicking academic genealogies in scientific training and embracing multiple/partial perspectives, but Margulis' solution has a different brand of feminism and science again. Hers is an odd combination of obdurate conservatism and scientific creativity. She and her theories do not look out of place in a postmodern carnival that celebrates difference in a number of the fields where she holds significance. Like Gould and Eldredge, she fights to keep her theory under the aegis of Darwinism, yet she regularly challenges the law of the father and continues to open science to gender critique by supporting her own symbiogenesis story, a carnival story redolent with feminist politics.

Lamarckianism, epigenisis and non-mendelian heredity

Le Chevalier Jean Baptiste Lamarck formulated his ideas around an organism changing during its lifetime and those changes being heritable. The main thrust of his argument

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29 Barad, 'Posthuman Performativity', 808.

was that the organism changed its habits and needs in response to environmental conditions, thus 'influencing the strengthening and weakening of organ functions and, in turn, evoking hereditary changes in organs'.[30] While his theory of environmental impetus and organic agency as mechanisms of change is often demonised in modern biology, it was an important step in evolutionary thinking because it contested the doctrine of perfect creation and viewed developments in organisms as historical. Lamarck's views directly influenced Darwin; however, Darwin chose natural selection as the main mechanism of evolution, with his concession to organisms changing in response to environment reduced to 'pangenes'. 'Pangenes' were gemmules generated by the somatic elements of the organism that travelled, via the circulatory system, to the germ line cells and ensured that changed traits in the organism would be inherited by offspring. According to Blacher, who documents the theory of inherited characteristics, Darwin believed that the concept of natural selection would probably entirely replace the idea of direct adaptation. Historically, it is important to consider the fall of Lamarckianism in the context of the rise of neo-Darwinism, as rejection of the idea of a responsive germ plasm is key to current thinking in biological science and ignores the key issue of emergence in biology.[31] This process was promoted by two scientific scandals in the first half of the twentieth century.

The first incident involved Paul Kammerer, a scientist who worked at the Biological Institute in Vienna in the early decades of the twentieth century. Kammerer's experiments were dedicated to changing amphibian phenotypes by altering environments. His successes apparently included growing eyes in eyeless cave newts by exposing them to certain light frequencies, changing the coloration of salamanders over several generations by exposing them to different environments, and – most infamously – forcing the development of nuptial pads in the male Midwife toad.[32] This toad always mates on dry land and therefore does not need the thumb pads

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30 L. I. Blacher, *The Problem of the Inheritance of Acquired Characters: A History of a priori and Empirical Methods Used to Find a Solution*, trans. F.B. Churchill (New Delhi: Amerind Publishing, 1982), 26.

31 Reid, *Evolutionary Theory*; Reid, *Biological Emergences*.

32 From both documentation in Koestler, *The Case of the Midwife Toad* and Blacher, *The Problem of the Inheritance of Acquired Characters*, it appears that Kammerer was more of a dedicated naturalist than an empirical scientist as understood today. He did record experiments, but not rigorously. Koestler emphasises Kammerer's special – possibly unique - skills with keeping the animals and maintaining their environments and Blacher also points out his experiments have not been replicated due to the difficulty with this aspect of the work. It appears that Kammerer was not only caught in a particularly culturally loaded debate, but was also a transitionary figure, more reminiscent of the previous century where class, rather than a lab coat, was often a marker of interests in science-based subjects like natural history. It is also evident from Koestler's readings of the situation at the time that scientific dialogue was also in

to grip the female as waterbound species do. Kammerer put them in an aquatic environment to force the growth of the pads. He claimed to succeed experimentally but was accused of falsifying his results and suicided. According to Koestler, in *The Case of the Midwife Toad*, the war made it difficult for Kammerer's results to be examined by other scientists, and there was a lot of personal antipathy between scientists on the continent and those in Britain, where Kammerer's experiments were interpreted as Lamarckian in a scientific culture where neo-Darwinism was gaining credence. Another problem was also the difficulty in repeating the experiments. Kammerer apparently had a particular talent for breeding amphibians that has not been seen since,[33] and science was already moving in the direction of primarily studying the mammalian body story.

Indirectly connected to the Kammerer scandal, and another indicator of the intensity of the debate raging in Europe at the time was the case of Trofim Denisovich Lysenko.[34] Lysenko was a Russian scientist who achieved positions as president of the Lenin Academy of Agricultural Science in 1938 and director of the Institute of Genetics of the Academy of Sciences in 1940, and who used those positions to enforce doctrines of 'vernalisation' and 'vegetative hybridisation' in the Russian scientific community.[35] Vernalisation was an attempt to get crops to grow in the very small seasonal windows between intense winter cold and summer droughts. Soaking and chilling the seeds allowed summer crops to be gained from a winter planting without actually risking the death of the seed from too harsh a winter and 'sowing in the mud' permitted an earlier crop that avoided summer drought.[36] The logic of this process translated into a Lamarckian position of the environment having a crucial effect on the organism. Vegetative hybridism was a different matter. Discussion into the 1930s, prior to molecular biology, was unclear as to whether plant grafts represented cellular fusion and created a new organism or whether they created a 'chimera'. Quotes from Lysenko's papers are revealing:

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the process of changing from class-based conversations between peers to a more careerist model.

33 Blacher, *The Problem of the Inheritance of Acquired Characters,* 179.

34 Helena Sheehan, *Marxism and the Philosophy of Science: A Critical History* (New York: Prometheus Books, 2001), 151-244. Kammerer was invited to the Timiriazev Institute, a centre of Lamarckian research, by the Communist Academy in 1925. He accepted the post but the scandal of the Indian ink coloration of the pads of his Midwife Toad specimen broke around the same time and he committed suicide before he transferred to Moscow.

35 Blacher, *The Problem of the Inheritance of Acquired Characters.*

36 Sheehan, *Marxism and the Philosophy of Science*, 151-244 and Richard Lewontin and Richard Levins, 'The Problem of Lysenkoism', in *Radicalisation of Science: Ideology of/in the Natural Sciences* ed. Hilary Rose and Steven Rose (London: Macmillan, 1976), 32-64.

> The scientific term 'chimera' denotes those organisms whose tissues apparently consist of the mechanical combination of tissue from two varieties. In fact, such so-called chimeras can be viewed as manifestations of the phenomenon of mosaic inheritance where one part of the organism possesses the characters of one of the 'parents', the other part from the other 'parent'.[37]

Given an incomplete understanding of genetics and the then current and volatile debates around Darwinism and Lamarckianism such interpretive expositions may be understandable. However, Lysenko also told notable academic fibs:

> In the joining of two young plants of different varieties through grafting, it seems as if a transfer of hereditary characteristics takes place from one component to another. If seeds are taken from such grafts, the same thing occurs in the seed generation as usually takes place in sexual hybridisation ... At the present time there are hundreds of examples in which, as the result of a graft of two plant organisms of different varieties, a third, hybrid organism is obtained. The hybrid here is created by an exchange of genetic materials between the graft components.[38]

After attaining power, Lysenko set Russian science back considerably by refusing to accept Mendelian genetics; however, vilification of scientists like Kammerer and Lysenko only tells part of the story of the 'Lamarckian Heresy'.

In *The Problem of the Inheritance of Acquired Characters,* Blacher promotes criticisms of Kammerer at some length, and he also evaluates Lysenko in the context of the great number of unsuccessful experiments done on hybridisation of plants (and embryonic chickens) in Europe from 1898-1967.[39] However, apart from supporting the failing philosophy of Lamarckian evolution, the two men had little in common and present as historical contrasts, expressing a difference that can be read as carnival extremity. Both men became involved in a bitter cultural struggle as neo-Darwinism took hold of the western scientific imagination in the early twentieth century, but Kammerer appears to have been collateral damage whereas Lysenko was an *agent provocateur.*

Kammerer represented a cultural period that was losing currency at the beginning of World War II and has become even more antiquated and divorced from contemporary

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37 Blacher, *The Problem of the Inheritance of Acquired Characters,* 235.
38 Ibid, 235.
39 Ibid, 231-247.

notions of scientific scholarship since then. Aristocratically connected and educated, he was unprepared for the twentieth century, for the savagery of war and the savagery of a career scientist like the British biologist William Bateson who, according to Koestler, created his own reputation at the expense of Kammerer. Both Koestler and Blacher report Kammerer as highly ethical and say he worked more as a naturalist than as a modern scholar of biology.[40] His lack of academic currency and his political and personal deprivations mark him as socially powerless and clearly separate him from Lysenko, who was a powerful and connected scientist in the pre-war and post-war period. The Russian biologist, by contrast, represented the new force of totalitarianism, supported by militarism and an emerging scientific industrialism. Knowledge and discovery were no longer the province of class and were theoretically more democratised in Russia at this time, but Lysenko caused real and terrible suffering to the scientific fraternity in Russia.[41] As an historical figure he is much less sympathetic than Kammerer due to his accumulation of political and bureaucratic power and his association with the intolerance and cruelties of Stalinism.

That said, what these two extremely different 'carnivalised' historical figures have in common is the demonisation of their science. This demonisation is historically questionable, as argued by Koestler on Kammerer's behalf and Richard Lewontin and Richard Levins on Lysenko's behalf. Koestler points out that the war ruined Vienna to the point where neither Kammerer, nor the institute he worked for could afford copies of the journals in which he was being criticised. Finally, all that was physically left of his work was one ten year old bottled specimen of the Midwife Toad. When that was found to be interfered with, Kammerer killed himself even though he was not implicated in the interference. Contextualising Lysenko's science were the severe agricultural conditions experienced in Russia's varied climate, the difficulties of experimentation under those conditions and the accountability demands of the political hierarchy for immediate results from any programmes implemented. Also problematic were the logistics of establishing working peasant collectives and the demand on science that it materially and theoretically express current political ideology. Most significant, however, to this thesis is the 'actual state of genetical theory and practice in the 1930s'.[42] Genetics was relatively new and had not been assimilated into Darwinian

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40 Koestler, *The Case of the Midwife Toad*; Blacher, *The Problem of the Inheritance of Acquired Characters.*
41 Sheehan, *Marxism and the Philosophy of Science*, 231-240; Stephen Jay Gould, *Hen's Teeth and Horse's Toes: Further Reflections on Natural History* (London: Pelican, 1984), 134-44.
42 Lewontin and Levins, 'The Problem of Lysenkoism' in *Radicalisation of Science*, ed. Hilary Rose and Steven Rose (London: Macmillan, 1976), 39.

theory at that time. In fact genetics was perceived by Lysenko and other, better scientists to be an anti-Darwinian vitalist approach that denied the idea and reality of evolution by positing an unchangeable germ plasm. The materiality of the gene in the first half of the century was not denied, it just did not come with an explanation of its own origin and evolution, nor did it answer questions about the effects of environment on phenotype (and the possibility of continuing effects on future generations). There was also still the need to explain why all cells of an organism contained the same genes but produced different kinds of tissues. While genetics and Darwinism have since been reconciled into the central neo-Darwinist evolutionary theory of adaptive strategy, and some of the heat has been taken out of the debate by advances in disciplines such as genetics and embryology, there still remains a certain mystery about the interaction of organism and environment. This interaction is often dismissed by Darwinists and neo-Darwinists, who serve up Kammerer and Lysenko as cautionary tales, while they promote random mutation and natural selection as the sole organism/environment loop and the sole mechanism of emergence of new species. However, the truth is that Lamarck's ideas have never completely disappeared. Science philosopher Robert Wesson says of this:

> The enduring strength of Darwinism testifies to its scientific usefulness and validity; in like manner, the persistence of Lamarckism, despite the strong distaste of most biologists, indicates that it may have some substance. Lamarck, who was a pioneer of evolutionary thought many decades before Darwin and whose ideas were no more farfetched than those circulating in his day, has been uniquely regarded as an enemy – a fact that suggests that his ideas cannot be so easily abandoned as phlogiston or ether.[43]

Modern Lamarckian thinking identifies feedback loops on micro levels as opposed to macro levels of change in organisms. In the 1950s Sir Peter Medawar conducted research that indicated a significant plasticity in the immune system of baby mice. Thirty years later Edward Steele, Jeffrey Pollard and Reg Groczyski repeated Medawar's experiments, injecting very immature mice with millions of foreign cells. They found the mice became tolerant of the invading cells and appeared to pass the immunities they had developed on to their offspring.[44] In 1998 Edward Steele et al published the provocatively titled *Lamarck's Signature: How Retrogenes are changing*

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43 Wesson, *Beyond Natural Selection*, 225.
44 Vernon Blackmore and Andrew Page, *Evolution, the Great Debate* (Oxford: Lion Publishing, 1989), 149-50.

Darwin's Natural Selection Paradigm. Their research still focuses on the immune system, and seeks to answer the puzzling question of how a system could evolve to make antibodies that were never part of the evolutionary history of an animal.[45] Their conclusions are that random somatic processes of recombination and mutation are necessary to generate the enormous variety of antibodies and T cell receptors found in immune systems, and the mechanism for carrying out this process is found in reverse transcription, the copying of RNA onto DNA.[46] The process is called reverse transcription because it is the opposite of normal cellular processes, which sees RNA acting as 'messenger' molecules for DNA, copying sections of the helix as it unwinds and translating it into amino acid sequences for use in the growth, development and replication of the cell.

Weismann's barrier was a hypothetical construct, postulated at the end of the nineteenth century, which stated that this transfer of information could only go one way, from the germline to the soma. This is now known to be untrue. Certain viruses have an infectious cycle which binds them to the DNA of the cell. Steele's team describes the process thus:

> The virus enters the target cell, copies its RNA into DNA and then physically inserts the DNA copy of the virus into the DNA of the chromosome within the nucleus of the cell. Thus, when the cell divides, the integrated copy of the viral genome is propagated and transmitted to daughter cells. In other words, the hereditary material of the virus is permanently incorporated into the genome of the cells. Production of viral RNA by copying the integrated DNA can occur at a later time, leading to the production of a new infectious virus.[47]

Extrapolating further, Steele's team suggests that if the immune system can act in this way, and immunity to certain diseases and viruses can be inherited, then it is logical to assume that other features within the body can also adapt during the lifetime of one individual and be passed on in some way to offspring. Other researchers utilise Steele's research to critique Darwinism and neo-Darwinism, but they also consider a variety of mechanisms that may allow direct feedback from soma to germline. These include the movement, transposition, repetition, amplification, conversion or contraction of gene

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45 Steele et al, *Lamarck's Signature*, 72.
46 Ibid, 46-52.
47 Ibid, 49-51.

sequences.[48] Examples can be found in Cullis, who looks at flax plants exposed to different environments and soil types. Cullis found not only differences in morphology between the plants, such as different numbers of hairs on capsule septa, but also differences in DNA amount and molecular biology.[49] Ho extensively discusses a number of 'non-random changes in genomic DNA in certain environments which can become stably inherited in subsequent generations'. The examples she gives are of certain predictable responses to stress and specific chemicals in fruit flies and maize plants, and hypothetical 'biased gene conversion', such as when populations begin to express or activate certain homologous genes (Ho points out that changes to DNA can stabilise gene function as much as alter it).[50] However, she is very clear that, while she uses these researches as examples of contraventions of the biological rules laid down by the New Synthesis, she is not succumbing to gene reductionism herself and arguing her theory only from genetic evidence (assumed or proven). Neither she nor her co-editors identify themselves as neo-Lamarckians, as Steele's team does, because they extend their arguments of the plasticity of the organism into epigenetic responses within the entire organism and they are very concerned with the marriage of the organism with the environment as a central feature of shaping individual organisms and thereby, possibly, species.

Ho and Saunders advocate epigenetics as a force of biological change over selectionism. Their argument takes epigenisis out of its traditional field of embryology, where it has long been understood that some non-genetic codes program tissue differentiation, and into the whole lifecycle of the organism and ultimately into evolution itself. What epigenetic codes are exactly, and how they work, is still under investigation but their presence is vital to mammalian development, instructing the organism through its lifecycle and internal engineering processes, such as reproductive cycles and aging. Saunders and Ho team life long epigenesis in the organism with other panbiological concepts such as relaxed selection, neutral alleles and random drift, canalisation through possible cytoplasmic mechanisms and a consequent emphasis on the phenotype rather than the genotype. This leads to an open-ended carnivalistic picture of complex organisms changing through their own life time and over generations. It is a picture far removed from Richard Dawkin's deterministic robotic

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48 Jeffrey Pollard, 'New Genetic Mechanisms and their Implication for the Formation of New Species', in *Evolutionary Processes and Metaphors*, eds. Ho and Fox (London: John Wiley & Sons, 1988), 63-83; Ho, 'On Not Holding Nature Still', 117-144.
49 C.A. Cullis, 'Control of Variations in Higher Plants', in *Evolutionary Processes and Metaphors*, eds. Ho and Fox (London: John Wiley & Sons, 1988), 53.
50 Ho, 'On Not Holding Nature Still', 117-144.

DNA replicators, which are clearly governed by a more static sense of body-as-product rather than body-as-process.

Relaxed selection is found in populations where natural selection is not an immediate pressure and therefore many different genotypes, and possibly phenotypes will flourish. Random drift of DNA tends to complement relaxed selection and refer to the generational process of gene mixing, but this will be discussed further in the section on the Neutral Theory. This phenomenon has little effect in larger populations, but can be significant in smaller populations where certain genes expressed in one generation can become pronounced in following generations.[51] And, finally, canalisation addresses novel developmental responses and a possible mechanism of change in that most difficult of spaces, the one between genes and morphology. Ho and Saunders focus on the complexity and adaptability of the organism, contending that organisms live in a number of simultaneous relatively stable states, chemical, biochemical and biological, and some of their ability to do this comes from active or deliberately inactive epigenetic controls. This is Barad's 'intra-action' of multiple agencies, both from within and without the organism. What they describe is a dynamic, non-hierarchical configuration of internal and external systems that embodies both

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51 David T. Suzuki et al, *An Introduction to Genetic Analysis* (New York: W.H. Freeman, 1989), 79. Suzuki writes on the issue of random genetic drift: 'If A population is finite in size (as all populations are) and if a given pair of parents have only a small number of offspring, then even in the absence of all selective forces, the frequency of a gene will not be exactly reproduced in the next generation because of sampling error. If in a population of 1000 individuals the frequency of "a" is 0.5 in one generation, then it may by chance be 0.493 of 0.505 in the next generation because of the chance production of a few more or less progeny of each genotype. In the second generation, there is another sampling error based on the new gene frequency, so the frequency of "a" may go from 0.505 to 0.501 or back to 0.498. This process of random fluctuation continues generation after generation, with no force pushing the frequency back to its initial state because the population has no "genetic memory" of its state many generations ago. Each generation is an independent event. The final result of this random change in allele frequency is that the population eventually drifts to P=1 or P=0. After this point no further change is possible; the population has become homozygous. A different population, isolated from the first, also undergoes this random genetic drift, but it may become homozygous for allele "A", whereas the first population has become homozygous for allele "a". As time goes by, isolated populations diverge from each other, each losing heterozygosity. The variation originally present in the populations now appears as variation between populations." This process becomes very significant in groups that have been, at some time, severely reduced in numbers, such as elephant seals, a species that was almost hunted to extinction in the late 19th Century. The small numbers of animals that survived the hunt reformed a population that has little genetic variation. This means that random genetic drift critiques neo-Darwinism in two ways. Firstly, the 'neutral' nature of genetic process where many genes have little or nothing to do with survival and represent more of a chance sifting process of many characteristics. Secondly, selectionism functions only as a limited mechanism in which many chance events will limit the gene pool, as with the elephant seal where survivors happened to be in the right place at the right time and did not survive due to their particular fitness.'

stability and organised change.[52] Adjusting towards a 'norm' is *homeorhesis* in the organism, so Ho and Saunders pose *heterorhesis* as an alternative – a state where the thresholds of the organism's limits are stretched to a point where the phenotype or morphology changes and these changes may effect a species change if they are both severe enough and yet still exist within the thresholds of existence for the organism. A *New Scientist* article provides one possible example of heterorhesis in humans: a group of pregnant Dutch women who starved during the famine of the World War II predictably gave birth to very small babies, but, less predictably, those babies also went on to have very small babies too.[53] Had some threshold been crossed? Had some genetic package been activated that moved that population of organisms into a different mode of interaction with the world? Answers to these questions could conceivably redirect the entire discipline of biology, but prior to answering these questions there is a sense of carnival, a sense of the organism moving out of focus, of losing its closed and predictable parameters.

The epigenetic mechanism Saunders and Ho suggest for such possible changes in the organism to become hereditary is maternal cytoplasm: that is, the egg cytoplasm as a 'carrier of heredity independently of the nuclear genes and the necessary interface between nuclear genes and the environment in the coordination of developmental and evolutionary processes'.[54] This idea of maternal cytoplasmic inheritance is not widely accepted in science precisely because of its neo-Lamarckian implications, but it is consistent with the shifting boundaries and inversions of carnivalised disciplines and bodies, and of a feminist politic that seems to be emerging from interdisciplinary readings of evolution. Once again, a maternal substrate is foregrounded and so is the instability of the organism. Impermeability and steady states, the stuff of the static, closed, classical body are significant to many current scientific discourses and scientific representations of organic beings. However, through the work of people like Ho, Saunders, Steele and others, the perfect, unchanging body – the genetic product – is now also mapped over repeatedly with change and imperfection. Wide variation has to be literally incorporated in the body-as-process and gene definition becomes suspect. Previously accepted, dualistic logics of reading the body as conforming or transgressive move, dependent on viewing perspective, while 'inside', 'outside',

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52 Ho and Saunders, 'Pluralism and Convergence in Evolutionary Theory' and Mae-Wan Ho, 'Environment and Heredity in Development and Evolution' in *Beyond Neo-Darwinism*, ed. Mae-Wan Ho and Peter T. Saunders (London: Academic Press, 1984), 267-289.
53 Gail Vines, 'Hidden Inheritance,' *New Scientist* 160, no. 2162 (1998), 27.
54 Ho, 'Environment and Heredity in Development and Evolution' in *Beyond Neo-Darwinism*, ed. Ho and Saunders, 268.

'microscopic', 'macroscopic', 'competitive' and 'cooperative' all become compromised/compromising notions. Thus, the shadow side of reductionism and mechanistic thinking gives way to more complicated and implicated organic models of being, involving interpenetration and multi-level activities that impinge on, and react against each other historically, and from within and without the organism. If the environment is also viewed as multiply agented and subject to historical flux, then any idea of scientific metanarratives like evolution must become at least a combination of negotiability and law.

Panbiogeography and generative structures and constraints in organisms

The history of panbiogeography is in some ways less complicated than other facets of evolution, but it is crucial to understanding some of the changes taking place in evolutionary studies and it gives a further insight into synchronic/diachronic relations of living and non-living matter. Darwin is generally considered the father of biogeography because of his explicit references to it in *The Origin of the* Species; however, distribution of plants and animals were raising questions about evolution, geology and ecology long before Darwin published. Christopher Humphries and Lynne Parenti trace the history of biogeography through two main schools of thought, one going back as far as Linnaeus and the other beginning a century later with the biogeographer E. Forbes and the botanist John Dalton Hooker.

Species were not distributed in a predictable fashion and early scientists asked questions about populations of apparently related species existing on widely separated continental landforms. There was also the unusual coincidence of almost whole similar ecologies, i.e. numbers of similar species, being found in these disjunct areas. This provoked debate about geographical congruence and the nature of species itself. Carolus Linnaeus, the father of modern taxonomy, was the first scientist to attempt a narrative of distribution in the early to mid eighteenth century. He theorised life as originating on a tropical mountain with multiple habitats and then a gradual exposure of land that had previously been submerged around the mountain. This was followed by a migration of the species off the mountain to environmental niches with similar conditions. Humphries and Parenti track this thinking through to George Gaylord Simpson and mid twentieth century pretectonic theorising. As a hypothesis, the possible shifting of landmasses was pre-tectonic and unexplored because it did not delve into geological science for support, nor did it look into the relationship of geology and biology; rather biogeographical tenets were that organisms originated in

one or more centres and then migrated. Landforms were factored into the theory only as natural barriers affecting distribution, and they were mostly treated as unchanged and unchanging.

This narrative of inert land was contested as early as 1805 by F.A. von Humboldt and A.J.A. Bonpland. They talked about the importance of the history of the earth and speculated that continents may have been connected at some point in time due to the 'analogous structure of coastlines and the similarity of animals inhabiting them and on ocean surroundings'.[55] Several decades later de Candolle distinguished between two branches of plant geography. The first, ecological biogeography, considered 'stations' where external elements such as temperature, light and humidity could be measured. The second, historical biogeography, considered habitations and instances where the same species occurred in different habitats, thus raising questions about dispersal and migration as a driver to distribution.

While the two stories were not mutually exclusive they did tend to break down into two main streams of thought – dispersal by migration and vicariance distribution. The focus of dispersal biogeography is on migration. Thus dispersal, even across oceans, is explained by species moving out from a centre of origin and crossing pre-existing barriers. Vicariance biogeography, on the other hand, theorises that populations are widely distributed by land bridges or floating continents *before* the formation of a geographic barrier, such as oceanic divides, mountain building or glaciation. This debate as to whether distribution occurred before or after the formation of barriers, particularly with Darwin heavily in favour of dispersal, polarised all argument in the discipline until Leon Croizat developed the model that has come to be known as panbiogeography, or the vicariant form-making model of biogeography.[56] In this model, space, time and morphology are all acknowledged as shifting values, but a mapping process has also been designed to try and accommodate the complexities of tracking life and geological change together. Also, though the axes of the major values shift, depending on the specifics of a study, space is the privileged factor in panbiogeography and is used as the framework to track ancestral species through to their descendants via geological and geomorphological events. Croizat suggests that in working with this model it is legitimate to assume that the ancestral organisms are already geographically differentiated to a certain extent and will have spread out in

55 Christopher J. Humphries and Lynne R. Parenti, *Cladistic Biogeography: Interpreting Patterns of Plant and Animal Distribution* (Oxford: Oxford University Press, 1999), 19-20; Humphries and Parenti quote F.A.von Humboldt and A.J.A. Bonpland, 'Essai sur la géographie des plantes' (1805).
56 Croizat, *Space, Time, Form.*

their initial 'mobilist' phase. Echoing Punctuated Equilibrium's notion of stasis as the dominant mode, Croizat says that further differentiation will then occur due to geographic changes as organisms settle into 'immobilist' phases and various environmental niches appear.[57] So biological change is not predetermined by geographic process but is rather influenced and coterminus with it.

To translate his theory into a workable methodology, Croizat devised a system of nodes and tracking, using the accumulated modernist archives of taxa distribution and identifying 'nodes', points where there is a strong connective value between textured biotic communities. In a simple example, *Nothofagus,* or Southern Beeches, can be found in southern South America, New Zealand, New Caledonia, New Guinea, eastern Australia and Tasmania and macrofossils or fossilised pollen of the species are found in nearly all these areas and on the Antarctic peninsula, the Transantarctic Mountains and the Ross Sea regions of western Antarctica. It is then possible, using even just this one species, to draw 'tracks' between these similar taxons in their disjunct localities. The tracks are the shortest or most parsimonious lines that can be drawn between these centres and they are likely to yield a history, not only of the organism, but of the land masses where the organisms are found. In the example of *Nothofagus,* it would appear that it was once widely distributed on Gondwanaland, a supercontinent which once included the Indian subcontinent, Africa, Antarctica, Australia, New Zealand and South America.[58]

This is, of course, a science that constructs the history of the earth in broad geographic and temporal frames and panbiogeographical debate inevitably reveals more complexities while it seeks resolutions. As an example of a complex biotic community, Craw uses Croizat's example of the Galapagos Islands, an iconic site in evolutionary theory. Darwin studied the biology of the islands, then overlaid their natural history with a colonial story of origins that reflected his cultural experience. He theorised extensive migrations of species from the nearby mainlands of North and South America, and the fact that many terrestrial and shallow marine species on the islands seem to 'possess adaptations for long distance transport' seemed to confirm his hypothesis of dispersal from centres of origin.[59] The panbiogeography story, however, recreates the Galapagos as an ancient site of multiple biological and geological intersections and stories. Certain species are endemic to the islands and are found nowhere else, while other species are related to mainland species, but their sources are

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57 Croizat, *Space, Time, Form*, 177-189.
58 Craw, *Panbiogeography*, 25-29.
59 Ibid, 59-60.

surprisingly various, indicative not of consistent migration patterns, but of what Craw labels 'distributional fidelity to terrane boundaries'. Thus, historically the Galapagos is situated near a tectonic junction of several plates and ridges, and the result at this point in history is a biological carnival on the islands consisting both of endemic species and other species drawn from three major earth shaping tracks – one running north to Baja, California and other parts of North America, one running north-northeast to Central America and the Caribbean, and one running east to western South America.[60] Species on the islands, therefore, have possibly descended from earlier species endemic on those land arcs or on volcanic islands that came and went in the vicinity of the Galapagos for up to 15-20 million years before the present.

Accounting for the adapted life forms that appear to have some migratory capacity is then done by looking at the geological nature of islands like the Galapagos, formed in persistent volcanic hotspots. While the volcanic hotspot will remain, over time the oceanic plate above it will shift. As the plate shifts it moves the island formed on the hot spot with it and eventually a new island forms around the vent. Meanwhile, the old island moves further away and is eroded to an atoll, and finally disappears under the sea. Due to the movements being relatively slow there is an effective transition of the biota from older, disappearing atolls to new formed, nearby islands; therefore, there exists a fresh explanation for, say, the semi-aquatic iguanas that can swim but not over huge distances. When contrasted with these stories of species bound up in earth history, dispersal biogeography depending only on migration becomes a specifically colonial story, the scientific equivalent of *Terra Nullius.* That is, the newly discovered land is empty and migration becomes the foundation story, completely changing or erasing prior stories of occupation. Craw's panbiogeographic reading, on the other hand, is a layered, multi-origin story that sees migration as only one mechanism in the development of an ecology.

In the new panbiogeographic paradigm, space, time and form all possess demonstrable agency in the story that is the history of life. This gives vicariant form-making panbiogeography a disciplinary perspective in evolutionary studies that challenges and reshapes taxonomy, one of the cornerstones of biology:

> Our experience of these life cycles, lineages, or units is not of their existence solely in time, but of them as spatiotemporal bounded entities. ....If taxa are spatiotemporally bounded entities, then

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60 Ibid, 59. The Galapagos lies close to the intersection of the Nazca, the Cocos and the Pacific lithospheric plates and also to the Cocos and Carnegie ridges and the 'Panama fracture zone'.

> biogeography must be a necessary consideration in evolutionary, phylogenetic, and systematic studies, and a natural classification can only be established after, not before, a biogeographic analysis.[61]

Such a massive, complex and difficult story inevitably expresses instabilities and becomes carnivalised in its possibilities. Species in various stages of mobilism and immobilism, and the tracking of species through micro- and macro-geological and geomorphological history constitutes a vast model and any work within it inevitably privileges certain subjects and certain viewpoints, witness Croizat's original work was published in three huge volumes. This leads to other generic splits in the discipline: as stated before, panbiogeography generally privileges space, but cladistic biogeography privileges morphology and biotic patterns because, according to Humphries and Parenti, 'track analysis lacks rigour' whereas cladistic biogeography analyses and compares 'biotic patterns at the highest resolution so as to compare them to independent sources of data such as geological patterns'.[62] This trick of perspective reshaping and resizing is carnivalistic, and is also a marker of the instability of scientific authority. Whatever discourse of current biogeography is subscribed to, the impermanence of the world, even the mountains and seas, is impossible to avoid; therefore, the concomitantly scaled trivialisation of the many branches of human knowledge and authority is also hard to avoid. Science takes its place as a limited and recent tempor(al)(ary) authority, together with church and feudal hierarchy, and the whole planet continues to heave, swallow, reproduce and die on unimaginable scales.

It is a classic technique of Rabelaisian carnival (via symbols of bounty, appetite, excretion and death) to use the vastness of the natural world to diminish institutional power. Thus panbiogeography, and perhaps cladistic biogeography, presents something of a paradox. Are they participants in the scientific, evolutionary carnival, or are they stories that attempt to engulf other stories, recreating themselves as ultimate, as opposed to partial, authority? Is the new panbiogeography an effective, novel approach that can organise the extensive Western scientific data base of species distribution using the latent science of tectonics? Or, is it an over reacher discipline that will never be free of boundary disputes? After all, tectonic boundaries are not the

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61 Ibid, 113.

62 Humphries, *Cladistic Biogeography,* 40-90; Humphries sees the 'resolution' of taxa as being achieved by finding the root taxa and tracing distribution of related taxa and then mapping those roots onto locations and analysing the geological history via the biota. Theoretically, this should account for problems when refining the readings from widespread apparently homologous groups that exhibit problems of widespread taxa, unique clades and 'missing areas'.

exact lines shown on maps and the wide margins for error when using 'million years before present' as a time scale unit is not going to produce what is traditionally viewed as scientific accuracy.[63] Craw suggests asking if two populations of organisms separated when the Atlantic was 1, 10, or 100 km wide is a legitimate question, but there are many others with respect to boundaries.[64] Will panbiogeography be forever tripping over issues of liminality and (im)possibility, chasing time, space and biota through infinite, fluctuating three-dimensional grids? What about mapping species *within* features denoted by some readings as boundaries? When does a barrier change into 'an integral part of an organism's biogeographic focus', and who decides this? Some discussion is included in panbiogeographic texts regarding the problematic nature of the 'incomplete fossil record' and how it skews readings from the geological layer of life. And then there is the microscopic. How do they get admitted to this carnival of earth and life evolving together? This is not thinking specifically about molecular levels of taxonomic analysis, which are currently helping to build the discipline,[65] but rather wondering about microscopic, and even sub-microscopic, life forms themselves. To paraphrase David Hull, from Chapter Three of this thesis, on socio-biology: does panbiogeography have the capacity to tell the same stories about single cell algae as it does about African hunting dogs?

Not only does panbiogeography theory carnivalise knowledge by questioning boundaries, it also represents a significant shift from mechanistic to relational science, similar to other theories that are considered in this chapter. Darwin emphasised the possibility of dispersal to counter religious arguments of independent, multiple creations of species, but his world was dominated and limited not only by Victorian colonialism but also by Newtonian cause-effect thinking. Croizat discovered that organisms of varying dispersal abilities and capacities exhibit homologous distribution patterns congruent with tectonic structure, and this implies, according to Craw, a rejection of the traditional organism/environment binary separation and an embracing of the 'three fold parallelism of space/time/form'.[66] Many of the individual scientists considered in this thesis insist on this. In the traditional dispersalist model, there is a

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63 Gray, 'Metaphors and Methods', in *Evolutionary Processes and Metaphors*, ed. Ho and Fox, 209-237; Gray cautions that geology appears an overpowering force when considering evolution and it is important to remember that living organism and geological processes are engaged in a reciprocal relationship.
64 Craw, *Panbiogeography*, 12.
65 Ibid, 85; Craw et al refer to other scientists and suggest an argument exists in panbiogeography that not only rethinks the connections between macro and microevolutionary phenomena, but also the construction of molecular trees that may demonstrate a history of geographic structuring.
66 Ibid, 86.

use of 'absolute space', space which acts like a stable, three dimensional container in which forms are embedded. By contrast, Croizat's ideas of 'earth and life evolving together' and 'life as a geological layer' mean space may be privileged, but it also becomes only one of a number of contingent values in understanding the history of life and it can no longer be designated as a stable container. In this respect, panbiogeography not only offers an alternative to competitive natural selection models in science, but joins previously discrete stories of geology, geomorphology and biology. This shift speaks volumes about current predicaments in science. Disciplinary boundaries do not move to follow such epistemological shifts lightly or naively; rather, they become unsettled and more open because prior theory has become inadequate and they must try to follow the call to new orders and fresh meanings.

Morphology

The study of morphology, form in nature, almost appears to be diametrically opposed to panbiogeography. Panbiogeography focuses on grand stories of geological movement and the formation of life as inevitable concomitants of continents and islands, while morphology, with its considerations of the kind of constraints experienced by form in biology, is as specific as the oddly tandem development of bright colour and toxicity in a rainforest frog. Panbiogeography is diachronic, concerned with history and historic contingency in the shaping of life, while morphology is synchronic, concerned with establishing rational principles behind the ordering of individual organisms. Panbiogeography establishes history as an integral part of the organism, while morphology questions contemporary biological thinking because current biology is predicated on history, assumptions of common ancestries being indispensable to Darwinian notions of descent. These two stories of the organism and the continent are carnivalistic and ironise each other in evolutionary thinking partly because of their differences in scale: panbiogeography pictures biology through ecological histories, while morphology concentrates on trying to construct ahistorical rational unities in generative cells. Morphology finds ancestry issues problematic and distracting. This is signified in disciplinary focus: panbiogeography studies the organism in the context of the larger world, while morphology seeks to understand how self organization in a bud or a limb leads to a specific spatio-temporal manifestation in a single life form.

One expression of the unity of the two approaches to evolution, despite their disparity of focus, comes in their challenging of dispersal from centres of origin,

random mutation and selectionism as primary species shaping tools and their shift away from population genetics into the specifics of extrinsic and intrinsic forces applied to biological organisms. The problems with dispersal theories have been addressed in the panbiogeography section but the problems with regard to form and random mutation and selectionism still need to be considered.

Historically, resistance to natural selection as the full explanation of morphology continued in Eastern European science through the first half of the twentieth century. One reluctance continental science had to accepting Darwin's evolutionary model, already discussed in the neo-Lamarckian section of this chapter, was to the purported inviolability of germ plasm, which seemed to counter the very notion of biological change. A further reservation was generated by the idea of random mutation, a directly contradictory concept that seemed to suggest an infinite plasticity to living things. These ideas did not sit well together for many continental scientists. Blacher directly quotes a number of the scientists of the time: Hans Driesch believes Darwinism is 'a recipe for how to construct a house of definite style by the mere random piling up of rocks'; Simonovich Berg says, 'What sort of cause forces an organism to change in a definite direction is as yet unknown to us....An organism has the capacity to adapt itself actively to the environment, revealing thus the apparent presence of some kind of internal regulating principle'; and Armen Levonovish Takhtadzhan says the statistically open model of random mutation is an invitation to biological chaos and that 'direct adaptation' through random mutation amounted to Lamarckianism under another name. [67] In the West, one of the strongest opponents of Darwinism, in the early years of the twentieth century, on the issue of morphology, was D'arcy Thompson.[68] Thompson refused to cede biological form to genetic determinism, believing that form told its own very specific story with regard to the forces of physics and the necessary exigencies of chemistry. He saw Darwinist logic as an impediment to understanding the development of organisms and argued for 'adaptation produced not by natural selection ...but directly and automatically impressed by physical forces operating under invariant laws of nature'.[69] Thompson's methodology was topological.[70] That is, he used a branch of mathematics dealing with the properties of spaces in his 'theory of transformations', and he demonstrated his theory by manipulating organic shapes to

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67 Blacher, *The Problem of the Inheritance of Acquired Characters*, 158.
68 D'Arcy Wentworth Thompson, *On Growth and Form*, trans. ed. John Tyler Bonner (Cambridge: Cambridge University Press, 1917).
69 Gould, *The Structure of Evolutionary Theory*, 84.
70 Peter T. Saunders, 'Development and Evolution', in *Beyond Neo-Darwinism* ed. Ho and Saunders, 256-261.

reveal similar underlying structures in what initially appeared to be difference. One fish of a particular shape could distort into the very different shape of another, indicating what Thompson saw as a basic 'bauplan', developing shape and form not under the control of specific 'genetic switches' but involving processes affecting 'whole region[s] of tissue.[71]

Robert Reid notes that the neo-Darwinist 'morphology by genetic decree' came under scrutiny early. The term 'pre-adaptive' was invented, as biologists struggled to understand the tensions between transitional stage adaptive evolution and qualities of the organism that may have existed prior to an evolutionary demand being made upon it and why they existed. Reid's account of this struggle reveals incipient carnival and is quite humorous as he quotes early commentators:

> Carter observed: in all adaptations the animal must to some extent be pre-adapted in this sense: it must always possess characters that can be modified to give the adapted character'. But how do modifiable characters arise in the first place; are they adaptations to the previous environment or to the one before that; whence the goose's gooseness? What, moreover, as Willis asked, is the adaptive advantage of the monocotolydenous condition in plants compared to the dicotolydenous condition? 'Both grow intermingled everywhere almost everywhere and in much the same proportions. There is no monocotyledonous mode of life that suits a Monocotyledon better than a Dicotyledon, yet there are very great structural differences between them.'[72]

Ho edits her collections with the intention of foregrounding morphological issues as having primary significance for revising evolutionary ideas. Contributor Gerry Webster looks at the problems of difference and sameness in the organism with a critical eye to a taxonomic constitution of species that has to explain the 'intrinsic nature' of the organism rather than ancestral history or individual difference.[73] Other contributors continue the theme: Brian Goodwin, who has long critiqued Darwinism and neo-Darwinism, offers a unitary view of organisms by looking at evolution through a 'field theory' of morphogenesis that involves understanding development of

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71 Ibid, 258.
72 Reid, *Evolutionary Theory,* 38.
73 Gerry Webster, 'The Relations of Natural Forms', in *Beyond Neo-Darwinism*, ed. Ho and Saunders, 193-217.

the organism during early embryonic stages,[74] and in another article he argues for 'multipotentiality', where parts of organisms can be transformed (usually by some sort of interference) into other parts.[75] Søren Løvtrup, concerned with taxonomy, refers to living species to create a pattern of dichotomous dendrograms on the basis of the morphogenetic processes of the embryo and the subsequent development of the organism.[76] This echoes Fox and Matsuno's approach as they dispute random, open systems for their chemical prebiotic proteinoids, where only a limited group of amino acids ever forms from a vast number of possibilities.[77] The truth is that the organism is always constrained – and it is not just the predetermination of the gene offering that constraint. Ho's piece in *Evolutionary Processes and Metaphors* looks at the scrambling of homeotic genes in Drosophila and the effect of environmental perturbations in E.coli as neo-Lamarckian events, but still says the 'real problem of heredity is to account for the stable and repeatable nature of reproduction'. She then suggests this is due to development not being a simple function of DNA, but one involving 'the complex interrelationships between the different levels of organism and its environment'.[78] Again, we return to Barad's notions of multiagential performativity and 'intra-action' in a carnivalised, permeable, uncontainable organism/environment 'intra-relationship.

This carnival of interdisciplinary narratives about the organism demands an acceptance of a power paradox within the organism. Evolution reveals the moment where chaos and order exist simultaneously – the chaos of the grotesque and open body and the authority of the closed and ordered body map over each other and provide the contrast necessary for carnival, as do the open and disordered body of the culture of science and the authority of the closed and ordered culture of science. This contradictory exposure explains to some extent the degradations and simplifications of evolutionary ideas that feed out into the 'marketplace' of publishing. Neo-Darwinism

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74 Brian Goodwin, 'Field Theory of Reproduction and Evolution', in *Beyond Neo-Darwinism*, ed. Ho and Saunders, 219-241. Goodwin suggests different forces work together with genes to ensure a unity of process common to unicellular and multicellular animals and can form the basis of a 'rational taxonomy'.

75 Brian Goodwin, 'Morphogenesis and Heredity', in *Evolutionary Processes and Metaphors*, ed. Ho and Saunders, 145-162. Again Goodwin argues genetic equivalency is too static and there must be systems of 'harmonic' and 'global fields' that, when perturbed, can have complex consequences for development.

76 Søren Løvtrup, 'Ontogeny and Phylogeny', in *Beyond Neo-Darwinism,* ed. Ho and Saunders, 159-190.

77 Fox, 'Protenoid Experiments and Evolutionary Theory', 15-60; Matsuno 'Open Systems and the Origin of Protoreproductive Units', in *Beyond Neo-Darwinism,* ed. Ho and Saunders, 61-88.

78 Ho, 'On Not Holding Nature Still', 136.

asks only that we hold in our heads the idea of gradual change by mutation and the selection of certain genes over a long period of time that will shape an organism and make it well suited for survival in its particular environment. It is a familiar narrative that raises questions but still feels comfortable. Morphology does not fit as neatly into evolution as genes do. Discourses around morphology simultaneously require a receptivity to change in the organism and a belief in the constancy of the organism.

Most of the scientists quoted in this thesis argue for a degree of neo-Lamarckian responsiveness, what is seen as organismic adaptability within certain thresholds, in the organism and a need to prioritise and understand the stable, self-organising principles that ensure an embryo or a seed results in a form that is going to be predictable within certain parameters. One of the contentions of this thesis is also that those tensions represent the carnival time, and one of the results of this multi-field perception of change and stasis in the organism is that the point of dissolution presents an opportunity to recreate authority as well as forms. From the extremes of carnival, an authorised identity must be returned or else the participants and authorities within carnival will fall into the abject and lose all sense of definition.

Homology, parallelism and convergence

So, one question then is how to map the development of organisms, as representative of species or particular groups, to assist in understanding the self-organising principles that are built into form and life process and simultaneously to incorporate the possibility of environmentally responsive changes to external stimulus and life process. Different patterns have been suggested to understand common ancestries and configurations of divergence, but things become complicated when speaking about historical relationships between species. Is form specifically connected in an ancestral process, or does a predisposition to develop certain traits exist within all organisms? Homology – where similar structures in different organisms assume a shared ancestry – has been a significant part of the traditional explanation and has also been the Achilles heel of studying both the current and the ancestral relationships of organisms. There are many unanswered questions. For example, how do parts of an organism change and how do parts stay the same? What kind of decisions are made, and under what pressures? David Hull points out that there are numerous systemic approaches to constituting species, but he acknowledges the potential for the failure of empiricism and a 'vicious circularity' in evolutionary thinking that uses homology to infer

phylogeny and uses phylogeny to infer homology.[79] Ernst Mayr tries to clarify by distinguishing between processes that might result in similarity in body structures: parallelism and convergence. According to Mayr, convergence is where unconnected acquisitions or losses result in an apparent similarity; for example, wings in pterodactyls or bats, leglessness in lizards. By contrast, parallelism is where similar characteristics are produced by a shared genotype inherited from a common ancestor.[80]

From these distinctions it would appear that convergence comes from the plasticity of an organism moving toward certain functional patterns, while parallelism resides in the original deep time genotype. Convergence offers the best explanation for the independent development of antifreeze glycoproteins in Antarctic Perch and Arctic Cod[81] and the similar morphology of various cacti from the Americas and Euphorbias from Africa, designed to cope with aridity.[82] Equivalency and niche thinking, however, sees probable parallel binaries in the fauna of the European/Asian continent of Oceania and Australia, after Australia split from the supercontinent of Gondwanaland. Paired up, the parallels present logically: Tasmanian wolf/placental canids; Tasmanian Devil/Badger; Australian flying squirrels, moles, mice/placental flying squirrels, moles, and mice; and kangaroo/plains herding animals such as deer.[83] Pop ethologists such as Desmond Morris often use primate parallelism as a given to explore human biology and behaviour, while Elaine Morgan uses aquatic convergences such as streamlining, hairlessness and bradycardia as the basis for her aquatic ape theory. Robert Wesson lists many traits from organisms that 'may be viewed as more or less convergent or parallel', including streamlining of extinct marine reptiles and

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79 David L. Hull, 'Certainty and Circularity in Evolutionary Taxonomy', *Evolution,* 21 (1967), 177-178. Hull argues 'It is tautological to say that homologous resemblances are indicative of common line of descent, since by definition homologous resemblances are those resemblances due to common line of descent.'

80 Ernst Mayr, *Evolution and the Diversity of Life: Selected Essays* (Cambridge, Mass.: The Belknap Press, 1976), 463.

81 Liangbiao Chen, Arthur L. De Vries, and Chi-Hing C. Cheng, 'Convergent Evolution of Antifreeze Glycoproteins in Antarctic Notothenioid Fish and Arctic Cod', 3817-3822. The antifreeze proteins, discovered in 1960 by Arthur L. De Vries, originated in the Antarctic cod with a gene duplication that allowed a trypsinogen digestive protein to operate in a new way, while the Arctic cod antifreeze is constructed from a different sequence of bases to the trypsinogen gene.

82 Andrea Bennici, 'The Convergent Evolution in Plants,' *Rivista di Biologia/Biology Forum* 96 (2003), http://www.tilgher.it/chrCorrelati/upload/doc/RB_Bennici.pdf (Accessed January 21, 2004).

83 This is a general evolutionary consensus, promoted under convergent evolution in many encyclopaedic and general science texts and on line sites. However, to this point the fossil, morphologicial and molecular evidence is inconclusive and the mirroring by European placental mammals of Australian marsupials is really an evolutionary 'story' awaiting investigation.

current marine mammals, bird and mammalian improvements on the reptilian metabolism, and more specifically:

> Various fish and amphibians nourish embryonic young by something like the mammalian placenta. Pigeons (males as well as females) feed their chicks a sort of milk (Welty 1982,399). The pigeon's "milk" is stimulated by the same hormone, prolactin, that governs lactation in mammals (Kevles 1986, 136). The number of enzymes is limited, and they may serve related purposes. The hormone that produces brooding pouches on the backs of frogs is used in the mammalian uterus (Tyler 1983,134).[84]

How deep can we go? Convergence, parallelism and homology tell fascinating but sometimes fragmented and quite anarchic stories of historical genes, body plans and change. It would appear that understanding the history of species is like the apocryphal tale of the nine wise, blind men trying to discern the nature of the elephant as they explore individual parts of the beast. Each touch suggests a partial answer, but the real problem lies with synthesising the parts to make a whole new, and unfamiliar animal. Considering this process it is no wonder that neo-Darwinist thinking has such a strong appeal.

Molecular biology and the advent of DNA sequencing analysis are tools of promise in the search for synthesis, but the siren song of morphogenetic reductionism can be heard loud and clear in the example of the highly conserved Pax and Hox genes.[85] These genes appear to have had a regulatory function on the mirror-image, or bilaterian, body plan since the Cambrian period 550 million years ago. The commonality of these embryonic patterning genes to both vertebrate and insect body plans have prompted speedy conclusions of common ancestry, but some scientists like Jason Hodin argue that the tension between plasticity and constraints around developmental evolution still exist, even with such apparently 'universal' genes and origins stories.

Hodin questions the absence of embryonic expression of nested Hox genes in many sea urchins when the ancestral theory would require their presence in all metazoans, and from studying the science literature he finds functions and expressions of the Hox genes are not consistent. One of his most accessible stories is of Pax6, a gene labelled

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84 Wesson, *Beyond Natural Selection*, 189-90.
85 Corey S. Goodman and Bridget C. Coughlin, 'Special Feature: The Evolution of Evo-Devo Biology', *Proceedings of the National.Academy of Sciences,* 97, no. 9 (2000), 4424-4425.

'master regulator of eye development in mice and flies'.[86] Reading this scientific gene story critically, Hodin points out that in mice Pax6 has other identifiable functions to do with brain, nose and pancreas, whereas in the worm, *C. elegans*, it is involved in head and sensory neuron development. The original claim for the gene comes from induced mutations involving Pax6 that results in ectopic eyes on legs in mice and flies. Hodin contends that other genes also produce these mutations, and that further genes are implicated in eye development in flies that do not have counterparts in mice. Expressing his frustration with conflicting uses of homology in evolution, he says of the eye development issue:

> This example really brings into focus the problems encountered with the use of the word "homology" to describe both molecules and morphology. Yes, the "homologous gene" (properly the "orthologous gene") is used to build the both the fly and the mouse eye. But are they used in the same way? The appropriate way to address this question is not to see if the mouse gene works in fly eye development. The mouse gene was found to regulate eye development in Drosophila (Halder et al., '95), yet there is a functional Pax6 in *C. elegans*, an organism that lacks eyes altogether. Based upon its sequence similarity, I wager that *C.elegans* Pax6 would also work in fly eyes. A positive result tells you only that the biochemical properties of the protein have been conserved, not necessarily that its function within a certain morphological structure has also been conserved. The commonplace use of the same gene within an organism performing distinct functions in a multitude of tissues reveals why this experiment is generally uninformative with respect to evolutionary history. Instead, one way to address the potential similarity in function of fly and mouse Pax6 is to examine the black box in between transcription factor and morphological structure.[87]

Hodin's 'black box' lies at the heart of those paradoxical issues in evolutionary development. The Pax and Hox genes are culturally and scientifically significant at this point in time, but how exactly should their story be approached? Can, or should, their story be told so that it stays open to possibility and complexity, rather than being diverted into literalist, reductionist metaphors such as 'blueprint', 'computer code',

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86 Jason Hodin, 'Plasticity and Constraints in Development and Evolution', *Journal of Experimental Zoology (Molecular and Developmental Evolution)*, 288, no.1 (2000), 1-20.
87 Ibid, 7.

'text letters' or 'morse code'?[88] Direct and even consistent causality seem insufficient in puzzling out ancient genes that speak to obscure processes of deep time: processes that – if theories of parallelism rather than direct ancestry are correct – may have seen the homeobox genes 'recruited' in many different ways, at many different times during the rise of metazoan life forms. To explain the strange constancy and flexibility of genes, Stephen Jay Gould uses terms like 'deep homology' and 'exaptation', and speaks about the result of strong internal channelling of 'underlying regulators' that may even create rapid 'truly saltational change'.[89] Robert Wesson, science philosopher, raises the issue of the 'responsive genome' with both adaptive physiology and adaptive behaviours that certainly appear to channel organismic responses to environment, but then he also speaks to 'the power of attractors' and a 'shared potentiality...if different families follow parallel courses beyond the adaptive requirements'.[90] Jason Hodin connects convergence, independent evolution of similar characteristics from an alternate mechanism to homology, to plasticity of the organism, and points out that such constraints need considerably more investigation before they are conclusively named as an ancestral phenomenon. With this perceived tension, it is almost surprising that reductionist stories hold such sway academically and in the popular imagination.

Perhaps it is because the language for expressing the complexities of both homeobox gene constancy and gene co-option elude the sound byte, and fall short of media demands for easily presentable 'sexy' information on evolution. Perhaps it is because discrimination in times of carnival becomes more difficult with regard to authority – a perforated line can exist in carnival between a figure of authority and a figure of fun. Bakhtin's readings of carnival focus on the medieval representations of Rabelais, but they also had conspicuous and dangerous relevance to mid twentieth century Russian politics, and beyond that they have relevance to current discourses in science where authorities and stories often contradict each other, assume political postures that have little to do with empirical investigation and have slippery credibility.[91] The inexplicable fidelity and malleability of life also suggests other aspects of the confrontations inherent in carnival. Life's abundance, adaptability, perserverance and complexity continually confronts science, as science beavers away at labelling and controlling it. In Rabelaisian terms, the world wins against the

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88 L. Ceccarelli, *Rhetoric and the Field of Human Genomics: The Problems and Possibilities of Mixed Metaphors* (Seattle, Henry Art Gallery, 2002); Ceccarelli speaks to the role of language in constructing scientific reductionism.
89 Gould, *The Structure of Evolutionary Theory*, 85.
90 Wesson, *Beyond Natural Selection,* 191.
91 See Chapter Three of this thesis for a discussion of constructions of authority and science.

institution. Science that is true to its empirical processes finds it difficult to promote or hold a stable picture of the organism. The genomic bible is being overwritten, not only by the counter-fundamentalism of creationism, but also by the clamour of interdisciplinary polyvocality. The organism is a multidisciplinary, dialogic junction mapped by discourses of ancient and current chemistry, symbiotic histories, developmental constraints, environmental constraints, and it is at the mercy of the 'labile' genome [92] – it is a 'high seismic activity zone'[93]. While genes, particularly ancient genes like Pax and Hox, hold the hope of neutral, fixed knowledge for science, they are also keys for undoing disciplinary divides and have acted in a historically and culturally relativistic fashion to uncover further questions, layers and even paradox.

The neutral theory[94] and Gaia

Historically, all science is underpinned by the hopeful rationality of mathematics, but mathematics often plays the role of trickster in evolutionary theories. It may appear to map a foundational idea, but to be understood as even scientifically relevant, the concept behind the equation will be explored and often culturally and ideologically invested through discourses not practicing the same logics. Seductive though the idea is, mathematics in evolutionary thinking is never conclusive, it can only be contextual to the particular idea it is addressing. Formulae have not so far closed the story, because the story is unstable, multiple and persistently open. William Hamilton's reciprocity theories of inclusive fitness assist with the dilemma of the selfish gene and sociality, but what exactly do they prove? Game theory context is what gives the equations meaning in evolutionary science, but their leakage into more colloquial discourses has resulted in high levels of debate and confusion. The two theories discussed in this section evoke a similar process, with both investigating particular issues through calculable information, but the way in which they are culturally produced, expressed and invested is very different to the core content of their mathematical and chemical logics. The neutral theory is not as 'user friendly' as the Gaia theory, which seems to have moved beyond disciplinary boundaries to involve the popular imagination, but each has its own social context and values. The difference

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92 Smith, *Did Darwin Get it Right?*, 160; this concession comes from a traditionalist who supports neo-Darwiniism, socio-biology and game theory.
93 Donna Haraway and Lisa Nakamura, *Prospects for a Material Informatics: An Interview with Donna Haraway* (Electronic Book Review, 2003), http://www.electronicbookreview.com/thread/technocapitalism/interview (accessed September 30, 2003).
94 The 'neutral mutation-random drift hypothesis' is the full title of the theory, but it is normally known simply as the 'neutral theory' of evolution.

in the two stories serves then to demonstrate a number of issues that reflect upon the post neo-Darwinist cultural production and reception of science stories, and they also serve as barometers of possible difference between institutionalised science and non-institutionalised science.

The neutral theory rose out of population genetics. Presented by Motoo Kimura in 1968, its original appeal was to molecular biology rather than evolutionary theory. With its genesis in the science of electrophoretic methods of sequencing and analysing DNA, it turned up a surprising level of genetic variability in individuals. This was only detectable at the level of molecular chemistry, and did not appear to be directly connected either to the individual phenotype, even though polymorphisms at multiple loci in the organism implied a large mutational load in the organism. To explain this in terms of both the organism and the species, the neutral theory argues that the mutations have little or no effect and express themselves within populations without attracting a selective reaction. The basic but significant assumptions that rise out of this story are that functionally less important molecules evolve or change faster than more important ones; less disruptive changes occur to the genome more often than more disruptive ones; proteins regularly undergo amino acid substitutions which do not lead to phenotypic changes, and neutral changes of gene frequencies within populations reflect a process of random drift rather than active selection [95] Kimura's calculations also suggest these neutral and 'nearly neutral' changes, where similar amino acids substitute for each other in protein production, happen at quite a high rate. Further implications of this theory, then, are that most changes in the organism are maintained in the population by an as yet unidentified mechanism, and there is also the possibility that these very tiny changes could lay the foundations for greater changes in the future.

Sympathetic to Sewall Wright, who designed 'the shifting balance theory', an idea which combined genetic drift and natural selection, Kimura is also influenced by H.J.Muller, who argues for self-reproduction in both ordinary and mutated genes. Considering Muller was working prior to the establishment of the new synthesis in the 1930s, his insight was special. Muller's emphasis was on the great range of genetic variability in a population, which allowed for a relaxed rather than competitive response to selection and included a recognition of both stability in the gene and its capacity for change. All these ideas encountered problems in the new synthesis.

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95 Motoo Kimura, 'Genetic Variability Maintained in a Finite Population due to Mutational Production of Neutral and Nearly Neutral Isoalleles', *Genetical Research* 11 (1968), 247-269.

Kimura himself notes the effect the strong adaptationist stance of the 1960s had on the notion of genetic drift when it denied the selective neutrality of mutant genes:

> Looking back, I think that it is a curious human nature that if a certain doctrine is constantly being spoken of favorably by the majority, endorsed by top authorities in their books and taught in classes, then a belief is built up in one's mind, eventually becoming the guiding principle and the basis of value judgement.[96]

This is a significant restatement of Kuhn's pattern of 'normal' science, which relies on the perpetuation of certain ideas within the institution through professorial authorities and textbook dissemination. It draws attention to the way in which the neutral theory has been marginalised academically (and therefore popularly), even though it addresses significant issues in the foundational evolutionary discipline of population genetics. Sewall Wright was more contentious than the other two doyens of population genetics, R.A. Fisher and B.S. Haldane. Choosing Wright as his primary intellectual progenitor meant that, from its inception, Kimura's theory posed a test to patriarchal authority in the new synthesis. Furthermore, the work itself appeared to challenge Darwinian orthodoxy by suggesting that mutation could occur that would not be selected for and that the drift of neutral mutations through a population could shape a species more than selection. These were relevant issues within tertiary teaching and research institutions that formed, and continue to form, a life support system for the neutral theory. The neutral theory breathes a particularly rarified air of mathematical academia, and unless a viable connection can be made between mathematical models of molecular evolution and phenotypic evolution, it is unlikely to move out of that environment to become a popularised idea. While not intentionally elitist, part of the neutral theory's predicament is that it relies on thinkers working at high levels in disciplines as diverse as biotechnology, molecular biology, population biology, population genetics, ecology and evolutionary biology, demographics, zoology, entomology, biomathematics and more.[97] Currently, it only flourishes inside the academy and requires its devotees to track it across disciplinarily diverse journals and conferences, and it also relies on dedicated presses to assemble the publications that offer different parts of the puzzle in this complex area.[98] This is a very different picture from other evolutionary theories

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96 Motoo Kimura, *The Neutral Theory of Molecular Evolution* (Cambridge: Cambridge University Press, 1983), 22.
97 Naoyuki Takahata, ed., *Population Genetics, Molecular Evolution, and the Neutral Theory: Selected Papers* (Chicago: University of Chicago Press, 1994); Brian Golding, ed., *Non-neutral Evolution: Theories and Molecular Data* (London: Chapman and Hall, 1994).
98 Ibid.

such as Punctuated Equilibrium, Serial Endosymbiosis Theory and Gaia which have been more openly contentious, gained popular momentum and shifted more readily toward forming part of broader cultural discussions.

Kimura is cautious in situating himself and his theory and has gone to some lengths to address the problem of appearing to reject Darwinism. While recognizing other evolutionary factors such as 'population size and structure, availability of ecological opportunities, change of environment, life-cycle strategies, interaction with other species, and in some situations kin or possibly group selection',[99] Kimura still holds that natural selection is the primary mechanism for adaptive evolution. However, he doesn't believe the neutral theory fits the neo-Darwinist model of gene selectionism, one of the main problems being the complete mapping of fitness and selection onto genetics when Kimura acknowledges fitness and selection are influenced by other factors such as development and environment.

To say that the neutral theory does not hold a challenge for Darwinism refuses an important part of its own story and simultaneously sets up a polarity, as if the choice for an evolutionary mechanism lies only between these two options. Genetic drift could well turn out to be of greater significance in evolutionary process than selection, but at this point in history it is difficult to accord effective primacy to any single idea in a series of ideas from various disciplines, including natural selection, because of the carnivalisation of the field as explored in this chapter. However, while Kimura may be reluctant to stand professionally against Darwinism, he does assert that the neutral theory is not genocentric. His theory reads the genome as inherently unstable, and that instability probably resulting in skewed representations of genes in a population. Thus his theory undermines the tidiness of neo-Darwinism through its unusual double focus, relying on studies of amino acid and protein change and substitution situated within mathematical frameworks of hypothetical and real populations. That is, at one level the neutral theory deals with the very corporeal reality of the genetic expressions of fruit flies, while on another, more etheric level it is encountered and developed only in high level conferences, seminars and lectures.

The neutral theory is a carnival story because of its emphasis on constant mutation load on the invisible body of the gene itself. High mutation loads and genetic drift stand in contrast to neo-Darwinist narratives where genes act as emblems of stability and faithful reproduction. In neo-Darwinism the gene is hero; in neutral theory, picaresque DNA molecules wander unpredictably through finite population groups.

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99 Kimura, *The Neutral Theory of Molecular Evolution,* xii.

The neutral theory lives up to its name in topic and construction, but also in its situation. It is a patriarch's story in that it is Cartesian praxis between drosophila genes and the cabalistic language of pure logic and mathematics. However, it is also about using the languages of rationality to capture subversive, organic mutabilities, unauthorised movements of cellular chemicals that act in statistically predictable but literally unpredictable fashion in real populations. It walks a path between orthodoxy and upsetting orthodoxy, and while it has the potential to function as a major disruptive theory contributing to the unravelling of traditional and recent stories of evolution and biological change, it eludes popular excitement and barely survives through its necessary institutional life support machine.

The Gaia theory echoes some of the neutral theory's story, particularly regarding compatibilities with Darwinism and incompatibility with neo-Darwinism, but unlike the neutral theory, it presents conceptual reconfigurations that engage deeply with broad-based sociocultural, epistemological and material change. The power of the Gaia story lies in its conception, its active interdisciplinarity and the currency it now has in the wider culture. James Lovelock, the originator of the Gaia theory is an unusual scientist. He does not practice science in a conventional way, choosing to work mainly from an isolated English village. In describing his activities, Lovelock compares himself to painters or novelists. He says it is expected that these individuals should not be institutionalised, but as a lone scientist he is seen as an anomaly.[100] This image Lovelock creates of himself as an independent, somewhat renegade and creative scientist is not completely accurate as he served a long apprenticeship with a number of British organisations, including the National Institute of Medical Research in virology and cryobiology.[101] However, as soon as he was able he did self-select out of institutions, a process that marked him in certain ways. From one perspective he could be viewed simply as a consultant, but he also presents as an original thinker having had some difficulty with being accepted in the institutions of science.

At Houston to provide equipment, Lovelock was invited to join a meeting about the Viking missions to Mars to investigate the possibility of life. Disagreeing with

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100 James Lovelock, *Homage to Gaia: The Life of an Independent Scientist* (New York: Oxford University Press, 2000).

101 Ibid. Lovelock received his very practically based training in Murray, Bull and Spencer labs early in his apprenticeship, working mostly with photographic chemicals. Later he moved to the National Institute for Medical Research for twenty years, where he mostly dealt in virology and the detection of disease. He then went on to work in another department of the NIMR, pursuing his own work on cryobiology (freezing and thawing live hamsters), and from there to Houston in 1961 to join the moon exploration team. It was from this point that Lovelock's work truly became independent, but he had worked in organisations for over two decades to reach the position of consultant.

biologists, who wanted to search for micro-organisms in soil, Lovelock contended that such a localised search method was likely to be unsuccessful and broader tests were needed to establish the possible existence of life on the red planet. Inspired by images of earth from space, he turned to atmospheric entropy. The two field experiments he initially proposed were to analyse the chemical composition of the atmosphere. His argument was that an atmosphere close to equilibrium would indicate a high level of entropy and an unlikelihood of life. He also suggested testing substances for ordered chemical sequences such as hydrocarbons, which contain evenly spaced numbers of carbon atoms if they come from a biological source.[102]

His suggested field experiments were rejected for the expedition program; however, Lovelock's ideas did not go away. In focusing on how to identify life on Mars, he created a new story about life on earth. Named 'Gaia' by William Golding, the author,[103] Lovelock's story grew and was published as *Gaia: A New Look at Life on Earth.*[104] Two more books followed, but still the theory remains outside mainstream science – an interesting anomaly when the content is examined. Lovelock is, in many respects, a disciplinary traditionalist who does not move very far from the empirical method, but his extrapolative thinking suggests a new paradigm. Underpinning the new paradigm is the model of cybernetics. Whole systems self-regulate on the basis of memory, using positive and negative feedback to generate compensatory adjustments to achieve a balance around either fixed points (homeostasis) or certain operating points (homeorrhesis): some machines maintain this stability – all living organisms do it. Lovelock's questions then are: Can an entire planet do it? And if it can, is it then an entity of some sort?

> One of the most characteristic properties of all living organisms, from the smallest to the largest, is their capacity to develop, operate and maintain systems which set a goal and then strive to achieve it through the cybernetic process of trial and error. The discovery of such a system, operating on a global scale and having as its goal the establishment and maintenance of optimum physical and chemical conditions for life, would surely provide us with convincing evidence of Gaia's existence.[105]

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102 Ibid, 229-230.
103 Golding lived in the same English village as Lovelock. His two well-known novels, *Lord of the Flies* and *The Inheritors*, try to imagine culturally unmediated encounters with nature.
104 James Lovelock, *Gaia: A New Look at Life on Earth* (Oxford: Oxford University Press, 1989).
105 Ibid, 49-50.

Lovelock teamed up with Lynn Margulis, creator of the Serial Endosymbiosis Theory, and their evidence for Gaian homeorrhesis came mainly from the constancy of the reactive gases in the lower atmosphere and planetary thermoregulation over billions of years. Lovelock says that the terrestrial atmosphere is a 'biological ensemble, rather than a mere catalogue of gases' and several mechanisms work to maintain gas balances at good proportions for the sustenance of life.[106] Oxygen is used rapidly in respiration and would be quickly depleted, but it is replaced by regular burial of plants in sedimentary rocks. The burial fixes the carbon from the plants and releases the oxygen, keeping it at a steady 21% of the atmosphere. Methane is predominantly produced by anaerobic bacterial activity in wetlands such as marshes and estuaries and its presence requires a constant use of oxygen, which in turn ensures that the oxygen presence in the lower atmosphere does not get dangerously high. Nitrous oxide releases oxygen into the atmosphere from soils and seabeds and may act as a counterbalance to methane if the methane begins to consume too much oxygen. A considerable amount of Ammonia is released by biological sources and acts to stabilise the acidity/alkalinity of rain, and nitrogen exists in huge atmospheric quantities, useful because it is very reluctant to interact with other gases and its presence also balances the amount of nitrate ions in the sea, which would in turn affect salinity.[107]

Clearly, the recipe for the atmosphere is more complex than this, as there are not only the main constituent gases but also the trace reactive gases such as ozone, nitric acid and nitrogen dioxide and then there are the very transient reactive gases that will only exist in conjunction with other gases, and there are also man-made gases. Two challenges face science in seeking to describe the atmosphere. The first is telling the stories of each one of these gases and how they connect and contribute to the life of the planet and its biological inhabitants. The second is finding adequate metaphors to understand and explain their interconnectivity.

An example of interconnectivity is the sulphur cycle, one of the big stories developed within the Gaian narrative. Understood originally simply as a constituent atmospheric gas, dimethyl sulphide solves mystery through history when treated as an agent, rather than a passive presence, in the biosphere. A chance encounter between Lovelock and atmospheric scientist Robert Charlson provided the first insight into this mystery. Clouds need particles, tiny nucleii, to condense. The particles are readily available over land, but where they came from over the oceans was a puzzle. Charlson

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106 Ibid, 67.
107 Ibid, 64-79.

wondered aloud to Lovelock about the origin of the sulphuric acid and ammonium sulphate nucleii that seeded ocean clouds. Lovelock had given a lecture the day before on the regulation of the sulphur cycle through ocean algae and their emission of dimethyl sulphide.[108] The two pieces of information locked together and presented a cycle.

Dorion Sagan elaborates on both the current producers of oceanic sulphide, *Phaeocystis* and *Emiliania*, and the historic primacy of sulphur producing microbes. Sulphur producing bacteria preceded cyanobacteria (oxygen producing bacteria) and even now form an important layer in acre upon acre of microbial mats that flourish in marine muds, warm springs, marshes, and salt ponds and lakes.[109] A third piece of information reconnects the cycle back to Gaia through thermoregulation. Planetary thermoregulation is one of the two current staples of the Gaia theory. Having linked the sulphuric emissions of the algae to the ocean cloud nucleii, Lovelock and Charlson reasoned that what they were looking at was probably large scale climate self-regulation. Lovelock says:

> Here perhaps was the most important scientific discovery that either of us had made. Without the clouds over the ocean, life as we know it would not exist. This is because oceans cover seventy per cent of the surface of the Earth, and they are dark, and absorb sunlight strongly, whereas clouds are white and reflect sunlight. Bob [Charlson] told me that without clouds the earth would be about twenty degrees Celsius hotter and that a cloudless Earth would have a surface temperature near 35° C, which would make the world inhospitable for our kind of life.[110]

The constancy of the planetary temperature range is crucial to any belief that the Earth is a self-regulating entity. For three and a half aeons, approximately three and a half billion years, there has been life on earth. Early life undoubtedly consisted of anaerobic prokaryotes living in an atmosphere that current life would find toxic, and it existed under a sun that was up to thirty percent cooler than it now is. What is most interesting about the continuity of life under these circumstances is not that it became aerobic and changed the atmosphere (although that is interesting), or that life became extraordinarily diversified; rather, it is that in all that time, and in the midst of very

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108 Lovelock, *Homage to Gaia*, 255-256.
109 See Dorion Sagan, 'The Global Sulfur Cycle and *Emiliania Huxley*', in *Slanted Truths*, ed. Margulis and Sagan, 159-170.
110 Lovelock, *Homage to Gaia*, 256.

great changes to the sun's radiant heat level and the Earth's atmospheric composition, the planetary temperature stayed within the very small range that is hospitable to life. Lovelock suggests this comes from the 'tight coupling of biological and physical evolution'.[111] To prove this system, with the assistance of Andrew Watson, he constructed Daisyworld.

Daisyworld is a simple exercise in computer simulated planetary thermoregulation. A world is populated only by light and dark coloured daisies and regulates its climate by colour selection of the flowers. When its star is young and cool, dark coloured blossoms proliferate and make the world seventeen percent warmer than the light coloured plants would make it. As the star grows warmer, the lighter plants are more common, increasing the reflective value of the planet's surface and they keep the temperature down. The model was unexpectedly successful and even worked with grey daisies if they were given a chance to mutate to darker and lighter colouring.[112]

As with the neutral theory, the Gaia theory is Darwinian, but it is not neo-Darwinian. Selection proves a strong factor in both the arguments for atmoshpheric gas balance through microbe populations and the control of temperature, albeit through the computerised model of Daisyworld. On the other hand, Neo-Darwinism again operates too genocentrically when confronted by this model and again fails to account for complex environmental reciprocities when considering the evolution of organisms. Genes cannot explain the larger pattern of homeostasis as they are restricted to individual organisms. Genocentrism may be why some of the most savage attacks on the Gaia theory have come from neo-Darwinists, such as Richard Dawkins, rejecting the metaphors that Lovelock and Margulis have developed and critiquing the notion of a living world by claiming that if it lives it must have will, it must compete with other planets for survival and it must reproduce.

In an attempt to address these critics, Lovelock argues Dawkins' own case against him. Lovelock says that Gaia is a 'superorganism', something similar to a termite mound that realises its phenotypic boundary at the wall of the nest rather than with the individual occupants.[113] His Daisyworld model then offers a planet that is self-regulating without consciousness and will as understood by Western humanism. Dorion Sagan puts forward a procreative option on the problem of Gaian reproduction by suggesting that the human construction of biospheres and plans to terraform other

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111 Ibid, 249.
112 Ibid, 249-250.
113 Ibid, 261-262.

planets are, in fact, a form of planetary procreation.[114] The uses of these metaphors and the answering of these criticisms through novel thinking strengthens the Gaia theory as an ecofeminist model rather than weakens it, because it answers a clockwork, Newtonian model of the world with a complex system of inclusive, multiple and partial stories. Gaian thinking attempts to reperceive the planet wholistically, using current and historical scientific knowledges, as opposed to sacrificing them. While it is certainly still a problematic concept, current Gaian science resists portrayal of the earth as an entity in the romantic or animistic sense of nature unmediated by culture, but presents another entity existing as a whole system of organic checks and balances that ensures the continuance of life through mechanisms that may not ever be fully analysed or catalogued, or even perceived.

There is an almost unresolvable ambiguity to Gaian politics that seeps into the science. Conservation science and conservationists are concerned that the message the theory offers is one of a self-balancing system that will ultimately take care of itself. The implication in this line of reasoning is that, therefore, humans don't have to take responsibility for their activities. Lovelock and Margulis, on the other hand, advocate responsible human housekeeping of the planet, but both express frustration with what they see as misguided appropriation of the theory by environmentalism, an environmentalism that can romanticise Gaia and one that simply doesn't comprehend the scales of Gaian biology and chemistry. [115] Secondly, Gaia is contentious by contributing to the uncontrollable squabble of voices that represents the carnival of evolutionary science. It takes its place with genocentric, bacteriocentric and geocentric theories among others, but like all these theories it presents certain difficulties. Gaia may even be suspected of being counter-evolutionary. The message it carries of an ecologically maintained 'disequilibrium' and biochemical compensation seems to be the antithesis of a theory of change, but that message can then be reframed as continuous localised adjustments contributing to an extraordinarily complex organismic stability, composed of a near infinite number of multiple and partial stories. The living earth requires change to sustain homeostasis – this is the scientific

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114 Dorion Sagan, 'What Narcissus saw: the Oceanic "Eye"' in *Slanted Truths*, ed. Margulis and Sagan, 185-200; Sagan also offers a counter criticism in this essay of the idea of natural selection being applied to Gaia. It is part of a general critique of animal centred biology and the further application of these models of natural selection to individuals only. Sagan points out what other writers quoted in this thesis, particularly those in Chapter Three, say about the inadequacy of biological models that cannot be applied to all life forms.
115 Ibid, 156.

oxymoron of homeorrhesis. [116] As with morphology, the tensions between change and stability are key. Perhaps the important point is that returns to stability never return organism or system to exactly the same place.

Finally, as well as embodying evolutionary contradictions of stability and change in the living flesh of the world, Gaia theory is also a site of hybridised values and meanings, many of which reflect the spirit of carnival and also reflect the rising challenge of ecofeminism in science. Carnival disrupts conventional social discourse to pay a form of Bachanalian homage to life and death, processes often represented through an ahistorical time frame in the passing of seasons and the bounty and withering of nature. Bakhtin points out that carnival writing provides a reunified view of the world, a linking of many elements into a whole.[117] In carnival, there is an appreciation of a 'generating and growing superabundance', there is also 'a devoured and devouring world' in which 'one dense bodily atmosphere is created, the atmosphere of the great belly'.[118] What Gaia proposes evokes this Rabelaisian/Bakhtinian sense of oneness, but Gaia theory turns to scientific investigation and research to understand the connections and cycles rather than situating them in poetics. Gaia, therefore, embodies contradiction and flies in the face of Western science by using multiple and partial discourses that come out of mechanical and atomised perceptions and practices to promote a new potential unity.

The science and theory of Gaia continue to be a loaded, open-ended discourses. For example, Gaia seems unavoidably feminine due to the naming process, but is she femin*ist*? Patrick Murphy argues she is not, claiming that with the best will in the world Gaia imports male/female binary thinking into any address of the environment.[119] He notes that Gaia was the primary being to spring from chaos, but that she 'quickly becomes subservient to her son/husband, Uranos. As soon as the male arrives, the female loses her independence'.[120] As he selected a Greek point of origin it could be suggested that William Golding, the author who named the theory, utilised

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116 Dorion Sagan and Lynn Margulis, 'Gaia and Philosophy', in *Slanted Truths: Essays on Gaia, Symbiosis, and Evolution*, ed Lynn Margulis and Dorion Sagan (New York: Springer Verlag, 1997), 149; Sagan and Margulis draw a distinction between the homeostatic, which operates from fixed points, and the homeorrhetic which has a number of operating points and classify biological organisms as homeorrhetic. They draw attention to the problematic circularity of such systems within a linear culture through the seemingly contradictory logic of 'I am hungry; therefore I eat; therefore I am not hungry' and so on. Unlike a homeostatic system, this balanced and logical system can work with ongoing contradiction.
117 Bakhtin, *Rabelais and His World*, 61.
118 Ibid, 221.
119 Patrick D. Murphy, *Literature, Nature and Other: Ecofeminist Critiques* (New York: State University of New York Press, 1995), 60-61.
120 Ibid, 59.

Gaia to reinforce and continue masculinist notions of the world as feminised object. However, the transaction that occurred between him and Lovelock shouldn't be dismissed. Naming the theory not only brought an overt creative and humanities based resonance to the new science, it also opened a doorway to critique of the feminine within the context of an earth science paradigm. When Golding named Gaia, he endowed a modern scientific model with powerful mythic resonances. Whatever headaches Gaia brought by dragging classical Greek story telling into science, it also allowed a primal feminine force to erupt into a central discourse of modern patriarchal culture. Settling the two dimensions into a compatible reading is part of undoing binary thinking. Thus a further dimension of irony or carnival becomes apparent: Murphy praises Gaia as an attempt to 'resacrilise' nature, but ironically it is being resacrilised within the parameters of science, a contemporary cosmogenic story whose foundation rests on the 'taming' and control of nature.[121]

Margulis, mother to the Gaia theory as Lovelock is father, recognises something 'fresh, new, and yet mythologically appealing about Gaia'; however, she also recognises the disruption and significance of the story, refuses the entanglement of myth and emphasises the importance of alternative perspectives.

> Gaia is not the nurturing mother or fertility doll of the human race. Rather, human beings, in spite of our raging anthropocentrism, are relegated to a tiny and unessential part of the Gaian system. People, like *Brontosaurus* and grasslands, are merely one of the many weedy components of an enormous living system dominated by microbes.[122]

What Margulis is saying is crucial to understanding not only Gaia, but many of the developing theories of evolution that have been discussed in this chapter. We are experiencing a major shift in perspective in formal knowledge in the culture, as we move into a biocentric, as opposed to anthropocentric, perspective of nature. Notions of subjectivity and agency are changing and whole disciplines are becoming aware of the restrictive nature of traditional story telling. Placing Darwinist selectionism, or neo-Darwinist genes at the centre of scientific stories of evolution denies or minimises whole other dimensions to what is now being recognised in biology as 'emergence', a phenomenon that occurs when reductionism and understanding of the parts fails to explain the whole. Inclusive models are needed to join what have previously been the discrete disciplines like chemistry, physics and mathematics, representatives of

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121 Merchant, *The Death of Nature.*
122 Sagan and Margulis,'Gaia and Philosophy', in *Slanted Truths,* ed. Margulis and Sagan. 156.

Western science's highest logics, to other sciences and to open up even those high sciences to more sociocultural critique. Through Gaia, it is the sciences that seem to become inert, while the planet takes on vitality and agency. Viewed in this way, Gaia is an opportunity to keep reading across discourses, as are all the narratives discussed in this chapter.

Conclusion

Because the narratives of change presented in this thesis challenge traditional, more widely accepted scientific narratives of change, they contribute to the production of science as an exciting but potentially unsafe, carnivalised space. Most science writers and practitioners who write these kind of open, less reductive stories of evolution are aware of the dangers inherent in their approaches and the need to recontextualise their work and rescue scientific knowledge from the uncertainty, subversion and the appropriations of discourses such as creationism. They know that their radical thinking challenges the stability of the current 'genre' of evolution narratives and that they are accountable, not only for discipline specific stories they present, but for the way in which the discipline specific story might impact upon master narratives of change. New stories cannot be proposed without accounting for existing stories. Approaches in the various stories enumerated in this chapter involve various accounting mechanisms: criticisms of Darwinism, criticisms of neo-Darwinism and advocacies of Darwinism (advocacies of neo-Darwinism are absent from all these stories); some sort of compromise to the original framework of Darwinism; the introduction of a new concept and/or a new label or a reconception of part of the Darwinist theoretical structure. A different impulse when dealing with the anarchic potential of such multiagential, multidisciplinary dialogues is to apply more science to the overarching story of evolution, either favouring one discipline as a master narrative to contain other narratives, like panbiogeography, or using container stories extrinsic to evolutionary theory like Complexity Theory and Chaos Theory. This thesis, and specifically this chapter, notes the various processes that scientists and their science follow in dealing with challenges to the multi-dimensional evolutionary narrative. However, part of the work of this thesis, and this chapter, is also to argue for extending analyses of discourses of evolution into the arts and humanities to demonstrate the subversive and generative possibility of these scientific discourses and argue that the politics of these multi- disciplinary narratives may work to reconstitute the politics of the metanarrative of evolution in an unexpectedly ecofeminist form.

To give an overview of the stories in this chapter, a brief consideration of how the various scientists in this chapter deal with the evolutionary metanarrative is in order. Ho's two collections are dedicated to discipline specific science issues that destabilise Darwinism and neo-Darwinism, Darwinism because it has aged as a theory and restricts disciplinary thinking, and neo-Darwinism because it is a monologic, reductionist science theory. Ho and her fellow editors open the boundaries of the organism to include historic time scales, environmental response and the organism's multiplicity within existing scientific frameworks. Their response to the instability this generates is to meet their own challenges to evolutionary science with more science. The unifying framework for Ho, Fox and Saunders is the cybernetic, 'feedback/adjustment' model of Complexity Theory. Complexity theory is generally applied to high level questions in multipart systems such as ecology, behaviour or economics.[123] Lovelock, the original author of the Gaia theory, is also a committed cybernetic thinker. This metaphorical application of cybernetics as a solution is a struggle for control of complex and difficult ideas as much as it is an attempt to represent complex bodies/environments and their relationships. While the scientists who use it as an overarching theory do acknowledge culture and society as part of the biological picture, it tends to be tokenistic. Their critical methodology still operates to separate nature and science from cultural values, often underestimating the powers of anthropocentrism, eurocentrism and gender biases to assert themselves within western scientific discourses, and overestimating the capacity of the master discourses of science to solve problems of the scope they have identified.[124] Theirs is a layered politics of simultaneous subversion of science and containment of the subversion by more science.

Margulis, author of the Serial Endosymbiosis Theory, also supports Lovelock's Gaia and accepts cybernetics as a larger explanatory system for evolution. She, however, opens up the idea of a steady state, choosing more organic concepts like 'autopoiesis' and 'homeorrhesis' over 'homeostasis'. 'Homeorrhesis' posits wider arcs of 'operating points', as opposed to 'fixed points' of operation in complexity systems.[125] Her reticence with regard to mechanising planetary ecology through cybernetics is more clearly underpinned by a body-centred sense of carnival and an ecofeminist

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123 Peter T. Saunders and Mae-Wan Ho, 'On the Increase in Complexity in Evolution I. The Relativity of Complexity and the Principle of Minimum Increase, *Journal of Theoretical Biology* 90 (1981), 515-530.
124 Ho, 'On Not Holding Nature Still', 122.
125 Sagan and Margulis, 'Gaia and Philosophy' in *Slanted Truths,* ed. Margulis and Sagan. 145-157.

politic. Margulis segues from Serial Endosymbiosis Theory's multiple and partial stories of complexity and difference in the microscopic to the introjected and layered, living body of the planet using mediating metaphors such as human hunger to explain the smaller and larger balance systems, systems that never achieve full resolution or closure.[126] In Bakhtinian carnival theory the body of the planet is also generated from a similar sense of the life experience of an individual organic body. Gargantua's appetites and lower stratum functions represent the fecundity and complexity of life at a supra-human level, and Pantagruel's dreadful drought represent the constant tension between abundance and scarcity, life and death. Open and irregular bodies mirror each other in carnival literature, literary theory, science and science theory. In turn these open and irregular bodies of work resist closed, monumental and static stories of boundaries and connections.

Croizat and his supporters recreate biogeography as panbiogeography, an umbrella discipline demanding an interdisciplinary reading of space, time and form in biology, with space the privileged dimension. Panbiogeography raises synchronic and diachronic boundary questions, with organisms becoming bodies of significance within a scaffolding of vast distances and unimaginable time frames. Panbiogeography acts like a time machine in a detective story, swallowing Darwinian selectionist evolutionary theory rather than taking issue with it. The inclusivity of this theory also generates a politics of carnival and ecofeminism. Every 'body' – river, pool, hill, atoll, tree, microbe, mammal etc – participates in the carnival of form and this science practices Barad's ecofeminist/posthuman performativity as matter becomes agential and all relationship becomes *intra-relationship*, as opposed to interrelationship, in a system of material discursivity.[127] As panbiogeography undoes Darwinist biogeography and complexifies the external environment of the organism by factoring in time based change, so Ho's epigenetics and Hodin's differentially coopted *Pax*6 gene story contribute to an overall instability *within* the organism by factoring in time based change in genes and internal non-genetic organic systems. Nothing in these narratives offers a defining authority on the organism, its relationships to other organism or its relationship to its environment. Bodies just cease to be manageable and discrete. Partially the process occurs within the separate disciplinary stories, but it is exacerbated when different disciplinary stories are simultaneously mapped onto the organism. Then the organism becomes carnivalised by multiple and changeable

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126 Ibid, 149.
127 Barad, 'Posthuman Performativity', 801-831.

perspectives, and the environment becomes connected meaningfully and necessarily to the body rather than being separated from it.

Robert Wesson does a comprehensive scientific case study survey to look at published information supporting and contradicting the basic tenets in Darwinism and neo-Darwinism. He writes random mutation and natural selection as mechanisms, rather than drivers, of evolution, and argues for Lamarckianism and neo-Lamarckianism to be included in scientific history and investigation. He believes the conflicted processes of evolution can be explained by Chaos Theory. Like Complexity Theory, Chaos Theory follows relativity and quantum mechanics, but with 'a broad tendency to irregularity within regularity and determinism'.[128] Chaos theory is less mechanistic than complexity theory. Similar to homeorrhesis in some respects, it depends upon 'tensions' to order and change within a system as opposed to switches, and a chaotic system is also dependent on its starting point for predictors, therefore it has less 'regularity' than complexity theory. Different in tenor, both complexity theory and chaos theory are powerful and inclusive transition stories that offer a haven for those struggling with the difficulties produced by the discipline specific challenges in the field of evolutionary thinking discussed in this chapter. The main problem, at this point, is that both Complexity and Chaos Theories fail to incorporate any recognition of the politics of scientific ideas and their expressions of embedded cultural and social patterning in their treatment of bodies and science process,. So, Complexity and Chaos Theories are 'containment narratives', a way in which evolutionary thinking can be kept 'scientific' and not become embroiled in the breakdown of specific ideas or be subjected to cultural analysis, two processes that open science and evolutionary theory to the instabilities of the carnival body and market place discussion.

Because knowledge in evolutionary theory is destabilised at this point in history and can be read as carnivalised, scientists and writers like Lovelock, Ho, Margulis, Kimura and Wesson practice a sort of 'reconciliation politics'. That is, they support their own subversive stories and seek to develop them, but they reconcile their stories as Darwinist and scientific. They refuse the anarchic potential of their work and seek to situate it within the familiar. Others appear to more readily embrace the carnival dimension of their disciplinary story. Prebiotic scientists Sidney W. Fox and Koichiro Matsuno, are prepared to argue that their protocells and microspheres contradict Darwinian and neo-Darwinian competitive selection by demonstrating self-organisation and ready communication with the environment and each other. This

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128 Wesson, *Beyond Natural Selection,* 32.

alternative, non-selectionist presentation of evolution from pre-life science is, however, not as subversive as it first appears. While presenting a radical challenge to traditional evolutionary thinking, the prebiotic story is underpinned by the conventional reductionism of chemistry. At this point, chemistry holds a privileged position as 'hard' science and appears politically 'innocent'; however, the patriarchal science/church theatres that Fox (particularly) elects as venues for the drama of the microshperes are not innocent, and there is a significant patriarchal context to the layered politics of his work. His carnival ambiguity lies with being the father in charge of the 'maternal substrate', with prebiotic offspring that tell him 'personal' ecofeminist stories of community and self-organisation and agency. Motoo Kimura occupies a similar space, but his identity and his work are not so carnivalised. His neutral theory of mutation speaks to a busy world of constant, invisible change that works more on genetic drift than against genetic selectionism. Performed in the specialised intersections of mathematical logic and academic communities, the neutral theory has less cultural cachet than prebiotics but a similar political identity in some respects. Its challenge to selectionism as the primary driver of evolution is strong, but it is firmly grounded in the 'innocent' discipline of mathematics. These sciences, prebiotics and the neutral theory, participate in disruptions to evolutionary knowledge, but are perhaps less public than Gaia and Serial Endosymbiosis Theory, and they are still anchored in current prevailing authorities. Thus, their slipperiness of moving between subversive new stories and accepted practice and theory creates them as players in the science carnival just as much as the more controversial 'story telling' of biology and biogeography.

A problem created by the complexity of the politics of so many scientists, different disciplines and new ideas intersecting with big evolutionary stories is that it becomes intellectually easier to accept populist models of evolutionary science. Uninterrogated Darwinism and neo-Darwinism exert a strong force, pulling evolutionary scripts back to human dominance of nature, male social dominance, racialism and other eugenic subtexts, and capitalist organizations and exploitations of biology. Attempts at revealing or reformulating the complexities of evolutionary theory and science are regularly complicated by the regenerative, Hydran powers of genocentric thinking and the fact that scientific discipline does not contest scientific discipline on an even playing field. One potential cure for this is to ultimately require more cultural scrutiny of science stories. Evolutionary science has become carnivalised – from within its own discourses, at the challenged boundaries it maintains between its 'purified' subjects

and 'otherness', and in the relationship it constructs between mathematically based disciplines and the arts and humanities. To fail to acknowledge this situation and to investigate it, is to invite fundamentalist thinking into science and reinforce neo-Darwinist interpretations in more and more disciplines.

As Latour points out, science has a 'speech impediment' when it speaks for the non-human world and it needs to be situated and presented in a more politically transparent way.[129] This chapter has attempted the opening of multiple discourses relevant to post neo-Darwinist thinking. Carnival is just one metatheory that can be used to explore the ambiguous figure of the scientist, scientific discursive/material hybridity, un/natural novelty and irony in scientific discourses and their juxtapositions, and can focus on marginalised political readings and practices. It is particularly useful for examining evolutionary thinking because carnival focuses on subversions of authority, deconstructs polarities and is inclusive of material bodies and technologies, and discourses that explore material bodies and technologies, visible and invisible. Carnival also forms an essential tool for understanding one of the main arguments of this thesis: that evolutionary science is a multidisciplinary site demonstrating a strong potential for ecofeminist politics. Drawing the various theories discussed in this chapter together under the umbrella of an ecofeminist evolutionary theory and applying it to feminist science fiction stories, texts created and found in cultural studies, humanities and arts, allows for a carnival marriage of cultural and scientific models of change. To reiterate, these are stories of the permeability/responsiveness of organism and species, they attribute agency to the animate, inanimate and cultural, and they express a notion of continuous, multiple 'intra-action' of organism/environment. These values require a more open, interdisciplinary paradigm than neo-Darwinist selectionism, and even Darwinism, can support. Genocentric sociobiology has provided a valuable mind/body bridge, but it needs to be rescued from its love affair with hyperpatriarchal success stories and brought into a more inclusive story of the world and the many, many ways of being and changing.

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129 Bruno Latour, *Politics of Nature: How to Bring the Sciences into Democracy* (Cambridge, Mass.: Harvard University Press, 2004), 67.

CASE STUDIES

Chapter Six
The Tiptree Carnival

[First published in *Foundation: the International Review of Science Fiction* 33, no. 90 (2004): 34-43.]

"I honestly don't know what irony is. Either that or I live it day by day, moment by moment, eat it for breakfast like granola, so I don't recognize it."

I said: "To me irony seems like the normal outgrowth of ambiguity, of seeing both sides of every action. I don't understand how people can avoid being ironic, even about things that they respect religiously. One of the reasons I'm asking you about it is that irony becomes something I see everywhere, even when people don't intend it, so I have to go back and check . . ."

"Sounds like breakfast," she said.

Conversation between Alice B. Sheldon and Mark Siegal [1]

Hunting down the complexities of Tiptree's feminism and the way it puts the gender spotlight on science fiction is good sport – a fact recognised by feminist fans and writers.[2] But while this focus on gender has yielded a mother lode of critical appreciation of Tiptree's short work, it has proved a limiting tool with which to understand the novels. The major themes of Tiptree's short stories have been identified as sex, violence and death,[3] and much of this work still generates complex emotions in readers of both genders even thirty years after publication. They are not hopeful literature. 'Houston, Houston do you read?'[4] and 'The Screwfly Solution'[5] are two of her better known pieces. While not specifically dystopian, they refuse the invitation to utopia taken up by so many feminist science fiction writers in the 1970s. Read at a superficial political level, the message Tiptree seems to generate is a certain desperate and awful inevitability regarding gender. Sarah Lefanu notes this feature of Tiptree's stories, adding that the violence and death in the writing are always associated with the male sexual drive: 'the stories that explore this theme are deeply pessimistic and have a deterministic slant that is not present throughout her work.'[6] That this deterministic slant and pessimistic view of social change are not present throughout Tiptree's literature is what suggests to me possible readings beyond sexual fatalism. Gender

1 Mark Siegal, *Love was the Plan, the Plan was ... A True Story About James Tiptree Jr*, http://www.mtsu.edu/~dlavery/Tiptree/siegellwtptpw.htm (accessed November 24, 2001).
2 Phillips, *James Tiptree Jr*. James Tiptree Jr is a pseudonym for Alice B. Sheldon who . wrote stories and participated in fan letters and exchanges under her male pseudonym. The revelation that Tiptree was a woman caused many discussions about her writing and about sf and gender. Alice B. Sheldon also wrote as Racoona Sheldon.
3 Lefanu, *In the Chinks of the World Machine*, 109.
4 James Tiptree Jr., *Houston, Houston Do You Read?* in *Aurora: Beyond Equality*, ed. Vonda McIntyre and Janice Anderson, 1976.
5 Racoona Sheldon, 'The Screwfly Solution', *Analog Science Fiction/ Science Fact*, June (1977).
6 Lefanu, *In the Chinks of the World Machine*, 110.

alone is not the key to Tiptree's work, particularly the longer pieces, but is just one thread of a grand politico-cultural burlesque in the novels. The novels are more like circuses. They are Bakhtinian carnival at its best, offering inversions, subversions, linguistic play and grotesque bodies, all 'filled with this pathos of change and renewal, with the sense of the gay relativity of prevailing truths and authorities'.[7]

As fiction, Tiptree novels are unusual narratives, always anti-heroic and crushingly big picture: they tell 'down home' stories about ordinary people the reader will love and hate mapped onto extraordinary, world altering events. Thus *Brightness Falls from the Air*[8] is a story both about the fall of colonialism and the gathering of a small group of people who all have a personal interest in watching the death of a star, while *Up the Walls of the World*[9] maps a dysfunctional western scientific experiment onto time, space and divinity. This successful imposition of the insignificantly small onto the impossibly large is mostly accomplished through humour, and Tiptree has a wicked sense of humour. Often dark, it is lit by a lively sense of the ridiculous and works in a truly carnivalesque fashion. Changes in focus have readers believing complete absurdities as the creation and fall of worlds are embedded into narratives constructed around likeable people who make kiddie porn or who are drug addicts. It is a very special quality in Tiptree's writing that makes readers feel affection towards those who are normally castigated and despised, while placing them in situations that not only cast their individual foibles in a forgiving light but go a long way to redeeming our entire species.

This is the nature of carnival: Lilliputians and Brobdingnagians mix it with saints and sinners at the same bash. By creating a party of grotesque and exotic bodies and systematically inverting everything traditionally understood about sex and power, Tiptree forces us to participate in the strangeness of our own world. We understand alien by 'becoming' alien when we read these wild and unusual novels, and Tiptree's persuasive voice constantly urges us to dissolve boundaries, try on one mask after another, actively participate in the pageant that is science fiction, and then laugh at ourselves for trying to make sense of it.

To understand how this unsettling process works, it is worth looking closely at *Up the Walls of the World*, a story of chaotic grandeur. There are several narratives interleaved through the book with deep time and extra-planetary space included as actors on a cosmic stage. The group of individuals that form the human focus are

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7 Bakhtin, *Rabelais and His World*, 11.
8 James Tiptree Jr., *Brightness Falls from the Air* (New York: Tor, 1985).
9 James Tiptree Jr., *Up The Walls of the World* (London: Victor Gollancz, 1978).

carnival figures from the start. They do not fit comfortably into normal social hierarchies and express alternate, 'medial' realities of emotion, empathy and intuition.[10] Their bodies as well as their unusual mental receptivity also signify a carnival of difference as they participate in a government experiment on telepathy. There is Margaret Omali, the sexually mutilated black woman scientist with telekinetic power, the terminally ill young white male, Ted Yost, who is capable of creating powerful fantasies of denial, and Rick and Ron Waxman, twins who seem to constitute one divided person. Dr Dann is a drug addicted medical practitioner and Chris Costakis seems to have some sort of pituitary disorder, which has left him undersized and deeply paranoid. Frodo, Val and Winnie are women who seem to fall within normal parameters, albeit that Winnie is elderly and Frodo 'swarthy', but as Mary Russo points out in her book The Female Grotesque, simply being female qualifies them bodily for carnival. She says:

> The classical body is transcendent and monumental, closed, static, self-contained, symmetrical and sleek; it is identified with the 'high' or official culture of the renaissance and later, with the rationalism, individualism and normalising aspirations of the bourgeoise. The grotesque body is open, protruding, irregular, secreting, multiple and changing; it is identified with non-official 'low' culture or the carnivalesque, and with social transformation.[11]

The grotesque is often aligned with secreting, protruding and irregular female bodies. Tiptree supports this culturally normative duality, demonstrating time and again in stories that women represent an unprivileged pole in western culture, that they are variants from, and objects within, a dominant masculine cultural standard. This is illustrated by a particularly charged episode in *Up the Walls of the World*, where Dr Dann unexpectedly mind melds with the most beautiful woman in the group, Margaret Omali. It is worth quoting in its entirety:

> –Oh God, it's back. A frightening thrum is pouring through him, collapsing his world – a silent tumult that whirls him out of his senses.

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10 Laurie Layton Shapiro, *The Cassandra Complex: Living with Disbelief* (Toronto: Inner City Books, 1988); Shapiro argues that the repressed values of a culture that prizes rationality and logic will be the largely unspoken experience of the intuitive, the emotional and the instinctive. These undesirable values are then distributed among undesirable bodies and disempowered classes of people, women in particular. Thus it seems legitimate that carnival, particularly the Tiptree carnival, may in fact include specific states of mind as much as grotesque bodies – seers, prophets, the murderous, the insane, the traumatised and so on.

11 Russo, *The Female Grotesque*, 8.

And he is rushed into total blackness in which a spark blooms into a vision so horrifying that he tries to cry out.

The shape of horror is a white kitchen table, chipped and cracked; he has never seen anything so evil. He wants only to flee from the ghastly thing, still knowing with some part of him that it is unreal, is only in his inner eye.

Next instant reality goes entirely, he is swamped by dreadfulness. His limbs are wrenched out, he is struggling, gagged and spreadeagled, trying to scream at the sweating crazy dark faces above him in the smoky glare. A knife shines above him. Mother! Mother! Help me! But there is no help, the unspeakable blade is forced between his young legs, he can't wrench himself away. Hideous helplessness. Father! No! No! NO! The face that is Father laughs insanely and the knife rips, slices agonisingly – it is cutting into the root of his penis. Through the pain and screams his ears echo with drum-beats and vile beery stuff splashes onto his face.

Then everything lets go and he clamps into a knot around his mutilated sex, rolls and falls hard on the floor in a gale of loud male voices. An old black woman's face peers into his. He is dying of pain and shame. But as he clasps his gushing crotch he feels alien structure, understands he is female. His childish body has breasts, his knees are dark-skinned –

-And abruptly he is back in the empty night, back to his old familiar body: Daniel Dann huddled in a tin chair gasping 'No-no-no.'[12]

Much is made of Margaret Omali's difference. She is long and lean, beautiful and black, an object of desire to the unreconstructed colonial masculine. However, as the reader discovers in this passage, she is also grotesque because she is sexually mutilated. This is not voyeurism on Tiptree's part, but illustrative of her carnival thinking, her political foresight,[13] and her long reach outside the predominantly white, male middle class caste of science fiction characters: it is indeed an extraordinary irony that Margaret's pain is felt by a white doctor who would, by profession, cut into the body as object and who mis/uses his pharmacopeia to escape any feeling at all.

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12 Tiptree Jr., *Up The Walls of the World*, 109.

13 Female circumcision did not become a public and politicised issue in the West until over a decade after Tiptree's novel was published.

Deepening irony further, the female author with the male pseudonym leads the reader, classically young and male in this genre, into a castration nightmare only to wrench him out of it by changing the sex of the characters in a sudden mad mind swap. Dr Dann's second mind meld, with Valerie, gives him further insight into the female experience of difference where women's bodies necessarily exist as transgressive and even idealised physical beauty fails to mitigate the positioning of women as vulnerable and different in a male world:

> Now he knows only that he is suddenly in another world – a world named Val, a strange vivid landscape in space and time, composed of a myriad familiar scenes, faces, voices, objects, musics, body sensations, memories, experiences – all centered around his Val-self. His self incarnated in a familiar/unfamiliar five-foot-three body; tender-skinned, excitable, occasionally aching, with sharp sight and hearing and clever, double-jointed hands; the only, the normal way to be. And all these are aligned in a flash upon dimensions of emotion – hope, pride, anxiety, joy, humour, aversion, a force-field of varied feeling-tones, among which one stands out for which his mind has no equivalent: fear, vulnerability everywhere. This world is dangerous, pervaded by some intrusive permanent menace, a lurking, confining cruelty like an occupying enemy. A host of huge crude male bodies ring it, rough voices jeer, oblivious power monopolies [sic] all free space, alien concepts rule the very air. Yet amid this hostile world hope is carried like a lamp in brave, weak hands; a hope so bound with self that it has no name, but only the necessity of going on, like a guerrilla fighter's torch.[14]

So many kinds of women that men don't see.[15] Going beyond the human carnival, Tiptree invents other species in *Up the Walls of the World* – primarily the Tyrenni – which contribute to the parade of the extraordinary in this novel. A Tyrenni male is up to forty metres in width, and resembles a giant manta ray from the seas of earth. This is a species that has evolved to live in the winds that constantly circle the planet of Tyree. The Tyrenni society presents the reader with satiric inversions of western culture. Parenting is the occupation with the highest status on Tyree, and it is the sole province

14 Tiptree Jr., *Up The Walls of the World*, 223.
15 A reference to one of Tiptree's most famous stories, 'The Women Men Don't See', in *The Magazine of Fantasy and Science Fiction* December (1973). The story is about two women in a plane crash who choose to leave a remote location with aliens rather than stay with the men on the plane, who they obviously see as even more alien.

of the males. Females are too irresponsible and adventurous to care for the young. Fertilisation of the egg takes place as the female releases it to the winds of Tyree, whereupon the father catches it and then cares for the offspring as it develops. The further apart the male and female are, the better the chance of conception. This sexual act is called 'repulsion'. Such linguistic and physical inversions, particularly regarding gendered bodies and behaviour are a further significant element of carnival.

As the story develops, the two species become involved in a body swapping comedy. The Tyrenni are desperate to escape their dying planet, and they reach out across the void with their exceptional mental technology, searching for a new home. It is a crime for them to steal the bodies of sentient beings, but they connect with the group of humans who are performing telepathic experiments. Seven Tyrenni occupy the human bodies, sending the humans on an unexpected interplanetary visit to Tyree. Comic and cosmic justice is done: the great father Scomber, a Tyrenni who should have known better than to commit 'life crime', now resides in the dying body of Ted Yost; Avanil, determined advocate of Tyrenni females is incongruously thrilled to think she is in the powerful body of an elderly mother, Winona. Conversely, the low-status, elderly woman in the human group is now in the dignified and huge body of a Tyrenni father. And so it goes, bodies and minds change identities and fortunes, and remind the reader to 'be careful what you wish for'. That this is more Tiptree humour is clear. Such cautionary tales have comedic roots at least as far back as traditional Rabelaisan carnivals, where kings are decrowned, figures of authority are mercilessly mocked, the ambiguous/dangerous nature of rites of passage, such as marriages and births, are foregrounded, and people presumed dead experience unlikely resurrections.[16] Most amusing is the resituating of Major Fearing, a human perpetrator of dark deeds in the name of national security, into the body of a dog. It is both a bizarre inversion and a parody for a powerful and sinister man, clearly responsible for the termination of other humans, to become man's best friend, a creature that is often used for security purposes, but one that is also helpless over its own fate and can be destroyed on whim.

The CIA/DCC sub-plot in which Fearing is a player is, however, a minor comic element of the story. Even the destruction of the planet Tyree is not the main focus, because there is a third entity that is a significant actor in this unusual interstellar drama – a gigantic black cloud. The cloud is a member of a species which is revealed towards the end of the novel as a life form that creates 'fire breaks' where needed in

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16 Bakhtin, *Rabelais and his World*, 197-230.

crowded galaxies. The entity has an internal program to ensure the continued existence of life, but at the beginning of the book it is known as 'the destroyer' as it has lost its purpose and is simply cutting a swathe of destruction through space. In real time, on real earth, Margaret Omali dies. As she leaves the planet she is caught up in the telepathic beam of the Tyrenni and catapulted into the heart of the black cloud. Somehow she pierces its icy, death-like centre and touches the great being. It becomes aware of her life and requests communication with her through the symbols, 'time plus or minus infinity'. While she was on earth that code had frequently and mysteriously appeared on Margaret Omali's beloved computer when she was working on the telepath experiment, and she had joked with Doctor Dann about it being a 'ghost' in the TOTAL computer system.

The black cloud bonds with, and becomes guided by, the life force that once inhabited Margaret Omali's extraordinarily elegant and sexually mutilated body. It also accepts on board the rag tag band of human telepaths who come with most of the population of Tyree and the Great Field of Tyree, the living energy of the planet. Further comic scenes ensue as communication is re-established within the black cloud between minds, and the disembodied humans and the Tyrenni try to figure out who is who, how to move and, most importantly, how to communicate with the whale whose belly has become their latest address.

Some of the conversations, given the context, are surreal. As Dr Dann recognises Tivonel the Tyrenni:

> He is distracted by the faint persistent glimmer of more presences that seem to be moving parallel with them. Two, no, three others are here. An instant later he feels a strong, skilful Tyrenni mind-touch, is electrified by recognition. "Tanel!"
>
> "Tivonel, my dear, is that you? Are you –''
>
> "Tanel, stop, you're terrible! Image of coral laughter, leaping away. He subsides abashed.

And when Valerie relocates Winona:

> "Oh Winnie, I'm so glad you're all right!" Val's thought comes while he tries to apologetically to back away from their contact. He can hear Winona's transmission almost as if her voice were in his human ears. "Yes, I have Kenny here too, with his doggie. They're dreaming of hunting. Oh, hello, Dr Dann! How wonderful!"[17]

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17 Tiptree Jr., *Up The Walls of the World*, 272-273.

Etiquette for the disembodied! Bright and breezy conversations are being held between the occupants of a great black cloud in the middle of deep space: a black cloud which held back the explosion of the sun of Tyree so its people could escape, a black cloud which is responsive to the life within itself but only in limited ways. Tiptree describes something cosmic, awesome and mysterious in strong, sinewy language yet her characters speak as if they are having morning tea with the vicar. Where is the value in undercutting such an awesome context with twee middle class statements of greeting and propriety?

Tiptree exercises an often unappreciated talent for comedy knowing also that ordinary human conversation and colloquial expressions (Whew! is a favourite) build a disjunction in the narrative which then allows the human mind to co-operate in imagining the inconceivable. It is a sleight of hand to run separate realities together, using one to produce an illusion of familiarity with the other, but it is done consciously. The very ordinariness of Val and Winnie and Dr Dann normalises the alien vastness of the intelligence behind and within the great sentience: Time plus or minus infinity. Thus Tiptree builds the anomalies and complexities of vast space and deep time into the story structure in manageable forms. The infinite journey of a star creature is overlaid with the more temporally contained death of a planet as its sun explodes. That in turn is overlaid with a weekend experiment on earth. Three time frames operate simultaneously in this book, one of ages, one of centuries and one of days, and our attention is drawn to their separateness in the most subtle ways by tiny but frequent references embedded in the action.

Giadoc, the first Tyrenni to mind meld with the humans, realises the time scales on the two worlds could be different,[18] as does Dr Dann when he tries to understand how long the transplanted humans have spent in the scorched atmosphere of Tyree.[19] The star creature is 'aeons' old and its melding with Margaret Omali gives it 'coherence, complexity, a history'.[20] Conversely the joining of the black woman and the black cloud provides a sense of timelessness to her human consciousness:

> How long the simple joy of no-pain lasts she has no idea; here time is not.[21]

Human measurements become irrelevant, whether they are 'an atom's width or a light year', and Margaret Omali becomes one with the star creature in a place where 'Time

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18 Ibid, 179.
19 Ibid, 238.
20 Ibid, 193.
21 Ibid, 194.

no longer exists'.[22] The star creature transmits visuals to its hitchhikers of its own story, millions of years in the making. Traditional boundaries collapse as they do at carnival time. That time itself is a human invention and limitation becomes even more apparent when Chris Costakis approaches the star creature through Dr Dann to create time for the inhabitants of the star beast. They need time and use a pulsar to mark approximate earth weeks so they don't become completely disorientated.[23] By the end of the novel the power of the star creature to change time even more radically is clear. The young Margaret Omali, the child she was before her savage clitoridectomy, visits the doctor inside the star creature and says innocently as they watch a red giant in the darkness:

> "If we made time run backward, it would shrink again. And if there were people around it, they would be alive again, wouldn't they, Dan'l?"[24]

Only human time is linear and simple, and the little girl's question disturbs the good doctor. The notion of reconstructing worlds brings intimations of immortality, something both frightening and appealing. Ambivalent time is an extension of carnival time which Bakhtin notes is one of the determining traits of the grotesque image. In its primitive origins, carnival time draws on the passage of seasons and patterns of birth and death that are constantly repeated. This is what happens with the multiple incarnations the smaller beings experience in Tiptree's extravagant tale. Later, western time came to literally include a sense of history and historic change, but these elements are still always contradictory; that is, time does not exist beyond context and context can change. With at least three different time frames laid across each other in *Up the Walls of the World*, there can be no privileging of what Bakhtin refers to as the ready-made and complete of the classic aesthetic.[25] The splitting and simultaneous appearance of differently aged versions of Margaret Omali in the control centre of the cloud provide an example of the multiples of carnival, but they also act to disrupt both cyclical and linear time.

With disruptions to cyclical and linear time, change can also be viewed differently. Evolution is crucially linked to notions of deep time and twentieth century cultural ideas of change have been governed by the metanarrative of Darwinism, a theory which dictates biological transformation as slow and incremental, and argues that the

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22 Ibid, 195.
23 Ibid, 298.
24 Ibid, 303.
25 Bakhtin, *Rabelais and His World*, 25.

fittest would always be the survivors in any battle of nature. Darwinism supports and is supported by linear constructions of time, but has flaws when applied to deep time. Able to account for minor adaptations, deep time does not seem able to sustain evolutionary narratives of gradualism or selective ordering. In his book Deep Time, paleontologist Henry Gee claims that when we think of organic change we do not really see it, rather we impose it upon a 'restrictive view of reality based on our own limited experience, when reality may be larger, stranger and more different than we can imagine'.[26]

So, how do we paradoxically imagine change as something more different than we can imagine? What kind of mechanisms of change might be appropriate for deep time, cosmic scale and carnivalised stories, and does Tiptree use them? Tiptree does. This is a writer who disrupts Darwinist tenets of 'survival of the fittest' by selecting a rag tag bunch of misfits for ultimate longevity, and anticipates recent rewritings of evolution in several ways. Lynn Margulis originally worked with Jim Lovelock on the Gaia hypothesis which claimed a biological 'intelligence' at work through planetary homeostasis. She then went on to create 'serial endosymbiosis theory', or SET. In this theory Margulis postulates that evolution is not only competitive but is also co-operative, dependent on symbiogenesis, a process where an organism will merge with another organism and thereby acquire a group of new properties. Simply put, 'symbiogenesis brings together unlike individuals to make large, more complex entities'.[27]

While Margulis works this theory out in the microcosm of cellular biology, Tiptree works it out in the macrocosm of stellar space. Human and Tyrenni life forces become celestial organelles of a sort for the great black cloud, eventually participating in its growth and activities. Separately, all the entities in this novel are flawed and limited, together they make something much more than the sum of their parts. Dr Dann muses at the end of the book on what has happened:

> Voyager between worlds, I have been privileged beyond mortal man. I have met an alien race, I have encountered endless unknown things. What great changes has all this wrought in me? What transformations have I suffered to make me worthy of a place in such a drama? To witness, perhaps participate in the fates of worlds? To

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26 Gee, *Deep Time*, 53.
27 Margulis, *The Symbiotic Planet*, 12.

> enjoy something like immortal life? What great contribution will I make to the symbiosis?[28]

While he suspects that his contribution may, in fact, be insignificant, the reader knows these mere humans have not come to the situation empty handed. They have all brought something to the symbiotic merging, and Daniel Dann's particular gift is one of physical and psychic healing. This is a merging which is not only an alternative evolutionary mechanism, it is also a further symptom and expression of carnival. Carnival is a liminal place, a place of inversions and boundary challenges. And this is the Tiptree universe. Old things are recreated as new, what was familiar becomes estranged and different, what was grand becomes diminished and vice versa. The bodies we meet are exchanged, extreme and damaged: they exist as gargantuan, limbless, walking, flying, tiny, old, black, white, divided, multiplied, and problematically gendered. Finally they do not exist at all. Bodily etiquette is then humorously recreated in limitless space, while bodies and minds fall in and out of planetary time frames.

Tiptree is a satirist and a humourist, enjoying turning things on their head, so she also questions the contexts of bodies. Scientific discourses cannot be left on default settings. Science in this story is split from militarism, and selectionism is impossible due to the unpredictability of natural events. Reductive Darwinism is undermined by cooperative, creative symbiogenesis and physics is lampooned with the meaningless/meaningful phrase 'Time plus or minus infinity'.

With nothing sacred allowed in the world of carnival, by the closing of the novel Tiptree also deals blows to conventional monotheism and that pseudo-scientific marriage of physics and divinity that often results in the science fictional cliché of human graduation to an over-species. They are both well worn paths and lend themselves to mockery. Not pompous enough to propose that humanity has served some sort of lengthy apprenticeship, and has now been promoted to keeping company with immortals, Tiptree instead writes Margaret Omali, the guide and muse of the all-powerful black cloud, and her strange companions in the future as a series of comical accidents and ultimately as that well known political joke …

An astronaut comes back from a flight and announces to the world that he's met God and there are some surprises. First of all, …she's black …

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28 Tiptree Jr., *Up The Walls of the World*, 308.

Chapter Seven
Ecofeminist Science Fictions: Imagining Alternative Pathways of Biological Change and Co-existence.

[First published in *Foundation: the International Review of Science Fiction* 35, no. 98 (2006): 99-115.]

By contrast with the masculinist utopias and science fiction, these feminist visions of transformed natural and social worlds emphasise again and again that technoscience is not inevitable; as part of culture it is socially constructed and can be reconstructed. Thus, however powerful the present genetic/eugenic turn, it is not the only possible technoscience. Feminist myth-making through marginal genres offers a means of re-visioning the present so as to make other futures possible. At a time when high technology threatens us with its power and destructiveness, it is this fusion of creativity and courage in facing the unthinkable which goes some way to explaining the significance and lure of this writing. For feminist science fiction has created a privileged space – a sort of dream laboratory – where feminisms may try out different wonderful and/or terrifying social projects. In these vivid u/dystopias the reader is invited to play safely and seriously with social possibilities that are otherwise excluded by the immediacy of daily life, by the conventions of the dominant culture and by fear.

Hilary Rose[1]

Introduction

The years following the flourishing of feminist utopian science fiction writing witnessed other feminisms emerging within an extensive parent genre that is politically, scientifically and socially pliable. Apparently dominated by male writers, readers and fans in the early years, speculative fiction has always provided multiple sites of resistance for the feminine, and in the last three decades has become an arena of serious ideological discussion and disruption.[2] By the late 1970's, female fans were appropriating SF male/male, 'buddy' television representations of masculinity and creating the slash writing phenomena,[3] while Alice Sheldon was storming future reality

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1 Rose, *Love, Power and Knowledge*, 228.

2 Lefanu, *In the Chinks of the World Machine;* Merrick, 'Feminist/Science/Fictions'; Larbalestier, *The Battle of the Sexes in Science Fiction.* These are examples of texts that look at women in the history of sf writing.

3 *Star Trek*'s Captain Kirk and Mr Spock were the first characters to be appropriated and rewritten as sexual partners, others followed such as Bodie and Doyle from *The Professionals* and Starsky and Hutch, from the series of that name. Stories varied from light romance to highly erotic homosexual encounters. The original stories were hand duplicated for a small, specific audience and were quite hard to obtain, but the web has led to an explosion of slash stories which now encompass many relationships in film, TV and literature with a fan following. Commentary and analysis of this genre can be found in Henry Jenkins, *Textual Poachers: Television Fans and Participatory Culture* (London: Routledge, 1992); Camille Bacon-Smith, *Enterprising Women: Television Fandom and the Creation of Popular Myth* (Philadelphia: University of Pennsylvania Press, 1992); Constance Penley, 'Brownian Motion: Women, Tactics and Technology' in *Technoculture*, ed. Constance Penley and Andrew Ross (Minneapolis: University of Minnesota Press, 1991). Also, any reader should be aware that slash writers do not necessarily accept these critical authorities and debate has been intense and extended within the community of writers themselves.

studios with her 'ineluctibly masculine' stories.[4] Tiptree wrote like Hemingway with the heart of a feminist, and her story 'The girl who was plugged in' and Joanna Russ's book *The Female Man* helped birth the cyberpunk revolution.[5] Female writers like Pat Cadigan and Melissa Scott then invested the 'boy' trends of cyberfiction with new considerations of gender and technology, while C.J. Cherryh and Lois McMaster Bujold began to colonise and subvert the highly masculinised and militarised sub-genre of space opera. Other feminist writers of speculative fiction, such as Janet Kagan, Molly Gloss and Joan Slonczewski, moved towards ecofeminism and began the tasks of re-imagining nature, technology, power and subjectivity.

Critical thinking: ecofeminism, carnival and evolutionary theory

The sub-genre of ecofeminist speculative fiction has a complex and inclusive genealogy, which means many metaphors, theories and discourses can be used to map it. In fact, it is such a labile field that it is helpful to use multiple demarcations in exploring these texts. Critical precedents for this approach can be found in Bakhtin's heteroglossia, which assumes all texts to be culturally polyvocal, and the work of Thomas O. Beebee. Beebee claims all literary work inevitably involves more than one genre, and that real understanding of ideologies in genre must come from a sort of refraction process where one aspect of the work can be illuminated by comparison with another.[6] Following this methodology, this paper uses a number of approaches to demonstrate that ecofeminist science fiction is a literature of change, and the elusive metaphors of change that it uses can be grounded in a science of change – evolution and evolutionary theory. However, mapping the literature of change through the science of change is not a simple exercise in equivalency. Both the literary texts and the science are unstable and are engaged in emergent politics of their own, and both fields carnivalise bodies, environments and interactions in unpredictable and subversive ways. Ecofeminist speculative fiction becomes carnivalised in its narrative

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4 James Tiptree Jr., *Warm Worlds and Otherwise* (New York: Ballantine, 1975), xii. Robert Silverberg made a now famous error by stating categorically in the introduction to this volume, when speculating about the mysterious author's identity, that James Tiptree Jr could not be female: 'It has been suggested that Tiptree is female, a theory that I find absurd, for there is to me something ineluctably masculine about Tiptree's writing. I don't think the novels of Jane Austen could have been written by a man nor the stories of Ernest Hemingway by a women, and in the same way I believe the author of the James Tiptree stories is male . . . And there is, too, that prevailing masculinity about both of them [Hemingway and Tiptree] - that preoccupation with questions of courage, with absolute values, with the mysteries and passions of life and death as revealed by extreme physical tests, by pain and suffering and loss.'

5 Takayuki Tatsumi, 'Some *Real* Mothers: An Interview with Samuel R. Delany', *Science Fiction Eye* 1, no. 3 (1988) 5-11.

6 Beebee, *The Ideology of Genre*, 279.

drives to construct non-patriarchal, inclusive, polyvocal, non-polarised social and cultural models, while evolutionary theory is carnivalised as it struggles to move past genocentric, neo-Darwinist orthodoxy into respecting multiple, partial, and sometimes competing, scientific views on change and the organism. That all of this can be suggested in creative textual environments foreshadows hopeful new unities between arts and science, and demands careful attention be paid to both speculative, feminist stories and the plastic, useful field of speculative ecofeminism.

Ecofeminism currently has no singular definition due to its extensive cooption into many areas of academic theory and environmental practice, but according to Karen Warren it explores and responds to a variety of woman-nature connections. She argues that ecofeminisms proliferate in a similar way to feminisms, sometimes offering competing and sometimes complementary readings of text and experience. Ecofeminism embraces practical and empirical linkages of people of colour, women, children and environmental issues, with a particular emphasis on first world/third world/indigenous relationships, but it also includes historical ecofeminisms that speculate on matrifocal pre-agrarianianism and the rise of patriarchal culture. Conceptual ecofeminisms, on the other hand, focus on western dualistic thinking (male/female, culture/nature, reason/emotion etc.) that supports value hierarchies which extend exploitation and domination within a number of social frameworks, such as race, gender and environment.[7] While the latter has particular relevance in relation to science and its critiques, none of the ecofeminisms can be entirely divorced from each other or from the symbolic realm where the connections between women and nature are extended into religion, philosophy, art and literature.

Both ecofeminism and carnival can be difficult to track, but their inclusion of non-human, grotesque and transgressive bodies is a significant marker of change from normative, self-replicating, closed systems to open systems that celebrate and/or include difference. Mary Russo uses carnival to give a specifically embodied picture of boundary dissolution that closely reflects the non-realist imaginings of ecofeminist science fictional biologies and cultures:

> The grotesque body was exuberantly and democratically open and inclusive of all possibilities. Boundaries between individuals and society, between genders, between species, and between classes were

7 Karen Warren, 'Introduction [Ecofeminism and Social Justice]', in *Environmental Philosophy: From Animal Rights to Radical Ecology*, ed. Michael E. Zimmerman et al (Englewood Cliffs, NJ: Prentice-Hall, 1993) 263-277; Karen Warren, 'Ecological Feminist Philosophies: An Overview of the Issues', in her *Ecological Feminist Philosophies* (Bloomington: University of Indiana Press, 1996), x-xix.

> blurred and brought into crisis in the inversions and hyperbole of carnivalesque representation. [8]

Carnival, according to Russo, implicates class, gender and species, and designates all living bodies as cultural and political landscapes. Without invoking carnival, Donna Haraway uses the concept of the cyborg in a similar fashion as she critiques science as a story telling discourse, the stories told depending on historical context and disciplinary precedent.[9] Through her writings, the temporal and spatial boundaries of bodies are revised and hybrid bodies are reinscribed as organic/organic, organic/technological and visible/invisible hybrids. Containing and using technological, biological, creative, academic and political narratives, ecofeminist science fiction and science and literary critique then engage with both carnivalised narratives and bodies, laying down revitalised understandings of corporeality and culture.

Another reason carnival and ecofeminism intertwine as theory in this paper is their usefulness in explaining material and fictional instabilities that result when dualisms collapse into non-oppositional narratives and experiences. Binaries feed a Western historical sense of order, and their dissolution generates a level of chaos as previously unarticulated options emerge. Chaos rarely feels attractive or safe, and inevitably breeds anxiety-based backlashes and fundamentalisms that have their roots in attempts to restore dualistic orders. However, such a carnival environment is also likely to nourish irony, a sense of play, and even at times – as the Australian writer David Tacey suggests[10] – a sense of the sacred. Mikhail Bakhtin expresses the potential of carnival another way: he labels the dissolution of boundaries as a potential site in which old ideas may be critiqued and new ideas floated.

> The principle of laughter and the carnival spirit on which the grotesque is based ....destroys limited seriousness and all pretense of an extratemporal meaning and unconditional value of necessity. It frees human consciousness, thought and imagination for new potentialities. For this reason great changes, even in the field of science are always preceded by a certain carnival consciousness ... [11]

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8 Russo, *The Female Grotesque*, 79.
9 Haraway, *Simians, Cyborgs and Women.*
10 David Tacey, *Re-enchantment: The New Australian Spirituality* (Sydney: Harper Collins, 2000). Tacey argues that the spiritual values which used to be associated with church and formal religion has been displaced into creative arts such as writing. This displacement of values may be reflected in other institutions and activities in times of carnival.
11 Bakhtin, *Rabelais and His World*, 49.

That Bakhtin singles out science within carnival, and that science is a significant strand in science fiction is of particular relevance to speculative ecofeminist texts.[12] In ecofeminist science fiction, concepts of nature often take centre-stage as cultural double talk of fecundity and predation are deciphered and altered. The biological world is no longer simply 'red in tooth and claw', but neither is it a luminous and perfect goddess to be worshipped. It becomes something more complex than a site of displaced ideals and fears. The relationship of humans to non-human life and the environment, the role of material culture and technology in the world, constructions of human consciousness and non-human subjectivities, and the weave of the geological and life history of the planet are all threads in both science and science fiction. Needless to say, when all these important tenets of cultural understanding are reimagined, the resultant writings can appear anarchic and even intimidating, but they can also provide an ideal arena for deconstructing historical and current mind-sets and can act as a site for the potential reconstruction of new understandings, attitudes and beliefs.

This paper recognises a certain sub-genre of feminist speculative fiction as a subversive, carnivalised literature with ecofeminist potential, and connects that fiction to a carnivalised 'post neo-Darwinist' science of change and evolutionary theory, again replete with its own ecofeminist potential. In analysis, these two diverse discourses use surprisingly similar metaphors of social and biological change, models that move away from Darwinist and neo-Darwinist models of evolution towards a very different paradigm. The 'post neo-Darwinist' approach includes attributing agency to the organism, primarily through a sense of self-organisation, rather than seeing it as a passive unit acted upon by natural selection; it also insists upon including historical and current environmental contexts as a way of understanding the responsive and interactive organism. Speed of change is an issue in evolution, as is the permeability of the genome and the emphasis placed on cooperation and symbiosis, as opposed to competition. These are complex ideas, thus the section of this paper offering a more detailed overview of the particular sciences and theories that are acting to destabilise genocentric natural selection is integrated with a case study of an ecofeminist speculative fiction novel. Joan Slonczewski's *The Children Star* [13] illustrates, through its narrative forms and conventions as much as by its subject matter, how a work of

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12 Aldiss, *Trillion Year Spree* and Holquist, *Dialogism*; Aldiss argues that Shelley's *Frankenstein* is germinal to science fiction, while Holquist proposes it as the poster text for carnival theory.

13 Joan Slonczewski, *The Children Star* (New York: Tor, 1999).

fiction can imagine the extremities of carnival bodies and thinking, remap nature, humanity and technology and simultaneously model biological and social change.

Biotexts and changing worlds

Slonczewski's novel comes out of a tradition that began more than three decades ago. Feminist science fictions of the 1970's were, of course, the seed texts of the sub-genre of ecofeminist science fiction writing. Russ's anti-utopian *We Who are About to...*[14] points out the necessity of culture mediating nature, parodies twentieth century cultural arrogance with regard to the natural world and makes women dealers of death rather than givers of life. Marge Piercy's *Woman on the Edge of Time*[15] refuses to cede language, social process and technology to the masculine scientific military complex, using it instead to democratise verbal communication and reproduction, which in turn reframes community and nature. And finally Ursula Le Guin fuses feminism and post-colonial politics in *The Word for World is Forest*[16], a parable of the Vietnam war where the focus is a jungle destroyed and its indigenous peoples murdered and raped. These germinal texts went on to spawn more eco-writers, such as Nicola Griffiths, Elizabeth Moon, Janet Kagan, and Julia Ecklar , who use feminism and sexual politics as a base from which to address complex agendas of technology, science, education and conservation.

While these writers are all distinctive, they exhibit similar approaches to issues as diverse as disease, aging, genetic manipulation, habitat destruction and urban dislocation (once again, to name only a few!). Despite the carnivalisation of topics and bodies in their works, they share certain qualities that identify their writings as ecofeminist. Their work commonly undermines hero centred narratives by either offering a number of speaking positions within the book, having a plethora of characters (often grotesque or unusual in appearance), or they break the hero mould by making their central characters old, sexually alternative, ill or alien. Reproduction and/or the preservation of resources are also thematically central to the text and they often collapse traditional hierarchies of knowledge. Examples of this are found in Janet Kagan's *Mirabile*[17], where education is completely informal and genetic splicing is family fun time, and in Helen Collins *Mutagenesis*[18], where food production and

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14 Joanna Russ, *We Who Are About To ...* (London: Methuen, 1975).
15 Marge Piercy, *Woman on the Edge of Time* (London: The Women's Press, 1989).
16 Ursula Le Guin, *The Word for World is Forest* (New York: Ace Books, 1989).
17 Janet Kagan, *Mirabile* (New York: Tor Books, 1991).
18 Helen Collins, *Mutagenesis* (New York: Tor Books, 1992).

human reproduction are intensively scientifically managed and result in a complete loss of biodiversity.

Again, what is particularly interesting about this group of authors is their use and development of metaphors of change. These are so non-linear and variable that in themselves they become a marker of carnival and ecofeminism, with biological and cultural change often enmeshed, multifaceted and unpredictable. This does not mean ecofeminist science fiction refuses to tip its hat to the metanarrative of Darwinism when exploring biological possibilities, it just indicates a refusal to confine itself to linear Darwinist and neo-Darwinist templates of gradualism, genocentrism, random mutation and 'survival of the fittest'.

Co-existence can take many forms, social and biological, and does so in *The Children Star.* In this novel, the planet Prokaryon is chemically hostile to human habitation but it is desperately needed to cope with the pressingly large human population of The Fold. The issue is whether the existing ecology should be eradicated for humans to use the planet or not. Signalling its primary concern with environmental issues, the story then develops into a complex narrative of vested interests that vary from corporate colonialism to spiritually driven conservation politics. In Slonczewski's universe, machines become aware, buying their own freedom, and the traditional human form varies from the gorilla-like inhabitants of Urulan to the almost immortal, immeasurably wealthy, unspeakably beautiful people of Elysium. At the commencement of the story, humans have to be 'lifeshaped' by nano machines to be able to live on Prokaryon but it is prohibitively expensive, so mostly it is done by a dedicated religious order, as opposed to the secular governments who rule the many worlds of The Fold. The religious order is particularly concerned with saving, lifeshaping and resettling orphan L'liite babies who live on a planet blighted with disease.

Part of this narrative is easily recognisable as an allegory of current first world/third world politics, the advent of AIDS and the competing needs and interests of groups such as big business and conservationists, but other aspects of the narrative are more subtle. Because the writer develops multiple stories within the novel, the reader is not allowed to form attachment to any particular character or viewpoint, thus the focus of the text, via multiple viewpoints, is the planet Prokaryon itself and its problematic life forms. The text is biocentric, and with sentient machines and articulate microbes it

conforms to an important requirement of ecofeminist literature where non-human actors and characters are brought into prominence alongside human ones.[19]

Nor is humanity constituted in unchallenged ways in this book, rather it presents as a carnival of bodies, conditions and cultures. Evolution has occurred between populations that have split from similar root stock and been subjected to different environments. Sarai is a Sharer who comes from an ocean planet. She has purple skin filled with breathmicrobes, webbed hands and utilises 'click flies' for distance communication and vegetation for medicine and scientific research. Khral is a descendant of gorilla-hybrid slaves, and Verid Anaeas*hon* is a virtually immortal Elysian citizen from a floating city of gene-perfect children. Among the children of the spirit-colony, little Gaea has a spinal deformity that means she cannot walk, while 'jum seems to have Asperger's syndrome. Gender is not simple either. Brother Rod is coded feminine, subordinate as he is to the Reverend Mother, a nanoplast sentient, and his primary work is caretaking babies and small children. Verid Anaes*hon* holds the most powerful position possible among the many worlds of The Fold, her partner is female and her 'parent' in the communal nursery of *Shon*sibs was the Reverend Mother. Cultures are just as varied, ranging from the impoverished, threatened subsistence of the Spirit Colony, through the already terraformed Bronzesky, whose peoples seem to be simultaneously indigenous and scientifically literate, through to Elysium where human interaction with the world is completely mediated by technology, and illness and deprivation are unknown.

The driver of the narrative is ecological concern and a growing awareness of the non-human 'other'. Although Prokaryon is toxic to humans, there is an initial reluctance to terraform the planet because the humans of The Fold have finally become aware of the price of thoughtless development. They know that ignorantly 'cleansing' a place to make it fit for them has left a legacy of previously unrealised losses. Now they are more cautious, despite the desperate need to open new territory to help with overpopulation. Slonczewski deals with this issue delicately: the diverse and unusual environment is important but so are the humans, particularly the infants in the care of the small spirit colony. She is, however, careful to shepherd the reader through competing interests without sentimentalising either the human babies or the relatively undisturbed environments of Prokaryon. Instead she reveals them all as difficult, needy, worthy of protection, having intrinsic value and having agency and power.

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19 Murphy, 'Ground, Pivot, Motion', 146-161; 'Ecofeminism and Postmodernism', 41-60; *Literature, Nature and Other*.

Everything and everyone speaks in Slonczewski's universe, from money and machines to the microbial beings that prove, ironically, to be the most powerful force on Prokaryon, and possibly in the universe. The intelligent life-form that is at stake in the terraforming of Prokaryon is a microzoöide that conceals itself and colonises the colonisers before they realise it. This dramatically shifts the balance of power in the narrative. Even the immortal, continuously self-repairing Elysians cannot defend themselves against the microbe, which displays different features in every host. By the end of the story, the communicative microorganism holds the universe hostage with the threat of an aggressive epidemic, it prevents the terraforming of Prokaryon, yet it also demonstrates a paradoxical ability to assist other species in the settlement of the planet.

'Post neo-Darwinism'

Inevitably change does come to Prokaryon. And it comes fast, echoing the challenge to Darwinian gradualism of Punctuated Equilibrium. Three decades ago, Punctuated Equilibrium was proposed in an article by paleantologists Stephen Jay Gould and Niles Eldredge.[20] In the article, Gould and Eldredge argue against perpetual steady change in a given population, positing instead rapid periods of change, most likely to occur in geographically separated colonies that then form 'daughter' species. Slonczewski's book represents different rates of biological change, contrasting the mammalian hosts with their microbial hitch-hikers. Changes occur very quickly in the discrete microbe populations as they grow at the rate of a generation per human day, and the interaction they have with their particular environment (host) is vitally important in how they change. The resultant domino effect is that all organisms in the text are forced into rapid reorganisation, biologically and/or socially. Suddenly the humans of the Fold are confronted with a problem that will significantly and unpredictably affect bodies and cultures. Change is inevitable, and in this case shockingly rapid.

By using a microorganism, rather than a macroorganism, Slonczewski may be thought to sidestep the heart of the debate on Punctuated Equilibrium. After all, the microzoöids can be relegated to being part of the environment of the humans, rather than regarded as entities in their own evolutionary right. This is not the way it works. Rather, Slonczewski makes a complicated statement by using the microscopic entity;

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20 Gould and Eldredge, 'Punctuated Equilibria: An Alternative to Phyletic Gradualism,' 193-223.

she reminds her readers of the power and extent of life that is out of their field of vision, but persuades them not to see the microbes simply as antibiotic fodder by involving the reader in the puzzle of their nature and their means of communication. Khral describes them to Rod in a way that gives them the same status as larger life forms:

> 'They're large cells, about the size of an ameba [sic]. Your own body cells each store six billion 'letters' of DNA – and that's just a linear molecule. Each microzoöid stores a sentients worth of molecular connections. The molecules can donate or pick up electrons, acting as AND gates or OR gates. Some are switched on by light. A single microzoöid can pack fifty trillion connections, about the number of synapses in a human brain'.[21]

Donna Haraway writes about the 'totalising' discourses of scientific authority and their narrow and obscured vision, and she says the antidote is 'partial, locatable, critical knowledges'. [22] The world that has been shrunk to an adaptationist paradigm is the product of a totalising discourse, and would respond to the microzoöid problem as an issue of natural selection. So gradualism might take a bit of a blow when the virulent microbe escapes one environment and spreads, but in the end survival will still be about immune systems, and perhaps a little about money and luck. However, Slonczewski clearly contrasts this microbe, which can control its host, has a voice and can build its own communities, with the unambiguously fatal creeping sickness on the planet L'li. This situation, she says, unequivocally is an ethical story and requires ethical responses. Thus this life form becomes particularised and contextualised within the community of microscopic life and it offers a challenge to macroevolutionary stories that automatically separate the visible from the invisible. The microzoöids do not represent rapid evolutionary change just because they threaten human life, rather they sit at the centre of their own experience of rapid evolutionary change as they become sentient and exercise control over their environments, which incidentally happen to include human bodies.

Supplementing Punctuated Equilibrium, which is enmeshed with Darwinism, there are a number of other evolutionary theories that can be also be read both as biological and literary metaphors. One of the most significant models of co-existence and interactivity in biology does not come directly from the area of evolutionary theory,

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21 Slonczewski, *The Children Star*, 184.
22 Haraway, *Simians, Cyborgs and Women*, 191.

but bears strongly on any study of the process of biological change. Serial Endosymbiosis Theory (SET) contends that symbiogenesis forms the basis of the web of life and accounts for the variety of life on the planet earth and that this process 'brings together unlike individuals to make large, more complex entities'.[23] DNA was not invented, according to Lynn Margulis, it was incorporated – probably originally from bacteria into protist life forms, and from there it grew, in neo-Lamarckian leaps,[24] into larger, more differentiated organic forms. This symbiotic, co-operative view of biological change presents a very different model from the neo-Darwinian competitive view, and it also, by necessity, introduces complex notions of interactivity between the component parts of the organism, and the organism and its environment. Both in this biological paradigm and in the fictional world of *The Children Star,* the Wiessman barrier,[25] originally thought to ensure the germ cells (reproductive cells of an organism) remain unaltered by somatic change, is compromised. Organisms do not remain genetically pure and discrete, in both the SET theory and in carnival they are seen as multiple, invaded and changeable. All organisms are shown to be constituted of various levels of living entities; however, where science articulates on unseen organisms within bodies of larger organisms through an impersonal, objectifying discourse, Slonciewski chooses to give the microbes, and therefore the living multiplicities, their own voices. This is a rewriting of notions of biological relationship and agency.

Neo-Lamarckianism or epigenetics are the general labels given to theories that claim an organism has a reciprocal relationship with its environment. While being an active marker for both ecofeminism and carnival, these notions are radical disruptors of Darwinist and neo-Darwinist thought. Examples of neo-Lamarckianism from current science include Australian Ted Steele's work with the immune system which suggests the cells of the immune system change in response to the environment and are then

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23 Margulis, *The Symbiotic Planet*, 12.
24 Ibid, 36-37.
25 Weismann was a natural scientist dedicated to proving the impossibility of Lamarck's notions of biological evolution. He demanded empirical proof that soma could affect germline and produce inheritable characteristics, and pursued this end by doing experiments such as cutting tails off twenty-two generations of mice to see if the next generation came without tails. None did. He did not lay his theory down as law, saying that it could be disproved with new information, but the newly developed science of genetics adopted it as a dogma. Thus the Weisman barrier is now an integral part of theories of heritability and change that are difficult to challenge. See Smith, 'Weismann and Modern Biology', in *Evolution*, ed. Ridley; Reid, *Biological Emergences*; and Pollard, 'Is Weissmann's Barrier Absolute', in *Beyond Neo-Darwinism,* ed. Ho and Saunders, 573-591.

heritable in their changed structure.[26] Work by Mae Wan Ho showcases other examples of non-mendelian change in organisms, suggesting fruit fly genes can be altered in a heritable manner by chemical agents such as DDT, and that the same genetic plant material can produce altered phenotypes, and even genotypes in different environments that pass on adaptations.[27] The fruitfly findings can be classed as teratogeny, the making of monsters, but the scientific existence of generational, heritable change through human immune systems and flax plants cannot be denied, nor can the wealth of information on lifelong epigenetic modifications to the organism, some of which can effect future generations.

In world war two, Dutch women experienced famine and those who were pregnant gave birth to low weight babies. This was an epigenetic effect, the environment altered the physiological standards for that group of women in a way that was to be expected. However, there was an unanticipated consequence. Those babies then went on to also produce low birth weight babies despite being well nourished throughout their own lives and pregnancies.[28] What mechanism or affect unexpectedly activated that warned the organism that survival depended on conserving or needing less? The answers to puzzles of intergenerational change are not easy, and they represent further breaches of the scientific argument that genetic change cannot occur in response to environmental prompts and is not - should it happen - heritable. Meanwhile, as the scientific establishment moves slowly to negotiate divisions on these issues, fiction such as *The Children Star* prepares a pathway for public consideration and acceptance of these models. Slonczewski's parameters of change certainly include neo-Lamarckian responses, as the planet-bound microbe populations alter their new human hosts to adjust to the toxicity of Prokaryon. This is the clearest example of neo-Lamarckianism and epigenetics in the book, because without the 'lifeshaping' provided by the microzoöids, human beings and their offspring would have great difficulty surviving on the poisonous planet.

Protobiogenesis is the search for the chemical origins of life. Sidney Fox, researcher and scientist, has modelled the synthesising amino acids from heat and water as it is suspected that hot springs and geysers were actually the places where life was generated on earth.[29] His results were unexpected in terms of the current Darwinian model, including the unexpected priority that proteins assumed over DNA. In his

26 Steele et al, *Lamarck's Signature.*
27 Ho, 'On Not Holding Nature Still', in *Evolutionary Processes and Metaphors,* ed. Ho and Fox, 117-144.
28 Gail Vines, 'Hidden Inheritance', *New Scientist* 160, no. 2162. 28 November (1998), 27.
29 Fox, 'Proteinoid Experiments and Evolutionary Theory', 15-60.

experiments protocells formed easily and in large numbers and they showed a ready tendency to communicate chemically with their environment, albeit in a restricted range of the combinations that were actually available to them. All of this is contradictory to the neo-Darwinian expectation that cellular evolution would be DNA driven, slow, difficult and tenuous (gradualism, random mutation and selection). Fox interprets his macromolecules as 'self-organising' and considers them a prompt to rethink macroevolution as a random process. The protocells were self-directed, populous, and interactive, all features of the fictionalised microzoöids in *The Children Star*, and present a model of change that suggests interactivity, agency of the organism (whatever its size or complexity) and pathways that enhance certain predictable processes and even anticipate quite particular morphologies. Fox's findings also act as a cautionary tale about the backward engineering of events that current evolutionary approaches indulge. The current model didn't work when anticipating pre-cellular development, and Slonczewski's story warns that the current neo-Darwinist model is unlikely to be sufficient as knowledge of bodies, human and other, and environments, built and other, grow and become more complex.

Panbiogeography is yet another maverick evolutionary marker evident in this fictional work. Leon Croizat's model of mapping plant and animal species extends Darwinian biogeography by integrating biology with geology, thereby giving a diachronic dimension to species distribution as well as a synchronic charting. [30] Darwinism concentrates on centres of origin and random dispersal of species from the centre through populations controlled by 'natural selection'. Panbiogeography, however, tracks taxa and biota through time as well as space by simultaneously reading geological and biological change. That is, panbiogeography is a three dimensional model of change, where time, space and morphology are understood as relationships not categories. It is a system that led Croizat to state that 'earth and life evolve together',[31] a position which refuses the traditional Darwinian separation of organism and environment.

It is a big task for a work of fiction to transmit this complex notion, but Slonczewski works this theory as metaphor in *The Children Star*. The principles of panbiogeography are enacted through the microbes of the story. Originally the microbes colonise tumbleweeds, leathery, mobile vegetation, and the herbivores known as 'four eyes' on Prokaryon; however, when humans come to the planet they

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30 Craw and Page, 'Panbiogeography: Method and Metaphor in the New Biogeography', 163-189.
31 Ibid, 182.

present another territory for the microbes, one that the intelligent microzoöids can use to colonise the stars. Because the microzoöids replicate every half an hour within their host, each colony – be it tumbleweed, four eyes or human – experiences many generations growth over relatively short spaces of time and each colony exhibits very different qualities. Similarities which can be detected across all the microbes speak to a common origin, but by the time populations have taken root and colonised a variety of hosts a number of other factors have come into play, namely time of occupation, place of occupation and the nature of the interaction between host and microbe population. It is a powerful fictionalised representation of Croizat's model using reciprocal constraints of time, separation of populations, developing characteristics of isolated populations and the interactivity of an organic population with its environment. In broader strokes, the differences between human populations are also done in a similar way: In The Fold there have been significant changes in the populations of Urulan (gorilla hybrids), Shora (semi-aquatic), and Elysium (longevity), while Bronzeskyan's and l'Lillites seem similar and have not differentiated noticeably yet. This speaks not only to them as gene populations, but to their interplanetary history.

As scientific stories compete to shape the complex narrative of evolution, frameworks move from the chemical minutiae of prebiotics, the labile genome in neo-Lamarckianism and symbiogenesis in SET, to the larger frameworks of habitats and continents in panbiogeography, to planetary dimensions in Gaia theory. Gaia was created by James Lovelock when he was invited to contribute to a scientific team in Houston exploring life on Mars.[32] He suggested studying atmospheric entropy rather than soil sampling as a better indicator of planetary organic process. His idea was rejected, but it inspired him to turn his attention to the earth's atmosphere. This led to his claim that the earth is a living organism due to the constancy of the reactive gases in the lower atmosphere and planetary thermoregulation, which has maintained a steady, quite small range of temperature over billions of years.

> One of the most characteristic properties of all living organisms, from the smallest to the largest, is their capacity to develop, operate and maintain systems which set a goal and then strive to achieve it through the cybernetic process of trial and error. The discovery of such a system, operating on a global scale and having as its goal the establishment and maintenance of optimum physical and chemical

32 Lovelock, *Homage to Gaia.*

conditions for life, would surely provide us with convincing evidence of Gaia's existence.[33]

While Slonczewski does not specifically draw on this part of Gaia, she does use some of the science that supplements the theory to support her tale about microbial planetary 'masters'. The sulphur cycle is one of the stories developed within Gaia. Understood originally simply as a constituent atmospheric gas, dimethyl sulphide is actually an agent in the biosphere contributing to the creation of oceanic clouds. Lovelock and atmospheric scientist, Robert Charlson, provided the first insight into this process. Covering seventy per cent of the surface of the Earth, oceans are dark and absorb sunlight, while clouds are white and reflect sunlight. Without oceanic cloud, the planet would be about twenty degrees hotter, an environment that would not sustain life. Over land masses, sulphur is readily available to seed clouds in dust particles and so on, but it is a different story over the open ocean. Their question was, what provides their suphuric acid and ammonium sulphate nucleii? The answer is algae. The sulphur cycle relies upon ocean algae and their emission of dimethyl sulphide.[34] Dorion Sagan elaborates further on producers of oceanic sulphide, *Phaeocystis* and *Emiliania*, and the historic primacy of sulphur producing microbes. Sulphur producing bacteria preceded cyanobacteria (oxygen producing bacteria) and even now form an important layer in acre upon acre of microbial mats that flourish in marine muds, warm springs, marshes, and salt ponds and lakes.[35]

Slonzcewski creates an ecosystem of plants, animals and insects, with the microzoöids as the active microscopic element. She then endows the 'micromen' with

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33 Ibid, 49-50.
34 Ibid, 255-6.
35 Sagan, 'The Global Sulfur Cycle and *Emiliania Huxley*', in *Slanted Truths*, ed. Margulis and Sagan, 159-170. See also Lovelock, *Homage to Gaia*, 246. Lovelock refers to a trip he took with Lynn Margulis to the Baja Peninsula in Mexico. 'Along the edges of the continents, earth movement and the drifting of sand and shingle forms lagoons that trap ocean water. In the warmer parts of the world, these lagoons lose more water by evaporation than they gain from rainfall or from seawater leaking in from the ocean. Consequently, the salt in the water concentrates until it crystallizes to form what the geologists call an evaporative deposit. This process has been going on since the beginning of time and we find evaporite beds buried under sediments all over the world. They form the huge salt deposits, like the one that runs across northern Europe a few hundred feet below the surface and is made notorious by the salt mines of Eastern Europe. The algal mats sit on top of these evaporite beds. Lynn, her student, Greg Hinkel, and I speculated about the role of these mats in sustaining salt in the beds, and so keeping the ocean below the critical salt level of 0.8 molar. Above this salinity, organisms find it hard to survive. I watched as Lynn cut out with a small spade a cube of the mat four inches in size. We looked at its banded structure: each band was a different community of micro-organisms segregated according to the flow of nutrients and oxygen. Lynn showed how similar was this banded structure to that of the fossil mats over two billion years old. I was convinced by her lucid explanations that micro-organisms are the heart of Gaia and always have been.'

intelligence and the capacity to evolve and develop cultures within their living worlds. A large part of the interest generated in the microbe actions comes from their colonisation of human bodies; however, they manifest in other bodies and beyond the specific bodies of their hosts. Khral tells Rod the microbes are transmitted by the 'whirrs' into the stratosphere where they probably seed the clouds.[36] Prokaryon is then finally defended against cleansing and terraforming by weather, particularly storm clouds, acting as a direct weapon against the ships that try to approach. Lovelock and Slonczewski thus both promote models of large scale climatic self-regulation by microscopic life forms – Lovelock through his scientific model of a cybernetic, homeostatic system and Slonczewski through her fictional narrative of an alternative, connected, planetary consciousness.

Extending the Gaia theory Dorion Sagan answers Richard Dawkin's criticism that a living planet would have to be capable of reproduction, by suggesting the human conception and construction of biospheres and planetary terraforming is a form of planetary procreation.[37] Although the main focus of *The Children Star* is on the microbes controlling the microworlds of human bodies, there is nothing to suggest that they could not colonise entire planets and control them in ways similar to the way they control Prokaryon. Such novel thinking not only makes the possibility of something beyond a clockwork world conceivable in western science, it gives Slonczewski's narrative a strange reversible perspective. The humans of the fold, have already previously terraformed planets, thereby extending their habitats and emulating their original environment(s). Now, suffering qualms about the cost of such reproduction, they are more cautious in their approach to Prokaryon. In an ironic, carnivalistic twist, they encounter an evolving life form interested in colonising other worlds and not at first recognising the costs.

Conclusion

In some respects Slonczewski is exceptional in her SF writing because she herself is a molecular biologist and her work is often informed by very specific scientific information. In *The Children Star* she presents opportunities for consideration of, and responses to, the ethics and applications of science and technology such as cell biology, AI, immune system research, disease management and the interface of technologies and environments. She also certainly models a number of 'post neo-

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36 Slonczewski, *The Children Star,* 185.
37 Sagan, 'What Narcissus Saw: the Oceanic "Eye"', in *Slanted Truths,* ed. Margulis and Sagan, 185-200.

Darwinist' scientific theories of evolution for those not privileged to read within the academy, or perhaps for those who read within the academy but whose syllabuses limit the appreciation of the biological to well worn, uninterrogated pathways. Beyond this, however, she practices narrative techniques that centralise 'others', such as women, children, non-human life forms and sentient machines, just as she holds to baseline ethics of environmental respect and promotes active, ongoing interaction across every social, cultural and biological barrier.

To appreciate Slonczewski and other speculative writers as ecofeminist is not to say they solve the great dilemmas of environmental connection and usage, but rather to say they provide narrative pathways through the difficulties presented by the complex, sometimes confusing, needs and investments of a carnival culture. In this respect, the conclusion of *The Children Star* presents both strategic new unities and the ongoing open-ended dialogism that Patrick Murphy supports as a feature of ecofeminist fiction. Some aspects of the story resolve: for example the celibate, spiritual Brother Rod forms a romantic partnership with the simian scientist Krahl, thus symbolically ending the Cartesian dualism of mind and body. However, many aspects of the story are left open: the battle for freedom continues for sentients, l'Lillites still desperately need a cure for the creeping plague; and Spirit Colonies continue to struggle for resources that save but a few of the many needy children of The Fold. The opening up of Prokaryon offers a temporary solution to the pressures of refugees, but overcrowding will come again with increasing populations, while the relationships between the microbes of Prokaryon and humans are extremely complex and far from being resolved. And, of course, governing every decision that affects the many different interest groups and life forms in Slonczewski's universe is the imperial politics and economics of the superpower, Elysium.

Ecofeminist speculative fiction is a literature that creates and naturalises carnival. These narratives perform a vital function in their reflection of issues of our rapidly changing times as we rethink, renegotiate and reconceptualise how we live, where we live, why we live the way we do, and who we are. This may sound alarming to those who privilege traditional literary writing texts and 'value free' science above inversions, subversions and conversions, but the negotiation of new values and meaning in significant discourses cannot be postponed. As the canon fails and critical theories generate a worrying paralysis, moving activism 'off the streets and into the

salons',[38] western culture needs rich, accessible textual environments in which to rework crucial cultural problems. Ecofeminist stories provide a much needed space for floating both existing issues and potential solutions to those issues, while creating alternatives to fundamentalism and confusion. And it would certainly appear this literature truly functions as the invaluable 'dream factory' of the opening quote, when it offers a place where we can do test runs on what it could be like if a culturally central theory such as Darwinism failed, or how we could write scientific and fictional narratives to reflect a genuinely polyvocal universe.

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38 Ariel Salleh, *Ecofeminism as Politics: Nature, Marx and the Postmodern* (London and New York: Zed Books, 1997), xi.

Chapter 8
Castaway: Carnival and Sociobiological Satire in *We Who Are About To...*

[To be published in *On Joanna Russ*, ed Farah Mendelsohn (Middletown, CT: Wesleyan Press, forthcoming).]

Introduction

We Who Are About To... is an sf story of a doomed group of castaways, a 'lifeboat population' stranded on a tagged but uncharted planet.[1] It is also a dark tale about physical vulnerability and the failure of social identity and power. Eight characters, from very different backgrounds, suddenly lose context and/or authority. The millionaire family does not know what to do without money to protect them and the academic finds his particularized and theoretical knowledge useless in a survival situation. They all die, together with a football player, a wannabe government agent and a hooker. The only character that retains power (but not life) in this hopeless situation is the narrator, a member of a despised religious sect and a witch figure. Russ's novel is driven by a feminist politic but it is clear from this story that the author is also interested in the genre because of its 'seams', its potential to represent the irregular, aberrant, subversive and grotesque. This is a carnival text with carnival characters acting to destabilise many of the discourses of late twentieth century mainstream Western culture. Drawing on Mikhail Bakhtin's carnival theory, and Mary Russo's feminist extension of it, this chapter addresses the various subversions of literary forms this work offers, the textual challenges of exploring carnivalized bodies and social identities, and Russ's lampooning of neo-Darwinist stories of science and survival.

The theory of carnival, as first developed by Mikhail Bakhtin in his work on Rabelais, is grounded in medieval spectacle but has considerable relevance to contemporary culture as a critical and philosophical tool. Carnival reveals transgression and subversion in discourse and materiality, particularly in relation to bodies. It also speaks to society, the environment and time in a very different way from both modernism and postmodernism. A broad based and plastic theory, carnival embraces category crisis and provides a 'guerrilla epistemology'[2], similar to that of the cyborg, which undermines the dominant politics of the day, whatever they may be, and transforms currencies of meaning and significance into satire, farce and vulgar humor. Despite criticisms of utopianism, naivety and essentialism, based primarily on

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1 Russ, *We Who Are About To ...* .

2 Peter Hitchcock, 'The Grotesque of the Body Electric', in *Bakhtin and the Human Sciences*, ed. Michael Mayerfield Bell and Michael Gardiner, (London: Sage Publications, 1998), 80.

Bakhtin's uniting of the individual body with the social body and ultimately with the regenerative and fecund body of the planet, the theory of carnival remains relevant. As a tool, many critics who employ carnival express a degree of frustration with it, but they also acknowledge carnival as an antidote to repressive bourgeois and patriarchal values, and concede that its transgressiveness and inclusivity is useful. It is, however, particularly important to recognize the ambivalence of carnival theory with regard to gender.[3]

Rabelais' women are unvoiced and generally portrayed as archetypal figures such as the birthing woman and 'the bride' in popular festive forms.[4] Bakhtin takes his critical cues from Rabelais' work and fails to further follow issues with women and carnival expression. However, Mary Russo extends carnival to address women through carnival and the grotesque. She argues that the male body represents the classic closed and transcendent body, with its connections to rationalism and individualism, while the female is the protruding, secreting, multiple, changing and connected body. The female body, therefore, is 'other' and is more identified with carnival space and time, a space and time needed for cultural rejuvenation and the possibility of real change.

> The figure of the female transgressor as public spectacle is still powerfully resonant, and the possibilities of redeploying this representation as a demystifying or utopian model have not been exhausted.[5].

Russo rehabilitates the feminine through dramatic flight, which she sees as 'a freedom from oppressive bodily containment'. When the hysteric decides to jump or fly, thus escaping a phallocentric world, she reconstitutes herself as central and forces male spectatorship. While this action may mean the literal death of the female subject, it is also, according to Russo, the point where the masculine becomes the liminal, the female subject becomes realized and the arbitrary, imposed boundaries constructed between 'individual and society, between genders, between species, and between classes' become blurred and brought into crisis.[6] Russ's novel is consistent with Russo's feminist interpretation of carnival as she uses the philobatic moment of her

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3 Russo, *The Female Grotesque;* Bauer and McKinstry, *Feminism, Bakhtin and Dialogism*; Michael Mayerfield Bell and Michael Gardiner, ed. *Bakhtin and the Human Sciences: No Last Words* (London: Sage Publications, 1998) on carnival, the cyborg/carnival body and parody. See also Wayne C. Booth, 'Freedom of Interpretation: Bakhtin and the Challenge of Feminist Criticism', *Critical Inquiry*, 9 no. 1 September (1982), 45-76; and Evelyn Cobley, 'Mikhail Bakhtin's Place in Genre Theory,' *Genre* XXI, Fall (1998), 321-338.

4 Bakhtin, *Rabelais and His World*, 204-207, 220-227, 329-331.

5 Russo, *The Female Grotesque*, 61.

6 Ibid, 79.

particular narrator's escape to achieve a feminist critique of text and body, and her other archetypal/universalised characters demonstrate a carnival collapse of social mores and the demystification of many cultural values.

Genre

In the mid 1960s there were two popular television shows about castaways that still have mild cult status. *Gilligan's Island* is a farcical story of a charter boat shipwrecked on an uncharted island. There are seven people aboard the 'S.S. Minnow', stereotyped characters – the captain and his first mate, a sort of Laurel and Hardy team of buffoons; a middle-aged millionaire couple; an abstracted and absentminded professor; a breathy, glamorous starlet and a 'girl-next-door'. The other program, *Lost in Space,* is a family/child centered science fantasy show of weekly encounters with monsters, robots and alien environments. Again, the castaways number seven: the five members of the Robinson family, a 'first mate' who reinforces Professor Robinson's patriarchal authority within the group, and a stowaway, a comic scientist driven by greed and cowardice.[7] The premise of the two shows is similar. They share a certain comic stability as the cultural values of the castaways are transported whole and uninterrogated into the microcosms of the stranded groups. To maintain this stability, any history more detailed than a sketchy story of how the castaways appear in the present location is non-existent, danger is only ever a convention and not truly confronting, and any kind of sexual activity is taboo between members of the group. *We Who Are About To...* takes a similar premise of a castaway group, but then undermines the familiar stories of innocence, timelessness and naturalized social behaviors that are staple to the television shows.

The first lines of the narrator in *We Who Are About To...* are, 'About to die. And so on. We're all going to die'.[8] From this introduction it is clear that the danger to these castaways is immediate and not simply conventional, yet it is not what might traditionally be expected from an alien environment, particularly an alien environment in an sf novel. Conflict occurs when one of the women does not want to have babies and join the other castaways in recreating civilization. She resists and everyone dies. Some die by misadventure and some by her hand, but not before there is an unmasking of certain individual delusions and cultural deceptions. The castaway story is thus

7 There was also a robot in the TV series *Lost in Space*, which was anthropomorphized to some degree and contributed to the farcical relationship between Dr Smith and Will, the youngest Robinson child. The robot's speaking part was limited and much of the humor involving the machine relied on verbal repetitions, difficulties moving or programming problems.
8 Russ, *We Who Are About To ...* , 7.

rewritten with resonances of *The Lord of the Flies*, except that the chaos and murder in this text do not come from unconscious, psychology, but from a darkly celebratory, almost pagan, collusion with inevitable death. The conclusion of the two television series are never contemplated as anything but a possible rescue followed by happy-ever-after, whereas the conclusion of *We Who Are About To* ... is violent and disturbing. Death is the hors d'oevre, just as it will be the main course and the dessert. This is the deliberate carnivalization of a genre from an author skilled in textual criticism and readings:

> I had gotten to the point early on where I could watch the first two minutes of any TV show and know everything that would follow. The patterns became so predictable and so false that after a while you want to play with them, be sacrilegious...you have to be aware of these structures in order to resist them and allow your texts to create a dialogue or dialectic with them.[9]

The undermining of the popular castaway tale is only one of a number of genre challenges issued by this carnival story. Russ also confronts the genre boundaries of the novel itself, the genre of sf, and utopian writing within feminist sf. What is deeply ironic about this process is that she is not only a contributor to these traditions, she also defines them as a critic. Russ uses her knowledge of literary forms and narrative expectation to destabilize the genres she participates in when she writes imaginatively.

According to Bakhtinian dialogic criticism, complex book length stories always contain evidence of multiple discourses, and they defy stability or unity as a form by remaining open. The novel is part of a continuous chain of utterance, inevitably answering previous utterances and generating future utterances.[10] Put in different way, one more allied to carnival theory, the 'novel' body is moving away from formalist unities of time, space and hero centeredness, towards carnivalized, seamed bodies and decentered, ironic subjects.

Russ writes carnival, fully aware of the history of the novel and capitalizing on both conventions of textual form and disruptions to conventions in textual forms, as she floats new possibilities for her reader. In this instance she offers an unidentifiable, anti-heroic, archetypal narrator; a written text masquerading as an audio text, both broken and continuous, reliable and unreliable; and a text with an audience assuming a text

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9 Larry McCaffery, *Across the Wounded Galaxies: Interviews with Contemporary American Science Fiction Writers* (Urbana: University of Illinois Press, 1990), 176-210.
10 Mikhail Bakhtin, *The Dialogic Imagination: Four Essays*, trans. Caryl Emerson and Michael Holquist (Austin: University of Texas Press, 1981).

with no possible audience. Thus, with regard to the novel form itself, Russ enlarges the territory of metafiction with this book, just as she did with *The Female Man*, published in the same year. Both *The Female Man* and *We Who Are About To...* are precocious treatises on their own existence, commentators on their own reception, and parodies of countless prior stories. In the case of *We Who Are About To ...* the satire constellates around western phallocentric traditions of heroism, ingenuity, survival, and biological and cultural imperialism.

If Russ complicates western writing by parodying the novel genre, she further carnivalizes it by working in the sf sub-genre from a feminist standpoint. Sf is, in both form and subject, eminently carnivalistic. Michael Holquist, critical commentator on Bakhtin, nominates Mary Shelley's *Frankenstein* as the poster text for carnival, because it is an important case study of the grotesque body and intertextuality.[11] Shelley's novel is also nominated by Brian Aldiss as the primary science fictional text in the western tradition.[12] It is impressive that carnival and speculative fiction join together in the same historic text, but it is not really a surprise – Holquist says carnival writing and *Frankenstein* are about the 'novel body', and the inevitably historically patched stories we tell, while Aldiss says speculative fiction and *Frankenstein* are about 'our confused state of knowledge'. The emphasis of both is on the seams of the body/text, rather than on an unseamed body/text. Both carnival writing and most sf texts foreground the heteroglossic rather than trying to conceal it, accepting discourses such as politics, history and science as story telling focuses and bodies as inscribed and unruly.

In the common, and often frustrating, process of laying down rules in a rule breaking field, sf is often understood as being allied to other forms of writing, particularly when trying to distinguish speculative fiction from realist fiction or trying to identify its roots. Samuel Delany, for example, compares it to nineteenth century symbolism and identifies good sf as generative of mystical insight,[13] while Darko Suvin sees a relationship between sf and the pastoral and says that, like the pastoral, sf is 'metaempirical and non-naturalistic ... an estranged, literary genre which is not at the same time metaphysical'.[14] When Aldiss identifies *Frankenstein* as the primary sf text,

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11 Holquist, *Dialogism*, 94-106. As well as saying the book is a site for the grotesque, Holquist points out that it is a site of mirrored multiplicity and intertextuality, as it incorporates classical stories, origin myths from different traditions, and literature and science contemporary with the book.

12 Aldiss, *Trillion Year Spree*, 29-65.

13 Delany, *The Jewel Hinged Jaw*, 33-50.

14 Darko Suvin, *Metamorphosis of SF*, 20.

he allies the genre with the gothic, but Russ identifies the genre through function rather than effect. She picks up on another comment by Suvin and elaborates on the 'quasi-medieval', didactic nature of sf that holds the 'idea as hero'.[15] Ironically, where Russ might argue that sf is the relative of medieval didacticism, her particular brand of writing is actually more closely connected to the medieval *subversive* form of carnival. Both medieval mainstream culture and medieval carnival were blunt instruments of ideology, one broadly serving the dominant culture and more formal morality of the church and the other broadly representing the repressed nature-based culture and less regulated moralities of common folk. Carnival depended upon satire, parody, vulgarity and farce as it mocked religious, civil and academic authorities, often showing them as hypocritical, foolish, self-interested, and vulnerable.

Part of Russ's complexity lies with her multiple subversions of western story telling traditions. As a writer and critic, she understands the rich histories and heteroglossic constructions of drama and the novel, but she also understands the social potential of popular fiction and media. *We Who Are About To ...* is a novel and a science fiction story, yet it disrupts both these genres in terms of form and content. This disruption is often attributed to the feminist content of Russ's text, yet the disruptive qualities and powers of the story cannot be isolated to this specific political dimension of the book. Rather, they come out of Russ's refusal to be pious about literary and social institutions of any kind, and her determination to expose cultural vanities, patriarchal and otherwise. If her writing could be explained only as feminist polemic, it could be more readily understood within the critical framework of the very specific tradition of feminist science fiction, a tradition manifesting a field of utopian writings in the same decade that the anti-utopian *We Who Are About To ...* was published.

Russ, as critic, describes this field of imagined worlds where masculinist hierarchies and models of authority are undone. They are:

> classless, without government, ecologically minded, with a strong feeling for the natural world, quasi-tribal in feeling and quasi-familial in structure, [and] the societies of these stories are *sexually permissive* ...[16]

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15 Russ, 'Towards an Aesthetic of SF', 112-119.
16 Joanna Russ, 'Recent Feminist Utopias', in *To Write like a Woman*, 44.

They also exhibit the 'joys of female bonding' and often stage the rescue of a female child. Furthermore, they are reactive and 'very limited in violence.[17] These texts question existing social structures on the basis of a growing awareness of gender inequity, and propose alternatives that vary from nature-focused separatism to complete power reversals.

Russ disrupts this form so effectively because she knows it so intimately. The castaway group in *We Who Are About To...* is far from classless. In fact, their differences in social status are severe and stark, and from the first they snipe at each other. Not just the narrator, who annoys everyone by articulating the hopelessness of the situation, but also Cassie and John Udon, Nathalie and everyone else, and the Grahams as a couple. The situation is far from utopian. Authority is a pivotal issue and cannot be resolved, partly because the assumption of authority, in such a small group is public and therefore tricky, and partly because the covert nature of power is not easy to map and understand in such an unexpected and uncontained situation. Transactions within the group are inevitably unsettled, and sexual permissiveness is subordinated to the futile and embarrassing colonial priority of impregnation, initially enacted between Nathalie and the ailing Victor Graham in an attempt to preserve his sperm, and unaddressed in the taboo construction of nubile, pre-adolescent Lori.

Lori is a particular site of anti-utopian satire, representing as she does, the undermined convention of 'rescued female child'. Her rescue is (in the way of carnival) not simply oppositional and is not anti-utopian just because it is a failure to save. Lori, Valeria Graham tells the narrator proudly, was originally destined to die but Valeria paid for extensive medical work, and Lori ended up costing 'as much money as a small new England state' (93). Lori's life is a testament to Valeria's power, money and cynicism. The girl is a project, an extended investment. She is a toy, bought to keep an already bought husband amused and happy, and her 'café-au-lait' skin brings a resonance of slavery to this costing out of her life. Ironically, therefore, Lori wears many masks in the carnival and some of them are contradictory. She is both a purchase and a saving; she was saved from death before she could not – in this instance – be saved from death; and then she is saved as a genetic treasure (despite her medically suspect beginnings) so she (in turn) could save her own species when it became isolated on this planet. In the end she is victim, as opposed to being saved, but even then she may be saved from suffering. Russ's inspired irony carnivalizes the story of rescuing/saving the female child in all its western, white, imperialist arrogance, but

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17 Ibid, 44.

also reduces Lori's extreme (good *and* bad) luck to arbitrary events outside a political context.

Another specific 'anti-utopian' feature of *We Who Are About To...* is found in Russ's portrayal of violence. Russ identifies speculative utopias as reactive and very limited in violence. However, interpersonal violence between women and men resulting in the death of the man is often a focus of her own work. Feminist utopias generally shift violence out of the sphere of women's desire and power, but Russ embraces it and explores its narrative complexities. Critic Jeanne Cortiel points out three strands of narrative values connected with violence in Russ's fiction. Firstly, the female hero of the Alyx stories is an exceptional woman whose violence is instinctive and personal; secondly, failing to kill men illustrates a lack of agency for women in texts such as 'When it Changed' and 'My Dear Emily'; and finally, murder is a way of regaining female agency in *The Female Man* and *The Two of Them.* However, there is also a carnival dimension to Russ's textual violence that Cortiel misses.

As well as having comic value, Rabelesian abuse, thrashings and beatings often represent a significant metamorphosis of power – the decrowning of kings. This is what occurs to the castaways as they experience their falls. They lose dignity, become physically vulnerable and are even pathetic. Alan-Bobby, the young footballer rushes into a dark cave and knocks himself out on a ledge. On a sports field his impetuosity could bring him rewards, in an unknown environment it is stupid behavior that results in his death. He is the admired athlete turned buffoon. Nathalie, the would-be government agent, and John Udon, the academic, fall off a ledge and die. Potential and ability snuffed out by more miscalculation, and a literal fall is symbolic for these two who appeared to have elevated social status. Valeria, like an overconfident villain in a TV script, commits the clichéd mistake of not shooting the narrator when she has the upper hand. Instead she delivers a standard just-before-I-kill-you speech that allows the narrator to use her ingenuity to turn the tables. All of this violence has comic content, but the fall of each of these individuals represents not only the demise of that individual. It also represents the bringing low of whatever social value they held as the sole representative of that group on the uncharted planet.

Little more than a novella, *We Who Are About To...* flies in the face of many narrative expectations. It is uncooperative and does not give pleasure to readers in traditional ways, unsettling them and undoing expectations on all generic levels as novel, as science fiction, and as utopian feminism. Often carnival is identified on the basis of content, looking at grotesque bodies or the language of the market place, but

the subversion of literary form itself has precedent in Rabelais who parodies written forms from sacred liturgy to 'les belles lettres' and scholarly treatises. This is a process that works to undo both historical and cultural authorities and demands a complex and tiered receptivity in the audience that relies on their recognition of form and recognition of deviation from that form.

Body, social identity and carnival

The way that Russ maps the physical bodies of her characters, the social body they have left behind, the social body they try and construct, and the planetary body they are so precariously perched upon, also reveal carnival. Representations of body and social identity are unpredictable as the text reconfigures power and relationship. Bakhtin reads carnival as subversions of social authority. Mary Russo reads it as subversions of certain naturalized authorities of gender, with attention paid to physical and social reconfigurations. Russo's political presentation of carnival, picking up on physical and social transgressions, subversions and distortions and reading them from a feminist perspective, is apposite for the genre of sf and Joanna Russ's text in particular. For example, the Grahams present as a conventional heterosexual couple but closer examination undoes this illusion.

Samuel Delany reads Valeria as coded masculine. Because she is rich and exercised patriarchal powers prior to being shipwrecked, she is not 'defined by biological sex but rather ...constituted by socioeconomics as a power structure ... what Foucault would call a biopolitical field'. Further, when the narrator and Valeria physically struggle and Valeria is killed when the gun goes off, Delany sees the struggle as the importance of both the fight and the murder, because the narrator is opposed to what Valeria represents. If this is true, the logical extension of this reading is that Victor is coded feminine. He groomed himself for a rich wife, subjecting himself to enhancing cosmetic surgeries and training himself to please to the point where he calls himself a 'whore', both a feminizing and debasing term. And if Valeria's death is about power (struggles), his is about vulnerability due to a problem with his heart, the organ usually associated with love, romance and femininity. Valeria and Victor are cross-dressed characters, practicing a social and cultural form of transvestism, who find this situation forces them back into more predictable roles. The reversal is reversed, and Valeria the financial mogul is uncrowned while Victor, the fool and whore, is raised up by virtue of his sperm.

We Who Are About To... hinges on a number of comic reversals, part of what Mikhail Bakhtin describes as the 'gay relativity of prevailing truths and authorities ... the peculiar logic of the 'inside out', of the 'turnabout', of a continual shifting from top to bottom, from front to rear, of numerous parodies and travesties, humiliations, profanations, comic crownings and uncrownings'.[18] Russ's text also offers carnival readings of cultural sites commonly representing safety and protection. Government training, formal education, money, family and even organized sport become liabilities or useless to the group of castaways.

The Cartesian body is divorced from the mind, closed, complete and problematically linked to the world, while carnival is preoccupied with the open, protruding and secreting body that participates in the cycles of nature. The carnival body is often seen in terms of its parts, particularly those parts that relate to the 'lower stratum', the bowels and the genitals, and it is fecund and excessive. The bodies in *We Who Are About To...* are affected by the romantic tradition, which divorces them from that fecund, excessive, regenerative power of the world, and they become 'dismembered'. However, on the untagged planet, there is an obsession with reproductive processes that isolates the genitals. In the absence of technology, human reproductive organs will take the place of tools – they will be used to dominate and control the environment. Nathalie and Victor's awkward mating speaks to the way that western modernism divides mind and body, and body and environment. The mind will control the body and the body, in turn, will control the planet – this disassociation is part of the social and cultural values that are lampooned in carnival. And there is a serious distinction between male and female genitals and the stories they have attached to them. Victor is an older, dying man but his genitals represent expansion, colonization and the hope for the future, a way of preserving life (human) through possible reproduction. Cassie, on the other hand, remarks that her chances of coming through childbirth at her age and with a family history of difficult births is not particularly good. While the narrator points out that biology is not destiny with regard to birth histories, Cassie's doubts forcibly remind the reader of the difficulties of birth in pre-technological culture. The female reproductive organs represent contraction, fear, limitation and potential death.

Liminal values are fore-grounded and can be understood much better in a carnival space, but carnival also allows illumination of dominant or official cultural values in unexpected ways. In this text, a tiny cross section of American culture has been

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18 Bakhtin, *Rabelais and His World*, 11.

transported onto an uncharted planet and with it come its very own cultural restraints, harassment and threats. While the threats and violence appear to be contained by the trappings of civilization, this is an illusion. The threats and constraints are not a force that civilization as we know it is counteracting, they actually represent *part* of civilization. The assumption that the urge of an isolated group to retreat to barbarism will be irresistible is yet another cultural story that makes up the carnival experience of the text. In *We Who Are About To...*, unlike Golding's *Lord of the Flies*, the layers of western culture are not being slowly stripped away to reveal elemental humans, minus their technology and comforts. Rather they are being stripped away in such a fashion as to reveal what westerners *believe* are the underlying imperatives of human biologies. In Russ's book, domination and sexual access are preoccupations, not necessarily of an essential psychophysiology, but of a cultural belief relating to psychophysiology. That is, when the colonizing story of the castaways was countered by a different, skeptical story, the responding anger and threats come from contemporary notions and beliefs about nature and survival, not from some base biology that is surfacing in the characters due to their predicament.

As the response to provocation in the book is deeply political, so is the original catalyst. The narrator stands as an unraveller, a character who refuses to collude with the other castaways' attempt to present their predicament as manageable and coherent in terms of the society they have left behind. Physically, she is a woman of late child-bearing age and that makes her compliance with the group a significant issue, but she does not/will not comply and mocks the group dreams of colonization. The narrator is an important carnival figure because she is more than a personal challenge to the castaways on this planet. She is a mythic and historical challenge to the world they came from as well - configured as a witch she takes possession of the 'broomstick', a small motorized flier, and she is equipped with a pharmacopeia of drugs. Being mythic and historical endows her a different kind of carnival presence, a more loaded and controversial presence.

Mary Russo's feminist emphasis in carnival critique is embodied woman, woman situated in opposition to the closed, classical body, woman as the grotesque. In contrast, Joanna Russ's most significant carnival character identifies herself as 'nobody' – no body. She is *dis*embodied and is the only character who really makes an escape in any physical or psychological sense. Her 'philobatic moment' sees her flying free, escaping the privileges, illusions and power abuses that have come to the planet with the castaways. All have the opportunity to do the same as the narrator, but she is

the only one that can imagine a space not governed by the social and cultural constraints they have always known. She is the only one who can truly understand the non-negotiability of a 'new world'.

A world, a planetary body, inspires respect and interest by virtue of its massiveness, its immeasurable bounty and appetites, its agency in the life and death of lesser entities, and its longevity. Bakhtin speaks to the medieval attempt to negotiate the hugeness of the planet in Rabelais' stories of Gargantua and his enormous son, Pantagruel. Everything is done in excess, particularly in times of birth, and everything eaten and drunk in enormous quantities. Gargamelle, Gargantua's mother, goes into labor with him after consuming a vast amount of tripe, and a caravan of wagons loaded with food follows Panatagruel from his mother's womb, while the child himself eats a cow's leg as if it were a sausage.[19] These carnival stories include death in the Rabelaisian tradition, but they inevitably become cyclical, stories of fecundity and renewal, connected to the European, seasonal understanding of the planet. Russ's text is carnivalesque in its refusal of high culture and comic in its awkward violence, but it holds a modernist view on death and this world is an ancient, sinister stranger. The castaways are surrounded by life, but there is no birth in this novel, there are only a thousand creative, terrifying, ironic ways in which to die:

> Think of Earth. Kind old home. Think of the Arctic. Of Labrador. Of Southern India in June. Think of smallpox and plague and earthquakes and ringworm and pit vipers. Think of a nice case of poison ivy all over, including your eyes. Status asthmaticus. Amoebic dysentery. The Minnesota pioneers who tied a rope from the house to the barn in winter because you could lose your way in a blizzard and die three feet from the house. Think (while you're at it) of tsunamis, liver fluke, the Asian brown bear. Kind old home. The sweetheart. The darling place.
>
> Think of Death Valley ... in August.[20]
>
> And:
>
> We died the minute we crashed. Plague, toxic food, deficiency diseases, broken bones, infection, gangrene, cold, heat, and just plain starvation.[21]

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19 Ibid, 220, 331.
20 Russ, *We Who Are About To ...*, 20.
21 Ibid, 46.

Bodies and social identities are mapped in sometimes unexpected ways in *We Who Are About To...* . Nothing of the physical or social is safe or stable and, in this carnival, death is a prominent character. This is a darkening of Rabelaisan carnival, one that Bakhtin sees as a move to the Romantic grotesque and a context of terror, but it is still carnival.[22]

Carnival and science

Major cultural discourses challenge and change both the sf genre and the inclusive, critical form of carnival. Russ's text lampoons not only perceptions of nature, but also perceptions of power over nature. The unstable position science holds in carnival is similar to the central but unstable position of science in sf. Science and technology are valorized in some sf texts and demonized in others. One day they will save the world, the next they will destroy it. In sf the emphasis is often on technology, but Russ understands that less materially manifest science stories can also drive fiction. In 'Towards an Aesthetic of Science Fiction', she reads entropy, a 'dreadful and agonising iron physical law', as central to H.G. Wells' *Time Machine,* and says Ursula Le Guin's story, 'The Masters', 'has as its emotional center the rediscovery of the duodecimal system'.[23]

Neither Russ's critiques nor her creative writing are innocent. Just as she writes about feminist utopias as an academic and then subverts them in *We Who Are About To...* , so she understands and subverts the science story that is at the heart of this novel. Neo-Darwinism is a combination of Darwin's theory of natural selection and molecular biology. The broad idea is that the fittest survive, though both fitness and survival are complicated concepts, and Neo-Darwinism is historically and politically troubled, particularly where it intersects with the newer discipline of sociobiology. While both paradigms have redeeming features, they are deeply marked with the politics of patriarchy, colonialism, environmental exploitation and eugenics, often failing to take into account the role played by culture over genes in creating particular behaviors, and the role played by culture in scientific understandings and perception.

Many feminist scientists in particular see problems with the reductiveness and determinism of neo-Darwinism and sociobiology. They argue that scientific researchers with their selective approaches, read such things as violence and male

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22 Bakhtin, *Rabelais and His World*, 38.
23 Russ, 'Towards an Aesthetic of SF', 112-3.

promiscuity as natural.[24] Joanna Russ, however, is a different sort of critic. She is a fiction writer utilizing knowledge imaginatively and critically constructing fictional scenarios that confront, resist and provoke.

That material circumstances limit genetic success and human ingenuity is something made clear in the baby bird story. As the narrator is dying, she hallucinates about her past and recalls time spent with a lover. They are woken one morning by the intense, hungry screeching of a nest of baby sparrows in the air-conditioner. The narrator's lover wants to kill the birds, possibly by piping boiling water over them. The birds' extreme vulnerability and their tenancy in an unnatural environment, one they were never designed to occupy, turn this story into a parable: membership of an aggressively populating species does not ensure individual, or small group success in a bad situation. The castaways' colonization program is a self-deception springing from cultural indoctrination and fear, rather than a biological imperative. The conclusion of the book reinforces this reading. Rather than the ultimate survivor being a wonderful physical and psychological specimen of humanity, it is a middle-aged woman, with swollen ankles and a bad attitude.

The narrator, the final member of the group left alive, is an apparent enigma. Does she represent authority or does she represent a knowledgeable and competent subversion of authority? She is a musicologist, but her knowledge is broader based than the study of music would imply. She is a failed resistance fighter, but she still has a lot of fight in her. Because the text is carnival, these instabilities do not resolve. In fact, they are compounded with other instabilities as the narrator continues to unexpectedly combine power and subversion. In a major Janus-like incarnation she is scientist and anti-scientist. This is not a contradiction, it is a reflection of the ambivalent history of science itself embodied by the narrator. Carolyn Merchant, ecofeminist theorist, discusses the roots of science in the early seventeenth century. Francis Bacon, a 'father' of modern science worked with James I after his coronation to destroy witchcraft in England and to set up science as a cultural project using the 'modern experimental method – constraint of nature in the laboratory, dissection by hand and mind, and the penetration of hidden secrets'.[25]. According to the period, which was pivotal in overseeing the original power shift from the feminine 'black

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24 Patricia Adair Gowaty, Sarah Blaffer Hardy and Ruth Bleier are just some of the feminist scientists who have worked with socio-biological stories and the issues of anthropomorphic and androcentric language, and masculinised bias in interpreting links between genes and behavior. See Chapters Three and Four of this thesis.
25 Merchant, *The Death of Nature*, 127-148.

magic' to the 'white magic' of science, witches were understood as servants of nature whereas science was a recovery of man's rights over nature.

This historic complexity is a key to Russ's narrator. She has access to the discourse of science, but she is ultimately a servant of nature. When describing their situation, she uses language taken from a scientific epistemology that no longer exists for the castaways, a language that she recognizes will inevitably fall away and become meaningless in time:

> We are (O listeners note) one quarter the height of the trees, we are hairless, give birth to our young alive, are bipedal with two manipulating limbs, have binocular vision, we regulate our internal temperatures by the slow oxidation of various compounds (food), and we live no more than a century at the very, very most (at least it feels that way, as the joke goes) and we are caught rather nastily, very badly, and sometimes even comically between different aspirations. That is the fault of the cerebral cortex.[26]

Her language reflects their recent understanding of the world, but she knows western science is not on their side and cannot be. This is presented in comical-satirical ways. For example, any benefits that might appear in the technology they have with them tends to be time limited - unrechargeable batteries, sealed powerpack, cast desalination unit, the winding watch that stops. Extinction, not evolution, is their very real bogey now. *We Who Are About To...* speaks strongly to theories of natural selection, genetic reductionism and deep time. It is a work about people, a cross section of culture, trapped not only by biology, but also by notions of biology. As the castaways struggle to come to terms with their predicament, scientific ideas that have almost become religious beliefs get in the way of understanding their situation. Science takes its place as one of the prevailing authorities that can be mocked and even dismantled in carnival, along with other cultural and social powers. Russ is iconoclastic, able to imagine stepping outside of what is known, capable of proposing that 'history may just end arbitrarily, without the consolation of meaning'.[27]

Conclusion

Carnival and sf go well together, particularly if the sf is subversive. They both allow many liberties of imagination and expression. *We Who Are About To ...* is not

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26 Russ, *We Who Are About To ...*, 20-21

27 Jeanne Cortiel, *Demand my Writing: Joanna Russ/Feminism/Science Fiction* (Liverpool: Liverpool University Press, 1999), 209.

roistering, Rabelaisan farce, but it is humorous. Much of the comedy is situational and dark: Lori's abysmal ignorance of her vulnerability, Alan-Bobby's recklessness, Valeria's need to grandstand, the forced intimacy of Victor and Nathalie, and so on. In this place where money and conventional knowledge are no longer currency, characters are so out of context it is as if they have been caught with their pants down. The narrator, on the other hand, is smart, wry and crafty, outwitting her companions at every turn. Other humor in the text is dependant on challenges to dominant cultural forms, discourses, and authorities. Novels, utopian dreams, sociobiology, natural selection, time and space are all touched upon and tested for their assumptions and possibilities. Boundaries, perspectives and subjectivities slip and slide in an unsettling story that prevents the reader from selecting one viewpoint, one understanding, one thematic thread. In the end a powerful, uncontained carnival image remains for the reader.

A central, fecund and morbid archetype from carnival also appears with the death of the narrator. The archetype is that of the 'pregnant hag', the grotesque twinning of death and birth that is the very *raison d'etre* of carnival. Utterly starved, 'skinny legs, big knees, hanging belly', the narrator produces a child in her hallucinations. The little girl is not a child she particularly liked, but one that was named after an airport and might be 'a gateway, a sign or a messenger'.[28] Moreover, while she reminds the narrator of the cycle of life and renewal, the narrator complains that she still doesn't understand. This is not surprising. The truth is the little girl is not even a remotely hopeful figure. Kennedy is already dead herself, her potential cut off at an early age. Her visit to the narrator is not a promise but an act of closure. The narrator and the reader are left with only one option for continuity: It is time for the narrator to become part of the planet, to let the 'kind hill' bury her.

The unfinished and open body (dying, bringing forth and being born) is not separated from the world by clearly defined boundaries; it is blended with the world, with animals, with objects. It is cosmic, it represents the entire material bodily world in all its elements.[29] This is an appropriate, deeply symbolic, psychospiritual finish to a twentieth century carnival text, but in this story it creates yet a new, final level of absurdity. This is not *the* Earth, but *an* earth that provides the ultimate resting place for the eight castaways. If human activity, individual and social, is satirized as insignificant against the indifferent majesty of nature when the species is at home and

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28 Russ, *We Who Are About To ...*, 166.
29 Bakhtin, *Rabelais and His World*, 26-7.

in its rightful context, how much more pretentious does human activity appear when it is enacted on the surface of an alien(ated) world?

CONCLUSION

Pathways between disparate modes of knowledge and awareness such as science and creative writing are not a well-worn part of the intellectual landscape, particularly when the task is to seek a synthesis between some aspects of the two. This thesis uses Bakhtinian carnival theory, various feminist science theorists and ecofeminist understandings to consolidate a connection between stories from evolutionary science and stories from feminist science fiction. The relationships between these apparently very different narratives are rich and complex, being necessarily interdisciplinary and necessarily concerned with specifics and larger generic issues of literature and science.

As the first chapter of this thesis suggests, genre is a moveable feast of perspective and is always heteroglossic in that it contains multiple discourses, or what Beebee refers to as 'use values'. History and modes of production of sf offer staple descriptions of the genre, as do certain academic critiques such as Suvin's notion of 'cognitive estrangement' and the 'novum', the introduced novelty that changes everything. However, where the genre defining/tracking process in sf becomes intriguing is in its reactivity and instability, and this occurs in two significant areas: the first is in respect to the dialogic nature of the genre as it is produced through the sf community, the second is in respect to the complicated relationship of science(s)/technology to the fiction.

The historical and current dialogic nature of the genre is unusual. In the sf community, readers, writers and critics speak to each other about social/cultural/scientific issues through community discussion, and frequently through the writing of the fictions, metafictions, critiques and other publications. Identities of all participants can change, depending on the speaking position they adopt; for example, writers, critics, fans and/or scientists can occupy any or all of these roles at any point, and they will all swap hats regularly as they speak/write (on) texts, the nature of the genre, and particular issues foregrounded in the writing. Identities can also be confused and have significant effects on the community and the dialogues. Specific instances are Sandy Sanderson, a man who posed as a feminist editor of an all female fanzine using the name Joan W. Carr in Britain in the mid 1950s, and Alice B. Sheldon, who wrote under the male pseudonym James Tiptree Jr. and participated in discussion on gender in the sf community as a male from the late 1960s to the early 1980s.[1] Thus, within this highly interactive, genre based community, authority has

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1 Lefanu, *In the Chinks of the World Machine* and Jeffrey Smith, ed. *Khatru 3&4: Symposium: Women in Science Fiction* (Baltimore: Phantasmicon Press, 1975). *Khatru* was the symposium

particularly unstable constructions, and odd accountancies occur – academics have to work hard to earn the respect of the fans, and vice versa, while writers may write fiction or non-fiction books in answer to other fiction or non-fiction books they have read, and relevant ideas under discussion are promulgated in the very different forms of conventions, fanzines, peer reviewed journals, scholarly books, historical collections, and so on.

The second area of volatility in the genre occurs around science. Science is taken as a given in identifying and constituting sf. However, while the word 'science' is often insisted upon in genre definition, science itself is a complicated discourse that includes technology and an ever growing range of disciplines, and no rules exist on the representations or integration of that broad and varied discourse with the fiction. For some critics and writers science is a complex political, ethical, cultural marker within sf, for others it is an unquestioned, information-based discourse that is supposed to be transported uninterrogated into the genre, for yet others science and the genre perform an observable material/textual reflexivity, such as in the Star Trek/ NASA relationship explored by Constance Penley.[2] The argument in Chapter One of this thesis looked at science through predominantly literary-based understandings of the genre that seek to read science in science fiction as a functional value, as well as an historic trope. The argument of the thesis extends Brian Aldiss' idea that the primal text of the genre was Mary Shelley's *Frankenstein,* and that Darwinism was a signal driver of that text, to contend that evolutionary science is central to most science fiction narratives. Thus the connections between interdisciplinary metaphors of change are built: evolutionary stories are complex stories of change in organism and environment, and they find a surprisingly close correlative in the notions of change in sf texts – in this particular dissertation, feminist sf texts.

The dialogia of sf communities and the presence of scientific evolutionary discourse as structural metaphor within the literature point to the need for a theoretical reading of the genre that can accommodate the multiple historic and current perceptions of the genre and potentialities of both kinds of narrative and can move

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on feminism that Tiptree, the masculine identity of Alice Sheldon, was asked to leave. See also Helen Merrick 'From Female Man to Feminist Fan' in *Women of Other Worlds: Excursions through Science Fiction and Feminism* ed. Helen Merrick and Tess Williams (Perth: UWA Press, (1999), 118-24.

2 See texts such as David G. Hartwell and Kathryn Cramer, ed. *The Ascent of Wonder: The Evolution of Hard SF* (New York: Tor, 1997); Robert Bly, *The Science in Science Fiction: 83 SF Predictions that Became Scientific Reality* (Dallas: BenBella Books, 2005); Lawrence M. Krauss, *The Physics of Star Trek* (London: Harper Perennial, 1995); Constance Penley, *NASA?Trek: Popular Science and Sex in America* (New York: Verso, 1997).

between the materiality of evolutionary science and the challenging imaginary of feminist sf. In this thesis, Bakhtin's carnival theory, combined with the feminist science critiques of Haraway and Barad, prove a productive way to open the seamed genres of both evolutionary stories and feminist science fiction stories. As a theory, it accommodates 'prevailing authorities' and their orthodox debates, together with the subversion of authorities and rebellious perspectives that repercuss in both contested science stories and in feminist sf writing. The instabilities of authority and multiple identities mentioned in the sf community can be presented effectively through carnival theory as multiplicities, shifts, contradictions and inversions. The same carnival reading can be applied to evolutionary science narratives with their unstable, multiple and transmogrified authorities. The material bodies of nature and the imaginary bodies of feminist sf are also unruly and irregular, expressing agency and building subjectivities in unexpected, theory challenging dimensions. This material subversiveness of the physical and imaginary body, evidence of a failure to control and suppress that which is normally considered grotesque and is monitored and contained by dominant understandings, is a significant part of the application of carnival theory in this dissertation.

Establishing the relationship of evolutionary science and sf, particularly with respect to 'post neo-Darwinist' theories and feminist sf, is the further process that constructs the larger argument of this thesis. The driver, however, of the overall argumentation process is the opportunity to propose and explore an ecofeminist politic in both forms of narrative. The ecofeminist politic requires 'in principle' understandings – tertiary level insights into a Mardi Gras of life and life context, changing life and life context, and the various narratives we have in science and in fiction that produce understandings of life, context and change.

Carnival is basically an unsustainable condition, as it exists beyond spaces of regulated order and recognised authority and flirts with the complete loss of boundaries that leads to terror and abjection in the post-Romantic world.[3] So, the question with a carnival analysis must be how the disrupted boundaries and subverted authority will eventually reconstitute themselves. This thesis argues that strong, centralised, domination stories (scientific and/or fictional) offer a nostalgic, patriarchal politic that cannot be simply recreated once it is exposed and interrogated. For example, so many inconsistencies and tensions are revealed in Darwinism and neo-Darwinism in Chapters Two and Three that it is difficult to imagine genuinely acknowledging these

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3 Bakhtin, *Rabelais and His World*, 39.

issues and then making an effortless return to reductionism and binary thinking. Looking at the many scientific discourses that connect to the evolutionary master narrative, and change notions of change, recognition of multiple agencies in the interactivity of organisms and environments and interdisciplinary accounts of the world appear unavoidable. In other words, competition driven neo-Darwinist reductionism is only one model of transformation and is rigid in its notions of selectionism, gradualism and the boundary between organism and environment. Whereas an ecofeminist model could contextualise this model, and then take into account the many scientific stories of change and address the culturally relentless Western 'otherings' found in science and writings that use science as a significant discourse.

Reperceiving evolutionary science as a culturally based as well as a scientifically based meta-discourse with a potentially overarching politics of difference forms a position from which to engage both the field and the many contributory stories that comprise evolutionary discourse. Chapters Two and Three consider Darwinism and neo-Darwinism as deeply conflicted stories that have grown through scientific resistance, scientific development, religious resistance and more scientific resistance. The focus of these chapters is on the carnival dimensions of traditional evolutionary science: the entwined cosmological stories of creation presented by evolution and fundamental Christianity; the unravelling power of the theory of punctuated equilibrium; the ambiguous academic authorities of scientists constructing interdisciplinary, gene-based stories; and the challenge to objectivity with respect to subjects of study. Carnival theory identifies and accepts all these stories for their humour, subversiveness, monstrousness and material and textual bodies of difference. An ecofeminist reading through Chapters Two and Three identifies the same stories, but recontextualises the domination politics of reductionism, dualism, anthropocentrism and the habitual separations of organism/organism and organism/environment. Rather than giving competition and the gene pre-eminence, an ecofeminist reading incorporates it as one complementary story in an evolutionary grand narrative of mutiple agencies and fields.

Chapter Four considers the only feminist story of human evolution from primate stock, and provides a sort of bridge between the mainstream ideas discussed in Chapters Two and Three and the 'post neo-Darwinism' of Chapter Five. The aquatic ape is the grotesque feminine that directly challenges man-the-hunter in the human evolutionary carnival. On the beach, she wades in the shallows, looking for food for

her highly dependent, over-vocalising young as her oestrus cycles move into a lunar, tidal pattern and her body becomes hairless and streamlined. Elaine Morgan's Aquatic Ape Theory reconceives the body and the environment of the prehominid, and proposes a rapid fire, neo-Darwinian plasticity to the organism during a Miocene window of opportunity. The AAT is a powerful mix of old and new ideas, moving the evolving human through changing geology and ecologies using stress and selection. It is a polyvocal, multidisciplinary, politicised and open-ended narrative, a combination that upsets more conventional human origin stories. In the shift from a carnival reading to an ecofeminist reading of the AAT, the internal ecologies of the prehuman body and the ecologies of the physical environment are examined through a number of dialogues with science. Biochemistry, palaeontology, virology, geology and ecology are included in the cross-disciplinary dialogues, sometimes initiated by Morgan and sometimes initiated by interested scientists. These stories destabilise masculinist stories and permit carnival and ecofeminist readings of this particular narrative that actively seeks a reappraisal of patriarchal monologic models of expression.

The post neo-Darwinist theories of Chapter Five extend the historical body of organisms from the prebiotic cell to the homeorrhetic planet. Various disciplines that produce evolutionary science also produce an open, irregular, carnivalised body: macromolecules with qualities of interactivity and 'self-organisation'; the incorporated, symbiogenetic body of Serial Endosymbiosis Theory; the contextualising planetary body of panbiogeography, with its agented bodies of continent, mountain range, atoll, river and so on. These are some of the many stories of evolution that constitute the carnival of science and body. And while carnival celebrates the extraordinary and different and takes pleasure in the subversive, ecofeminism refuses to continue the divide between life and life, animate and inanimate and insists on geographical, biological and theoretical ecologies. Karen Barad puts the case for acknowledging the materiality of such ecologies succinctly:

> Phenomena are produced through agential intra-actions of multiple apparatuses of bodily production. Agential intra-actions are specific causal material enactments that may or may not involve "humans." Indeed, it is through such practices that the differential boundaries between "humans" and "nonhumans," "culture" and "nature," the "social" and the "scientific" are constituted. Phenomena are constitutive of reality. Reality is not composed of things-in-themselves or things behind-phenomena but "things"-in-phenomena.

> The world is intra-activity in its differential mattering. It is through specific intra-actions that a differential sense of being is enacted in the ongoing ebb and flow of agency.[4]

In terms of popular accessibility, reductionist stories are strong – in terms of looking at the world as connected, simultaneous, historical and complex, reductionism is obviously insufficient. The feminist sf writers considered in the case studies of Chapters Six, Seven and Eight of this thesis write into this awareness. As they carnivalise bodies and social and cultural phenomena, they also carnivalise current evolutionary science and use 'post neo-Darwinist' metaphors of change in their stories. Tiptree, subversive comic genius, takes symbiogenesis to the stars; Slonczewski, genetic scientist, expresses multiple metaphors of scientific and cultural change, but situates ultimate power with the intelligent microbe; Joanna Russ, critic and carnival writer, savagely satirises patriarchal stories of dominance and colonisation and leaves the final word to the grand endurance of the planet.

Carnival is an unnerving theory. It can produce humour, but as Bakhtin says when he discusses carnival and romanticism, and Russo says when she discusses carnival and the feminine grotesque, it can also produce dangers and terror. Loss of authority and boundaries is frightening, but this thesis argues that the compromise of boundaries in carnival is not just frightening, it may also be shadowed by a hopeful politic of difference that proposes new perspectives and new unities across very different disciplines. Undoing the Darwinian hero narrative of genocentric evolutionary science opens up evolutionary science's 'other' narratives of change for consideration, and suggests a new ecofeminist metanarrative. The continuing relevance of that metanarrative relies less on scientific exclusivity and more on a multidisciplinary approach, less on dominating nature and more on contextualising humans within nature, less on monologic interpretations of the world and more on partial and multiple stories, less on anthropocentrism and more on multiple subjectivities and agencies. Insisting on the importance of both cultural and scientific threads of such a metanarrative opens up further rewritings of evolutionary history and encourages the feminist science fictional imagining of more politically inclusive futures.

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4 Barad, 'Posthuman Performativity', 817.

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